ALPHA-6A-1 Alpha Air Monitor Technical Manual

Eberline *A subsidiary of*
Thermo Instrument
Systems Inc.
P.O. Box 2108
Santa Fe, New Mexico 87504-2108
(505) 471-3232 FAX: (505) 473-9221

ALPHA-6A-1

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS


Alpha
Eberline
7
8
9
4
5
6
1
2
3
0

SECTION 1. INTRODUCTION

A. GENERAL DESCRIPTION

The ALPHA-6A-1 is a continuous alpha air monitor which, if properly configured, will calculate the activity due to particular isotopes. It accomplishes this using a 256 channel analyzer and a set of parameters and equations which accurately measure activity by subtracting out counts due to other isotopes. In addition, the ALPHA-6A-1 archives historical data, checks for alarms and responds to user commands.

The ALPHA-6A-1 comprises a detector assembly, a 256 channel analyzer, two 8-bit microprocessors, a dot matrix liquid crystal display, a twenty key membrane keypad, a mass air flow sensor, two serial ports, a real time clock, a lithium battery, a rotating beacon, a bell, a beeper and external alarm and failure contacts.

B. SPECIFICATIONS

1. Mechanical

   Size: 15" wide x 13 3/4" high x 12-1/2" deep

   Weight 15.4 lbs. (7.0 kg)

2. Environmental

   Operating Temperature: 0 C to 40 C (32 F to 104 F)

   Storage Temperature: -20 C to 60 C (-4 F to 140 F)

3. Electrical

   a. AC Power

      120/240V, 50/60 Hz at 1/2 amp maximum (during alarm). A plug-in circuit board in the AC input module is used to configure the instrument for either 120 or 240 volt operation.

   b. Battery

      The lithium coin cell battery will operate the real-time clock and preserve data for five years or more if a power failure occurs or if the instrument is turned off.

   c. Relay Contacts

      The alarm and fail relay contacts are accessible at rear panel terminal boards (SPDT) and are limited to 1 amp, 120 Vac.

4. Radiological

a. Detector

Silicon diffused junction type, area = 490 mm^2, diameter = 25 mm

b. Filter/Filter Holder

1) Standard Two Inch Holder

This holder is designed to use a 47 mm diameter filter. Millipore ^{R} SM, 47 mm, 5 micron is recommended.

2) Optional One Inch Holder

This holder uses a 25 mm diameter filter. Millipore ^{R} SM, 25 mm, 5 micron is recommended.

3) In all cases, an air flow rate of one cubic foot per minute (cfm) is recommended.

c. Counting Efficiency

Approximately 45% of 2Π (gross count) from a plated one inch diameter active area ^{239}Pu source in the filter holder. The efficiency is about half that amount when an unmasked full diameter source is used in the large filter holder.

d. Max Counts

The detector processor (P2) can store up to 16,000,000 counts per channel in its internal memory. The maximum total count for any region is 100 million.

e. Maximum Count Rate

The maximum gross alpha input pulse rate is approximately one million pulses per minute (PPM). The average processing time (dead time) for each pulse varies according to the pulse amplitude. The dead time loss for a one million PPM rate is approximately 25% at channel 50 (20 microsecond dead time) and 37% for channel 255 (35 microsecond dead time).

5. Serial Ports

The ALPHA-6A-1 supports two RS-232C serial communication ports; a printer port and a remote port for communicating with an external device. The printer port is dedicated to ASCII protocol but either ASCII or binary protocol may be selected for the remote port. Both ports have configuration parameters associated with them which are given default values upon start-up. These parameters may be edited by the operator. See Section III.D. and Appendix A for port configuration details.

6. Other

a. Computers

Two 8-bit 80C31 microprocessors. Processor number 1 (P1) has 64K EPROM/64K RAM. Processor number 2 (P2) has 32K EPROM/32K RAM. P1 functions as the main processor. It is primarily responsible for acquiring the spectrum from P2, using the data to calculate values, archiving data at regular intervals, interfacing with an operator and checking for alarms. P2 is referred to as the detector processor. It is dedicated to receiving incoming counts from the detector and to sorting them according to pulse height to form a 256 channel spectrum. The processors communicate over a dedicated serial bus at 187.5K baud using Intel's uLAN mode of interprocessor communication.

b. Air Flow

The recommended flow rate is one cfm through the one inch diameter center of the filter. A mass air flow measurement system continuously measures flow in the range 0.5 to 2.0 cfm with an accuracy within 10%, precision within 2%.

c. Display

256 x 64 dot matrix, liquid crystal display.

SECTION II. INSTRUMENT OPERATION

A. OVERVIEW

When an alpha particle strikes the ALPHA-6A-1 detector surface, the detector circuit generates a pulse signal. The amplitude of the pulse is proportional to the energy of the alpha particle as it strikes the detector. The signal is fed to a 256 channel pulse height analyzer which generates a digital value representing the pulse amplitude. This digital number is read in by processor 2 (P2) and P2 increments a counter which is designated by the amplitude of the incoming signal. There are 256 such counters, each one representing a channel. Over time, an energy spectrum evolves and this information is sent to the main processor (P1) for analysis.

P1 is responsible for the overall operation of the monitor. It polls P2 for spectral data at regular intervals and then uses the data in equations to calculate activity and other values of interest. P1 archives both spectral data and calculated values in history files and continuously checks for failure, alarm and warning conditions.

The ALPHA-6A-1 will display spectral data or history file data, each of which is presented in a graphical format and updated at regular intervals. In addition to the graph, the operator is presented with information which includes the monitor status, the date and time and air flow rate.

Upon request, the ALPHA-6A-1 will present a series of menus which allow the operator to perform a variety of tasks. These menus allow the operator to set the date and time, view history files, check monitor status, change alarm points and more.

The monitor continuously scans for keyboard input and for remote port input Upon receipt of a command from either location, P1 will decipher the command and perform the task specified. Most tasks may only be performed by operators with security access. See Section II.D. for details.

The MENU and VIEW keys are special high priority keys. When MENU is pressed, the display will always return to the highest order menu list. When VIEW is pressed, the display will always return to the most recently selected graphical presentation. (Alarms and warnings, if any, will be acknowledged first when these keys are pressed.)

B. DISPLAYS

The ALPHA-6A-1 presents the operator with two types of graphic displays. The first type is a spectrum display which presents the entire spectrum or portions of the spectrum called regions of interest (ROIs). The second type simulates a strip chart and presents a graph of an alarm variable and its reference value (alarm point) versus time.

The power-up default display is a spectrum display of Region 0, all channels. To choose another spectrum display, the operator must press the VIEW key followed by the region number desired. If the region selected does not exist, the monitor will display “Not Defined”. If the region does exist, the monitor will clear the display, present a graph of the new region and update the text information on the left.

To choose a strip chart display, the operator must press the VIEW key followed by the "." (decimal) key and the strip chart number. (For example, [VIEW] [.] [4]). The strip charts are numbered 1 through 6 and correspond to alarm set points 1 through 6. If the strip chart selected (1 through 6) does not correspond to a defined alarm set point, the monitor win display "Value Not Defined" or "Parameter Not Recognized". If the alarm set point is defined, the monitor will clear the display, plot graphs of the alarm variable and its reference, (alarm point) and will display text information to the left of the chart.

The latest display selected becomes the new default one. It will be the one displayed when returning from menu operations.

1. Spectrum Display

The spectrum display presents spectral data in graphical format with channel numbers along the horizontal axis and channel counts along the vertical axis as shown in Figure 2-1. The display also presents information to the left of the graph which includes the current time and date, the monitor status, the air flow rate, the region number, the total counts in the region, the cursor location and the counts in the cursor channel. The cursor is located just below the horizontal axis of the graph. The cursor control keys on the keypad may be used to view portions of the spectrum, to "zoom" in on an area of interest, to define or delete a region of interest, and to display the counts present in individual channels.

a. Cursor Movement

The cursor can be moved to any channel being displayed by using the left and right arrow keys. As the cursor is moved, the information located to the left of the graph is updated to show the channel where the cursor is located and the counts which have accumulated in that channel. The user may hold down an arrow key to cause the cursor to proceed more rapidly along the axis until it reaches the channel desired. Another method of cursor movement is as follows: Press the CH[ ] key followed by the channel number desired and the ENTER key. This will cause the cursor to "jump" immediately to the channel specified. If the channel selected is not on the graph the cursor will not move.

b. Viewing a Region of Interest (ROI)

While in the spectrum display mode, a graph is on the display at all times. Upon start-up a graph of the entire spectrum is displayed. This is the graph for Region of Interest 0. Region 0 is always defined as Channels 0 through 255. It may not be re-defined or deleted. There are a maximum of nine other regular ROIs (plus one temporary ROI) and the user may view any "active" ROI by pressing the VIEW key followed by the region number desired. An ROI is "active" if it has been previously defined (see the next section). Once the user chooses an ROI the graph for that region will be displayed and will remain on the display until the user selects another region or exits the spectrum display mode.

c. Defining a Region of Interest

A region of interest is a series of consecutive channels treated as a unit. An ROI is defined by its lower and upper channel boundaries. The original power-up default configuration automatically defines 8 of the 9 remaining regular regions of interest. (Region 0 is always permanently defined from channel 0 through 255. No history files are maintained for region 0.) These regions (numbered 1-8) are set-up for the detection of ^{239}Pu and should not be altered without careful consideration. However, these regions may be re-defined or defined as shown below if the user has security access. See the section on "Security".

1) Choose the lower channel boundary. This channel must be included in the graph presently being displayed.

2) Move the cursor to the channel chosen (see "Cursor Movement" section).

3) Press ENTER to anchor the lower boundary.

4) Choose the upper channel boundary. This channel must also be included in the present graph.

5) Move the cursor to the channel chosen.

6) Press SAVE followed by the region number desired. The new region will be displayed.

NOTE

The upper boundary may be defined first followed by the lower boundary if desired. Also regions may overlap or encompass other regions.

The region of interest specified is now defined as the region including all the channels in between and including the two boundary channels entered. A history file will be kept on this region and this region may be displayed and printed. Once a region is defined, the definition is retained in the event of power failure or when the instrument is turned off.

Example: While viewing region 0, define region 9 to extend from channel 80 to channel 121.

1) Press "CH[ ]"

2) Press 8

3) Press 0

4) Press "ENTER" to move the cursor to 80

5) Press "ENTER" again to anchor one end of the intended region

6) Press "CH[ ]"

7) Press 1

8) Press 2

9) Press 1

10) Press “ENTER” to move the cursor to 121

11) Press “SAVE”

12) Press 9

The new region will be displayed.

d. Temporary Region

The user can “zoom” in on any portion of the graph by setting up a single temporary region as follows:

1) Press CH[ ]

2) Enter the channel number of the first boundary desired. (This channel must be included in the present graph.)

3) Press ENTER (the cursor is positioned at the lower boundary.)

4) Press ENTER again to “anchor” the first boundary.

5) Press CH[ ]1

6) Enter the channel number of the second boundary desired. (This channel must be included in the present graph.)

7) Press ENTER (the cursor is positioned at the second boundary.)

8) Press VIEW (or press SAVE)

9) Press ENTER

The current graph will be erased and replaced with a graph of the region specified by the two boundaries entered. The region will be numbered 10. The user may now use the cursor to scan the counts accumulated in each channel of the region shown. The only difference between this “temporary” region and the others is that no history files are generated for it. Once established, region 10 may be recalled at any time by pressing VIEW, ENTER. This temporary region definition is also saved during power down conditions.

e. Printing Region of Interest Data

If any region is being viewed and if a printer is connected to the ALPHA-6A-1 the channel data of any active region may be printed by pressing PRINT followed by the region number. If a printer is not connected or is not responding, the ALPHA-6A-1 program will timeout in approximately 20 seconds and return to normal operation.

f. Deleting a Region of Interest

The user may delete any region of interest (except Region 0) if security access has been attained (see Section II.D. on Security). The user should be forewarned that the default configuration uses Regions 1 -7 for ^{239}Pu calculations. To delete an active ROI define that region as extending from channel zero to channel zero as follows:

1) Press VIEW

2) Press 0 (the graph for Region of Interest 0 is now being displayed.)

3) Press CH[ ]

4) Press 0

5) Press ENTER (the cursor is positioned at channel 0)

6) Press ENTER again to anchor the cursor

7) Press CH[ ]

8) Press 0

9) Press ENTER

10) Press SAVE

11) Press the number of the region to be deleted. (To delete the “temporary” region, press ENTER at this step.) Once a region is deleted it cannot be viewed and its history files are no longer maintained. Deleting an unused region will conserve computer time and provide for faster keyboard response and faster communications.

2. Strip Chart Display

The strip chart display presents side-by-side graphs of a selected alarm variable and its reference (alarm point) value versus time as shown in Figure 2-1. (Strip charts are obtained by pressing [VIEW] [j [1 through 6].) If the alarm variable is a history variable, the monitor will plot its 64 point one-second, one-minute, one-hour or one-day history file from left to right, beginning with the most recent data point on the left. If the alarm variable is not a history variable the monitor will plot its current value as a straight line. See Section III.C. for a description of history files.

The reference value (alarm point) may be a fixed alarm limit or a variable. If it is fixed, the monitor will plot a straight line at the constant value. If the reference is a variable and also a history variable (or a multiple of a history variable), the monitor will plot the reference line based on data from the 64 point history file, otherwise it will plot its current value (or multiple) as a straight line.

Two pointers are shown alongside the left edge of the graph. They are used to help the operator distinguish between the graph of the alarm variable and that of the reference value. The alarm variable is plotted using a solid line and is pointed to by the solid arrow. The reference value (alarm point) is plotted using a dashed line and is pointed to by the "clear" arrow. The pointers are up-dated at each update interval.

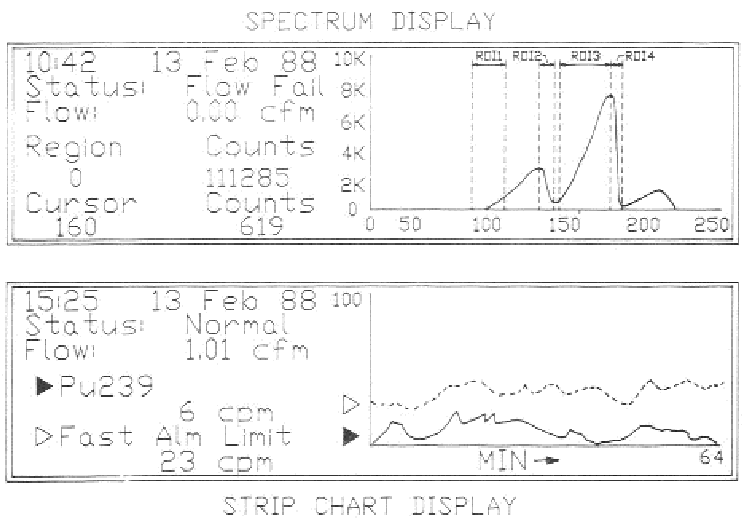
A legend to the left of the chart lists the alarm variable name and its value alongside another solid arrow and the alarm set point name and its value alongside another clear arrow. This helps the operator to determine at a glance if the alarm variable has tripped an alarm and how it has related to an alarm level over a period of time.

If the alarm variable is a history variable, the time detail of the file will be displayed just below the horizontal axis. The monitor will plot the one-minute history file by default but the operator can change the default by using the left arrow or right arrow keys. The left arrow selects shorter times, days to seconds, and the right arrow selects longer times, seconds to days. Alternately, the PREV and NEXT keys may be used to change the times. The PREV key is used to scroll from seconds to minutes to hours to days and the NEXT key to scroll from days to minutes to hours to seconds.

The strip chart display uses data stored in the history files regardless of when the data was placed in the files. If the ALPHA-6A-1 has been turned off for a period of time, the strip chart display may show current data in a continuous line with old data. Viewing the history files will show the date-time stamp for each fine of data. See Section 11I.C.1.

The strip chart display does not have a cursor associated with it and the strip chart itself cannot be printed. However, the operator does have access to history file data via the DATA INQUIRY menu (Section II.C.1).

Figure 2-1. ALPHA-6A-1 Displays



C. MENUS

The ALPHA-6A-1 presents a series of menus which allow the operator to perform a variety of tasks. The operator may use the menus to view history files, print history files, view monitor status, print monitor status, set alarm parameters, set user constants, stop, start and reset P2 counters, set the date, set the time, set the printer and remote port protocol, load the default configuration, enter the access code and edit the access code. The "Menu Selection Table" (Table 2-1) gives an overall view of the menu structure and the key sequences required to perform the tasks listed above.

The operator enters the menu mode by pressing the MENU key. Once in the menu mode, the main menu shown below will be displayed:

[1] DATA INQUIRY
[2] ALARM/COUNTER CONTROL
[3] SYSTEM SET-UP
[4] SECURITY ACCESS
MENU: 0000

The security code entry is required for operations under [2] and [3] above.

1. Data Inquiry

The operator may choose to view a history file for any of the history variables which include 5 user-defined variables, 9 regions of interest and the sample flow volume. The operator may also choose to view the current monitor status. After selecting "DATA INQUIRY" from the Main Menu display, the operator will be presented with the following sub-menu:

[1] VIEW USER VARIABLES
[2] VIEW REGIONS OF INTEREST
[3] VIEW SAMPLE VOLUME
[4] VIEW MONITOR STATUS
MENU: 0001

If the operator chooses menu item 1, the monitor will display a sub-menu which lists five user variables by name. If the user re-defines these variables, (via the remote port), he must be sure to rename the variables and specify the units appropriately so that the user-variable menu is readable and correct (see Section III.A.4. for details).

After selecting a user variable, the monitor will display the time detail menu. This menu allows the operator to select the one-second, one-minute, one-hour or one-day history file for the variable chosen. For example, with the default configuration, the operator may view the one-hour history file for plutonium activity (Pu239 cpm) by entering the following key sequence; MENU, 1, 1, 1, 3. Plutonium activity is a variable assigned by the default configuration.

The operator may also choose to view a history file for one of the 9 regions of interest. The operator must select a region of interest desired followed by the time detail desired. This is accomplished via a set of sub-menus very similar to those used for viewing a user variable history file. For example, the operator may view the one-minute history file for region of interest 4 by entering the following key sequence; MENU 1, 2, 4, 2.

The operator may choose to view a history file for time-integrated flow volume by selecting “VIEW SAMPLE VOLUME” followed by a selection from the time detail menu.

While the monitor is displaying any one of the history files it will respond to a special subset of keys as follows. The PRINT key may be used to obtain a hard-copy of the file being viewed. The PREV key may be used to scroll back through the history file from the most recent data point to the oldest data point. The NEXT key is used to scroll from older data to newer data. The operator may also use the up and down arrow keys to scroll through the file one data point at a time.

The monitor continuously checks for failure, alarm and warning conditions. However, due to the lack of space available on the status fine of the display, the monitor is only able to post one condition at a time. To obtain a more detailed account of the current monitor status, the operator can choose to “VIEW MONITOR STATUS”. The monitor will list every failure, alarm and warning condition along with a phrase which indicates if the condition is normal or not. This status display is continuously updated and may be printed out be pressing the PRINT key while the status is showing on the display.

2. Alarm/Counter Control

If the operator selects “ALARM/COUNTER CONTROL” from the main menu, the following sub-menu will be displayed:

[1] SET ALARM PARAMETERS
[2] SET USER CONSTANTS
[3] STOP COUNT
[4] START COUNT
[5] RESET COUNTERS
MENU: 0002

If the operator selects “SET ALARM PARAMETERS”, the monitor will display a list of the defined alarm set points. The “Menu Selection Table” (Table 2-1) shows the names of the alarm set points defined by the default configuration which include flow fail, noise, fast alarm, slow alarm, flow alarm, and concentration. If the user has re-defined the alarm set points (via the remote port), the names which appear in the alarm parameter sub-menu will be the new names assigned by the user.

The alarm parameters which are edited via this menu are actually the scale factors or alarm constants (ALARM(n).SCALE) associated with each of the 6 alarm set points. (See III.B.2. and Appendix A). The operator must first select the set point desired. The monitor will respond by displaying the current value of the scale factor for the alarm set point selected. The operator may edit this value using the numerical keys to specify the new value, the BACK SPACE key to back up if necessary and the ENTER key to replace the old value of the parameter with the one just entered. It is important to note that the left and right arrow keys may not be used to move the cursor while editing. These keys are used to enter the numbers 4 and 6.

To edit a user constant, the operator must select “SET USER CONSTANTS”. The monitor will respond by displaying a menu which lists the names of the user constants being used. The default configuration uses 4 of the 5 constants which include the nominal air flow rate, the spectrum acquisition interval, a Pu constant used by the plutonium algorithm and a detector efficiency constant used to calculate concentration. These constants may be edited in the manner described for the alarm parameters.

If the operator selects “STOP COUNT”, the counters in P2 will be stopped and the P2 HALTED warning condition will be annunciated immediately. The “START COUNT” menu item allows the operator to re-start P2 counting and to clear the P2 HALTED condition.

If the operator selects “RESET COUNTERS” and then presses ENTER to confirm it, P2 will reset all 256 channel counters which in effect zeros the spectrum. The air flow volume register will also be reset to zero.

3. System Setup

If “SYSTEM SETUP” is selected from the main menu, the following sub-menu will be displayed:

[1] SET DATE
[2] SET TIME
[3] SET PRINTER PROTOCOL
[4] SET REMOTE PROTOCOL
[5] SET AUTOLOG INTERVAL
[6] LOAD DEFAULTS
MENU: 0003

Menu items 1 and 2 allow the user to set the date and time respectively. If “SET DATE” is selected the monitor will display the date. If the date shown is incorrect the operator may edit it using the numerical keys, the BACK SPACE key and the ENTER key. The BACK SPACE key may be used to back up the cursor if necessary. The left arrow key cannot be used for the purpose since in this context it represents the number 4. The numerical keys are used to enter the new date. The cursor will automatically skip over the separator character “/” as necessary. The ENTER key should be pressed when the new date has been entered correctly. This causes the old date to be replaced with the new. If “SET TIME” is selected, the monitor will display the current time and the operator may edit it in the same manner. (The clock is set to the new time precisely when the ENTER key is pressed. The clock displays its exact time when the 2 key is pressed for [2] SET TIME above.

When the “SET PRINTER PROTOCOL” or “SET REMOTE PROTOCOL” menu items are selected a sub-menu will be displayed which lists baud, parity, data bit, and stopbit and term (termination). The REMOTE menu also lists echo, protocol, and address. The operator selects the parameter to be edited and the present value or status is shown. Pressing the “NEXT” key shows the choices available. (Numerical values may be entered directly from the keyboard, if desired.) Pressing the “ENTER” key selects the parameter.

When menu item 5 is selected, a sub-menu will be displayed which lists the 5 user variables. After a user variable is selected, the display will indicate the current logging interval for that variable - The operator may then use the “NEXT” key to step through the choices available and the “ENTER” key to select the interval desired. For example, the operator may view the current auto-logging interval for the third user variable by entering the following key sequence: MENU, 3, 5, 3. The operator may then select a new interval or exit by pressing the “MENU” or “VIEW” key.

The “LOAD DEFAULTS” menu. item forces the main processor, P1, to perform a cold start which loads the default configuration, zeros all history files and channel registers, and resets all parameters to their default values. See the “Default Configuration” section for details. If this menu item is selected, the operator will be prompted as follows:

LOAD DEFAULTS? PRESS ENTER TO CONFIRM

If yes, press ENTER If no, press any other key.

The operator must press ENTER before a cold start will be performed. This prevents the operator from inadvertently altering monitor configuration parameters and history file information.

4. Security Access

If the operator selects “SECURITY ACCESS” from the main menu, the monitor will display the following sub-menu:

[1] LOG ON
[2] EDIT ACCESS CODE
[3] LOG OFF
MENU: 0004

If an operator wishes to perform any task other than viewing or printing data, the correct security access code must first be entered. To log on, the operator must select menu item 1, enter the correct 4 digit code and press ENTER. From that point on, the operator will have access to all menus and functions. Once the monitor set-up is complete, the operator may want to “LOG OFF” to prevent further access to monitor parameters. The “EDIT ACCESS CODE” menu item is used to change the security access code to a different 4-digit number. This of course may not be performed unless the operator has previously entered the current access code.

While operating in the menu mode, the VIEW, PREV and MENU keys have special functions. The VIEW key allows the operator to return to the default display from any menu or display within the menu structure. The PREV key is used to backup through a series of sub-menus, all the way back to the main menu or the default display if desired. The PREV key is used in a different context when viewing a history file or strip chart. See the “Data Inquiry” and “Strip Chart Display” sections for details. The MENU key may be used to return to the main menu from any sub-menu in the menu structure.

D. SECURITY

The ALPHA-6A-1 security access system is based on a 4-digit access code which is set to a default value of 1287 when the monitor is shipped from Eberline. Once the customer receives the monitor an authorized operator should immediately edit the code to a new 4-digit value. (Once set, the code is in effect, until changed again or until “LOAD DEFAULTS” is selected from the SYSTEM SETUP menu. Power outages do not effect the code.)

The operation of the ALPHA-6A-1 is entirely dependent on a set of operating parameters which if changed would immediately affect the monitor's ability to measure alpha activity in air and to alarm. Consequently, the ALPHA-6A-1 protects itself by requiring the operator to enter a code before allowing access to certain menus and functions.

An un-authorized operator can perform a limited set of tasks which include viewing or printing a spectrum display, a strip chart display, the current monitor status and history file data. This operator may also acknowledge audible alarms but will not be allowed to perform any task that might affect the operation of the monitor.

An authorized operator can access all menus and functions after correctly entering the code via the SECURITY ACCESS menu (see Section II.C.4.). In addition to viewing data, the operator can set alarm parameters, set user constants, define regions of interest and user variables, control P2 counters, set the date and time, set printer and remote port protocol, load the default configuration and edit the access code.

If the access code is lost and cannot be produced, the default code, 1287, can be restored by totally erasing the RAM used by P1. This will, of course, erase all history files so any data needed should first be recorded. To erase the RAM:

1. Set the ALPHA-6A-1 power switch to OFF.

2. Remove the cover. (Four screws.)

3. On the main board, slip a thin insulator between the battery and the battery contact clip.

4. Short the VBATT fine to ground using a jumper wire. VBATT is found at A34-18, ground at A34-9. Alternately, short both leads of C23 together using a screwdriver blade or similar device.

5. Remove the shorting device.

6. Remove the battery insulator.

7. Plug the bell and beacon connectors into the receptacles (J203 and J204) on the power

8. Set the power switch ON.

The default access code, 1287, may now be used.

TABLE 2-1. MENU SELECTION TABLE

MAIN MENU	SUB MENU 1	SUB MENU 2	SUB MENU 3
[1] DATA INQUIRY	[1] VIEW USER VARIABLES	[1] Pu239 cpm*	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[2] Pu239 counts*	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[3] Concen pCi/LPu*	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[4] Noise counts*	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[5] Sigma cpm*	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
	[2] VIEW REGIONS OF INTEREST	[1] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[2] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[3] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL

* Indicates a name which may be edited through the remote port.

MAIN MENU	SUB MENU 1	SUB MENU 2	SUB MENU 3
		[4] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[5] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[6] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[7] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[8] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[9] CH[----]	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[3] VIEW SAMPLE VOLUME	[1] 1 SECOND DETAIL [2] 1 MINUTE DETAIL [3] 1 HOUR DETAIL [4] 1 DAY DETAIL
		[4] VIEW MONITOR STATUS	
[2] ALARM/ COUNTER CONTROL	[1] SET ALARM PARAMETERS	[1] Flow Fail* [2] Noise* [3] Fast Alm* [4] Slow Alm* [5] Flow Alm* [6] Concen*	

* Indicates a name which may be edited through the remote port.

MAIN MENU	SUB MENU 1	SUB MENU 2	SCROLL CHOICES
	[2] SET USER CONSTANTS	[1] Nom. Flow* [2] Interval* [3] Pu Const* [4] Eff. (4 Pi)* [5] <no name>*	
	[3] STOP COUNT		
	[4] START COUNT		
	[5] RESET COUNTERS		
[3] SYSTEM SETUP	[1] SET DATE		
	[2] SET TIME		
	[3] SET PRINTER PROTOCOL	[1] BAUD	300 1200 2400 4800 9600
		[2] PARITY	NONE EVEN ODD
		[3] DATABIT	7 8
		[4] STOPBIT	1 2
		[5] TERM	CR CRLF

*Indicates a name which may be edited through the remote port.

MAIN MENU	SUB MENU 1	SUB MENU 2	SCROLL CHOICES
	[4] SET REMOTE PROTOCOL	[1] BAUD	300 1200 2400 4800 9600
		[2] PARITY	NONE EVEN ODD
		[3] DATABIT	7 8
		[4] STOPBIT	1 2
		[5] TERM	CR CRLF
		[6] ECHO	ON OFF
		[7] PROTOCOL	ASCII BINARY
		[8] ADDRESS	
	[5] SET AUTO-LOG INTERVAL	[1] Pu239 cpm*	MIN
		[2] Pu239 counts*	HR
		[3] Concen pCi/l*	DAY
		[4] Noise counts*	NEVER
		[5] Sigma cpm*	
	[6] LOAD DEFAULTS		
[4] SECURITY ACCESS	[1] LOG ON [2] EDIT ACCESS CODE [3] LOG OFF		

* Indicates a name which may be edited through the remote port.

E. INITIAL OPERATION

The ALPHA-6A-1 is shipped from the factory in the default configuration,* ready to measure and alarm on airborne ^{239}plutonium.

Check that the number showing in the window of the AC input module (on the rear panel) is appropriate to the line voltage to be used. The number must be 120 or 240. If the wrong number is showing, unplug the power cord, open the window, pull out the circuit card, and re-insert it with the proper number showing. Plug the ALPHA-6A-1 into a power source.

Set the power switch to ON. The display will show software version and then show the spectrum of region zero with the related data. The beeper will sound and certain messages will show. Press any key to acknowledge each message and silence the tone. If a printer is connected, it will log the previous power off time and the present power on time.

Check the time and date shown on the display. If they are incorrect, refer to Section H.C.3. (The security code is required to reset the date and time.)

Unscrew the door latch all the way and open the door. Acknowledge the messages. Remove the retaining ring and install a new filter. Close the door and tighten the latch. When the door closes, the channel counters are reset to zero, the sample volume and the ^{239}Pu total count registers are reset to zero and counting is started.

Connect a low pressure source to the VACUUM hose barb on the rear panel. Adjust the source for a reading of approximately 1.00 cfm (recommended) on the ALPHA-6A-1 display.

The ALPHA-6A-1 is now in operation. As the radon/thoron daughters begin to collect and show on the spectrum, a check can be made on the ALPHA-6A-1 energy calibration by observing the location of the large radium C’ peak near channel 178. See Figure 2-1. When enough counts have been obtained to have a reasonably rounded curve, use the cursor to locate the channel with the highest count. If it is within one channel of channel 178, the calibration is acceptable. If not, refer to Section V, MAINTENANCE.

In the absence of any Pu on the filter, the computed Pu counts per minute (cpm) should average zero. If an average positive or negative bias is apparent when viewing alarms 3 or 4, refer to SECTION V, MAINTENANCE.

The plutonium alarm points are variables which are computed at each update. The slow and fast alarm levels are adjusted by changing the sigma multipliers associated with each alarm. (Sigma is a computed value, based upon the same numbers used to compute Pu cpm.) The slow alarm is defaulted at 2.5 sigma, the fast at six sigma. These multipliers may be changed under menu “SET ALARM PARAMETERS”. Fractional values are acceptable.

These alarm levels, 2.5 and 6 sigma virtually guarantee no false alarms on a nominally calibrated ALPHA-6A-1. A slow alarm sigma multiplier of 2.2 will afford more Pu sensitivity and should not cause unreasonably frequent false alarms. If an alarm occurs, the ALPHA-6A- 1 display “[VIEW] [.] [4]” or the REMOTE communications line can be used to determine the type (slow or fast) and by how far the alarm point was exceeded. An estimate of the urgency (false alarm, or not) may then be made.

*The value of constant 4 may be slightly different from the programmed default value. This constant represents the 4Π efficiency of the detector and is measured and set at the factory.

If desired, connect a printer to the PRINTER connector on the rear panel so that automatic logging of status changes and periodic recording of various values may occur.

Most defaulted ALPHA-6A-1 calculations involve data gathered no earlier than one minute ago so that one minute after a change is made, the answer is valid. (The change may be a filter change, a constant change, etc.) The concentration computation determines if there is a steady average increase in the computed Pu cpm and it uses history up to one hour old. It can take up to an hour after a change for the concentration value to become valid. The concentration computation is not used in determining Pu alarms.

SECTION III. INSTRUMENT CONFIGURATION

A. OPERATING PARAMETERS

1. Configuration

The measurement of alpha activity in air and the determination of alarms depends on a set of variables which include regions of interest, user variables, program variables, program constants and alarm set points.

A region of interest (ROI), is a continuous block of channels within the spectrum which is treated as a unit. These regions are used to isolate peaks within the spectrum and to identify other areas of interest. Each time the spectrum is acquired, P1 adds the counts from each channel in an ROI to form an ROI total. Totals from each ROI (except ROI 0 and ROI 10) are saved in history files and used in a set of default or user-defined equations to calculate values such as isotope concentration and isotope activity. These <u>calculated</u> <u>values</u> are called "<u>user variables</u>".

<u>A user variable is a value which is named and defined by an equation.</u> Each time the spectrum is acquired, P1 calculates the value of each user variable using the appropriate equation and stores the results in history files. The user variables may be used to measure isotope activity, isotope concentration, noise count rate, etc.

"Program Variables" are miscellaneous variables and parameters not covered by the definition of user variables. These values include parameters such as the baud rate settings for the remote and serial ports, the time-integrated flow value and the current flow rate.

An alarm set point is characterized by a name, an alarm variable, a reference value (alarm point) and a MODE byte. The name identifies the alarm set point and is used on the display, in the monitor status display, and in messages automatically logged to the printer. The alarm variable is updated every time the spectrum is updated. It is then compared to a reference value which may be a variable scaled by an optional scale factor or a fixed alarm limit. If the reference value is a variable it is also updated each time the spectrum is updated. The manner in which these are compared and the conditions which constitute an alarm are specified by the MODE byte. For example, the MODE byte specifies whether the reference value (alarm point) is an upper or lower boundary.

The ALPHA-6A-1 also provides five "user constants" which are user-definable through the REMOTE port. The values of these constants can be set through either the remote port or the ALPHA-6A-1 keypad.

2. Default Configuration

The default ALPHA-6A-1 configuration is set up to measure the level of airborne ^{239}Pu activity. The program uses an algorithm to accurately measure ^{239}Pu in the presence of radon and thoron daughters.

The following relationships were used to develop the default regions of interest (ROI) and formulas for the ^{239}Pu computations.

The nominal set-up of the pulse height analyzer measures pulses of zero to one volt amplitude. A signal from the detector amplifier with a pulse amplitude in this range will cause the appropriate channel storage register to be incremented by one. A "zero" amplitude pulse goes into channel zero and a pulse of approximately one volt goes into channel 255. The Energy-Channel Graph, Figure 3-1, was experimentally determined from various isotopes. The curve is described by:

Channel No. = [MeV - 0.37] [24.4]

MeV = [Channel No. divided by 24.4] + 0.37

The actual channel location of the various peaks may deviate slightly from the computed location due to minor differences in the filter to detector spacing, the density of the air in this space, etc.

The graph in Figure 2-1 shows a typical spectrum with alpha energy peaks centered at 6.0 (channel 137), 7.68 (channel 178), and 8.78 (channel 205) MeV. The algorithm uses four regions of interest, placed as shown, to section off portions of the peaks centered at 6.0 and 7.68 MeV. Note that the shape of the tails of each peak are very nearly exponential. In spite of the fact that the three peaks may have slightly different shapes, they all have approximately the same tail response shape. Therefore, in the absence of plutonium, the following formula approximates the conditions.

$$K \quad \frac{R3}{R4} = \frac{R1}{R2}$$

where Ri = the number of counts in Region i, K = an empirical constant

In the presence of plutonium, which contributes to the counts in Region 1, the equation must be changed to:

$$K \quad \frac{R3}{R4} = \frac{R1 - Pu}{R2}$$

where Pu = counts due to plutonium

The equation is then used to solve for plutonium counts as follows:

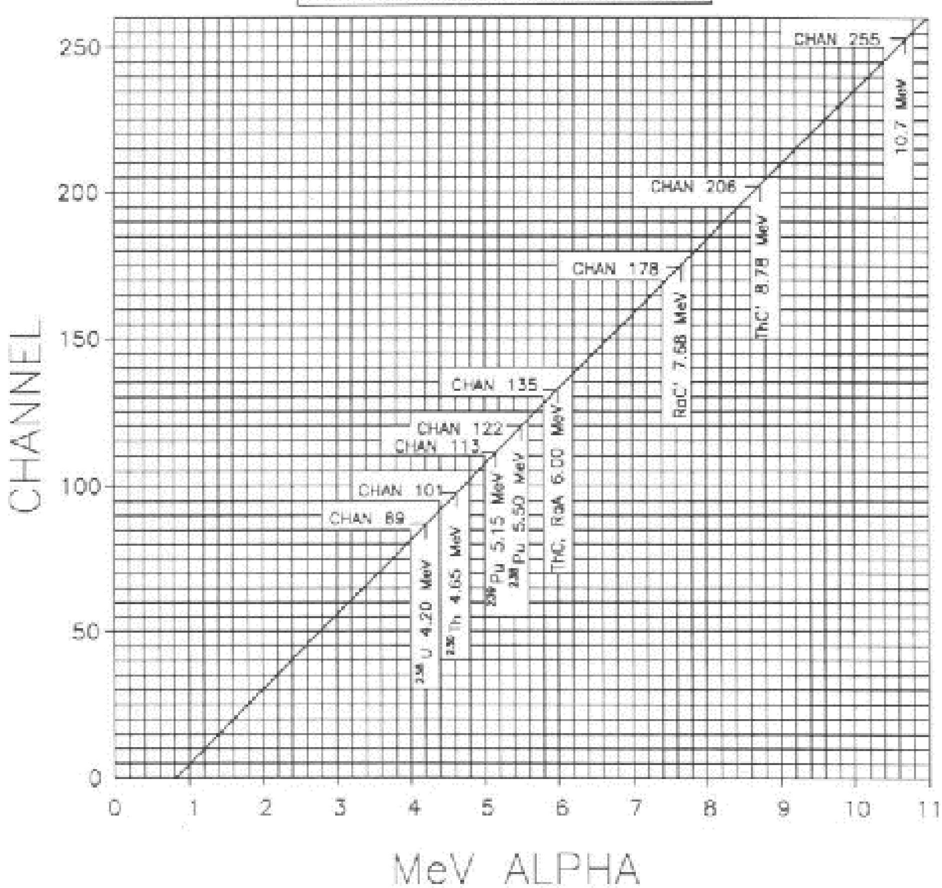
$$Pu = R1 - K \times \frac{R3}{R4} \times R2$$

This equation allows the ALPHA-6A-1 to accurately measure ^{239}Pu because it is able to compensate for wide variations in radon-thoron background, for changing peak shape due to "smearing", and for relatively small shifts in gain.

Figure 3-1. Energy-Channel Graph

$$\text{MeV} = \frac{\text{CHAN No.}}{26} + 0.83$$

$$\text{CHAN No.} = 26\,(\text{MeV} - 0.83)$$



The default configuration uses all five user variables to calculate plutonium activity, plutonium gross counts, plutonium concentration, noise count rate and plutonium activity sigma. These values are calculated each time the spectrum is updated and the current value of each is stored in a history file at one-second, one-minute, one-hour, and one-day intervals. Each time file retains the latest 64 data entries.

The program also calculates time integrated flow volume (since the door was last closed) in cu.ft., the flow rate in cu.ft./min. and the deviation of the flow rate from a nominal value. The flow volume is used in the calculation of plutonium concentration and flow deviation is used in providing a flow out-of-limits alarm. A record of the volume is kept in the history files.

The default configuration uses four of the five user constants and initializes them as shown in the “Default Configuration Table” (Table 3-1). The value of these constants which include the nominal air flow rate, the spectrum acquisition interval, the plutonium algorithm constant and the detector efficiency constant, may be edited by the user from the keyboard or the remote terminal. (Security access required.)

The six alarm set points are defaulted to check for (1) flow failure, (2) excessive noise in the guard regions, (3) a sudden increase in plutonium activity, (4) a gradual plutonium increase, (5) air flow out of limits, and (6) airborne Pu concentration in pCi/l. The flow fail alarm detects very low air flow. Any flow rate below 0.3 cfm is presented as zero flow and the flow fail alarm is given. The noise alarm detects a rapid increase in the counts present in the guard ROIs. The “fast” plutonium alarm is triggered if plutonium activity exceeds a high threshold (defaulted at six times the plutonium measurement sigma). The “slow” plutonium alarm will trigger on a lower threshold (defaulted at 2.5 times the plutonium computation sigma.) The flow out-of-limits alarm occurs when the change in the air flow exceeds the reference value, defaulted at 0.05 cfm. The defaulted Pu concentration limit is 0.02 pCi/l.

The flow failure, slow plutonium and flow out-of-limits alarms use “N of M” alarm checking. These alarm set points are checked each time the spectrum is updated but when an alarm condition is detected it is not posted immediately. Instead, the condition must hold true for N of M checks before the alarm win be posted. Flow failure and flow out-of-limits are defaulted to use 3 of 3 checking which means their alarm conditions must hold true for three consecutive updates before the appropriate alarm is posted. The slow plutonium alarm, by default, must hold true for three consecutive one minute checks before the alarm will be posted. The use of N of M checking allows detection of slow but steady changes in an alarm variable and helps to reduce the false alarm rate.

If a fast or slow (plutonium) alarm occurs, the rotating beacon, the bell, the message lamp, and the beeper will turn on and the status message will show the alarm. The alarm relay, which is connected to the ALARM terminal board on the rear panel, will actuate. If a printer is connected, it will log the time and date and type of alarm. The bell, the beeper, and the message lamp may be turned off by pressing any key. When the alarm conditions no longer exist, all of the indicators return to their normal state and the printer will log the return with a time and date stamp.

The following alarms and conditions are defaulted to cause the failure relay, which connects to the FAILURE terminal board on the rear panel, to deactuate:

a. Clock failure.

b. Communications failure between the two processors.

c. Lack of signal from the detector for two minutes.

d. Air flow failure.

e. Excessive counts in the noise ROIs.

f. Loss of power due to AC failure or setting the power switch off.

Except for loss of power, all of these events will cause the beeper and the message lamp to come on and the status message will show the event. The beeper may be silenced by pressing any key. As described above, the printer will record the occurrence and the ending of the event. When power is restored after a power loss, the printer win record the power off and power on times. When all of the listed conditions have passed, the fail relay will actuate to indicate normal conditions.

Four other events and conditions are defaulted to actuate the message lamp and the beeper and to be recorded on the printer, but will not cause any other alarms. They are:

a. Pu concentration exceeding the reference point.

b. Opening the detector door.

c. Stopping the counting process, whether caused by instructions from the keyboard, from the remote terminal or by opening the detector door.

d. Low battery.

e. Flow rate out of limits.

Pressing any key will silence the beeper and turn off the message lamp.

TABLE 3-1. DEFAULT CONFIGURATION TABLE

DEFAULT REGIONS OF INTEREST

Q	ROI_0	CH[000..255]	Entire spectrum
R	ROI_1	CH[100..121]	Plutonium peak
S	ROI_2	CH[128..139]	6 MeV upper part
T	ROI_3	CH[147..178]	RaC’ 7.68 MeV lower part
U	ROI_4	CH[179..190]	RaC’ 7.68 MeV upper part
V	ROI_5	CH[196..215]	ThC’ 8.78 MeV
W	ROI_6	CH[235..255]	Upper guard ROI
X	ROI_7	CH[020..040]	Lower guard ROI
Y	ROI_8	CH[000..255]	<not used>
Z	ROI-9	CH[000..000]	<not used>

DEFAULT USER VARIABLES AND EQUATIONS

A Pu239 cpm $(R - R_{59}) - CONST(3) \times (T - T_{59}) / [(U - U_{59}) + 1] \times (S - S_{59})$

R, R(59)-,CONST(3),T,T(59)-,U,U(59)-,(1.000)+/*,S,S(59)-*-

B Pu239 counts $R - CONST(3) \times T / U \times S$

R,CONST(3),T,U,(1.000)+/*,S*-

C Concen. pCi/L Pu $[(B_{64} - B_{94}) - (B_{94} - B_{124})] \times 0.00053 / [(F_{79} - F_{109}) \times CONST(4)]$

B(64),B(94)-,B(94),B(124)–,(0.00053)*,F(79),F(109)-/.CONST(4)/

D Noise cps $(W - W_{59}) + (X - X_{59})$

W,W(59)-,X,X(59)-+

E Sigma cpm $\sqrt{(R - R_{59}) + \{[CONST(3) \times (T - T_{59})] / (U - U_{59})\}^2 \times (S - S_{59})}$

R,R(59)-,CONST(3),T,T(59)-,U,U(59)-,(1.0000)+/*2^,S,S(59)-*+SQRT

NOTE: Subscripts following letters denote history data. Absence of a subscript denotes current value.

0..63	are one second entries, 0 being most recent
64..127	are one minute entries
128..191	are one hour entries
192-255	are one day entries

DEFAULT PROGRAM VARIABLES

F	[(CONST(2) x I) / (60)] + F	Sample volume (Cu.Ft.) since door closed
G	stamp	Time stamp
H	CONST(l) -I	Flow deviation
I	flow rate	Sample flow rate (Cu.Ft./min)

DEFAULT USER CONSTANTS

CONST(l)	1.00	Nominal flow rate (cfin)
CONST(2)	5.00	Spectrum acquisition interval (sec)
CONST(3)	0.12	Plutonium algorithm constant
CONST(4)	0.17	Detector efficiency (4 Pi)
CONST(5)	0.00	<no name>

DEFAULT ALARM Set Points

ALARM(l)	I < 0.1 cfm	(3 of 3)	Flow fail alarm
ALARM(2)	D > 100 cpm		Noise alarm
ALARM(3)	A > 6 x E cpm		Fast plutonium alarm (6 sigma)
ALARM(4)	A > 2.5 x E cpm	(3 of 3 minutes)	Slow plutonium alarm (3 sigma)
ALARM(5)	H > 0.05 cfm	(3 of 3)	Flow out of limits
ALARM(6)	C > 0.02 pCi/L	(8 of 8 minutes)	Plutonium concentration

DEFAULT ACCESS CODE 1287

ORDER OF COMPUTATION AT UPDATE Order QRSTUVWXY23FABECDH

3. Default Equations, Computation Details

Table 3-1 lists the default ALPHA-6A-1 equations of general interest to the user.

In normal (default) operation P2 (processor number 2) receives the pulse height data from each detector pulse and adds one more to the corresponding channel count. At each update interval (5 seconds by default), P1 receives the total count in each channel. It then, in sequence, updates the present total counts in all established ROIs, computes the present flow rate, the total sample volume, the ^{239}Pu cpm, the ^{239}Pu total count, the sigma value, the concentration value, the noise count and the difference between the actual flow rate and the nominal rate. (See ORDER OF COMPUTATION AT UPDATE in Table 3-1.) All of these values computed have "current" storage registers, separate from the history files. The next step in the update process is to update the display. Then, the one second history files are updated and possibly the one minute, hour, or day files as appropriate. All alarms are then checked to complete the update.

Each second, whether part of the complete update procedure or not, the one second history files are updated using the data in the "current" storage registers. Since the "current" storage remains constant between update intervals, the data in the one second files will be unchanged for a complete update period.

The various equations often use values from the history files. See Table 3-1. Since, in the update process, all user variables are computed before the history files are updated, the most recent value in the one second file was placed there one second before the computation took place. This makes the expression R-R(59), in the equation for Pu239 cpm, Table 3-1, the count increase in ROI-1 in the most recently elapsed 60 seconds.

The equation for Pu239 cpm (User Variable A) uses the increase in counts over the last 60 second in regions 1, 2, 3, and 4, and the value of user constant 3. It takes the form:

$$\text{Pu239 cpm} = \text{(ROI 1 gain)} - \text{CONST(3)} \times \frac{\text{(ROI 3 gain)}}{\text{(ROI 4 gain)} + 1} \times \text{(ROI 2 gain)}$$

The equation for Pu.239 counts (User Variable B) uses all the counts accumulated in regions 1, 2, 3, and 4, since the last reset, and user constant 3. It has the form:

$$\text{Pu239 counts} = \text{(ROI 1 total)} - \text{CONST(3)} \times \frac{\text{(ROI 3 total)}}{\text{(ROI 4 total)} + 1} \times \text{(ROI 2 total)}$$

The equation for concentration, picocuries of ^{239}Pu per liter, relates the average rate of increase in the Pu count rate to the increase in the total amount of air sample. It computes the average Pu count rate for the most recent 30 minutes and subtracts the average for the next most recent 30 minute period and divides this difference by the amount of air sampled in 30 minutes. The 4Π detector efficiency factor relates computed Pu cpm to Pu dpm. and the other constant changes cubic feet to liters, dpm. to curies, and 30 minutes to one minute.

$$\text{Conc.} - \frac{\text{(Avg cpm in last 30 min.) - (Avg cpm in previous 30 min.)}}{\text{(Air volume increase in 30 min., ending 15 min. ago)}} \times \frac{0.00053}{4\Pi \text{ Eff.}}$$

The equation for noise merely totals the increase in counts in guard regions 6 and 7 since the last update. The equation is written as if it checks back two seconds, but the one second history file values do not change between updates.

The equation for sigma uses exactly the same input parameters as the equation for Pu cpm. They are the increase in counts over the last 60 seconds in regions, 1, 2, 3, and 4, and the value of constant 3.

$$\text{Sigma} = \sqrt{(\text{ROI 1 gain}) + \left\{[\text{CONST}(3) \times (\text{ROI 3 gain})] / (\text{ROI 4 gain} + 1)\right\}^2 \times (\text{ROI 2 gain})}$$

4. Re-Configuration

The ALPHA-6A-1 is configured to measure ^{239}Pu activity by default. The user however, may reconfigure the monitor to measure another isotope. Reconfiguration must be performed using the remote port commands described in Appendix A.

The first step involved in reconfiguration is to section off portions of the spectrum into the regions of interest needed to measure the new isotope of interest. Most likely the regions which have been defined for the default configuration will not be suitable. The DEFINE command may be used to specify new regions of interest. Regions can also be established or changed using the ALPHA-6A-1 keypad.

Secondly, the user will want to redefine the user variables. Each user variable is characterized by an equation that is used to calculate it. For example, the default configuration computes variable "A" to measure plutonium activity. The equation for "A" uses the counts in Regions 1 through 4, counts saved previously for Regions 1 through 4 and a "user constant". The user will have to derive the equations needed to calculate values associated with the new isotope and then enter them using the DEFINE command. The user must also enter a name and units for each variable because they are used to construct the User Variable Menu.

The monitor must know how to format the values calculated for each user variable. This format information is provided by two parameters called "WIDTH" and "PLACES". "Width" specifies the total number of digits needed to display the variable and "places" specifies the number of digits to be displayed to the right of the decimal point. Therefore, an integer may require width = 8 and places = 0 while "REAL" data (see Section III.D.2.) might require width = 8 and places = 2. If width and places are not specified, the monitor will use the WIDTH and PLACES of the default configuration.

The user may also specify a conversion factor (.CONV) which the program will use to convert the value calculated by the equation to the units specified. This conversion factor is a "REAL" number and defaults to 1.00.

An example of the commands used to define a new user variable is given below: (See detail in Appendix A.)

SET A.NAME	=	NOISE
SET A.UNITS	=	CPM
SET A.WIDTH	=	8
SET A.PLACES	=	2
SET A.CONV	=	3
DEFINE A	=	[Formula]

Next, the user constants may need to be changed. The default configuration operates with four user constants. Constant number one is always used as the nominal air flow. The value is defaulted at one cfm. Constant two specifies the update interval which determines how often P1 obtains the channel count totals from P2, performs computations and updates the display. The default update period is five seconds and the value cannot be set lower than that due to the time needed to complete the update. Constant three is used in the default formula which computes the plutonium activity. Constant four represents the detector efficiency and is used in the plutonium concentration calculation. Constant five is not used by the default configuration, but is set to zero on a cold start.

A user constant has two attributes, a name and a value, which may be edited through the remote port using the SET command (see Appendix A). The value of the constant may also be edited from the keypad, see Section H.C.2.

Finally, after re-defining regions of interest, user variables and user constants, the user must re-define the alarm set points to alarm correctly on measurements of the new isotope. The default configuration uses 6 alarm set points. Set points 1 and 5 are used to detect flow failure and flow out-of-limits and since air flow rate is important to the measurement of any isotope, these set points should be left intact. However, set points 2, 3, 4, and 6 are related to the measurement of ^{239}Pu and should be re-defined to suit the needs of the new configuration.

There are nine parameters associated with each alarm set point which may be edited. These parameters are listed in Section IIII.B.2. and may be edited through the remote port using the SET command. See Appendix A. One of the parameters (ALARM(n).SCALE) may be set from the keypad via the SET ALARM PARAMETERS menu, see Section II.C.2.

B. ALARM SYSTEM

The ALPHA-6A-1 uses a system of priorities to check for three types of alarm conditions which include hardware failures, user alarms, and warnings. The hardware failures have the highest priority followed by user alarms and warnings respectively. The user alarms are user-selectable, the hardware failures and warnings are not.

1. Hardware Failures

A hardware failure is posted if the real-time clock fails, if P2 stops sending spectral data or if the detector fails as indicated by a low count condition. When a hardware failure occurs the message light and beeper will turn on, the fail relay will de-actuate and a message will be posted on the status line. The user may acknowledge the failure by pressing any key on the keypad. Once the condition is acknowledged, the beeper will turn off.

A clock fail is of highest priority followed by P2 fail and low count fail. If more than one hardware failure exists, the operator must acknowledge the failures one at a time beginning with the highest priority failure. As each failure is acknowledged, the status line will display the next failure, if one exists. After all hardware failures have been acknowledged, the status line will re-post the highest priority failure.

If a hardware failure exists, the ALPHA-6A-1 will not check the user alarms or warnings. The monitor essentially halts operation until the failure is cleared. Once all failures have been cleared the message light will be turned off and the fail relay will re-actuate. If a printer is connected, each status change is recorded by the printer.

2. User Alarms

The ALPHA-6A-1 maintains up to 6 user-defined alarm set points with alarm 1 having the highest priority, followed by alarms 2, 3, 4, 5 and 6. (The default alarms, 1 through 6, are flow fail, noise, fast alarm, slow alarm, flow out of limits and concentration.) The nine parameters associated with each alarm set point are listed below:

PARAMETER NAME	PARAMETER TYPE
ALARM(n).ALM_NAME	ASCII String, 9 Characters or Less
ALARM(n).ALM_VAR	Character (A..Z)
ALARM(n).REF_VAR	Character (A..Z) (if used)
ALARM(n).SCALE	Real
ALARM(n).N	Integer
ALARM(n).OF_M	Integer
ALARM(n).MIN_SCALE	Real
ALARM(n).MAX_SCALE	Real (r>0)
ALARM(n).MODE	Byte

n = alarm set point number (1, 2, 3, 4, 5, or 6)

ALM_NAME uniquely identifies the alarm set point name. ALM_VAR (the alarm variable) specifies what variable will be checked to determine if an alarm has occurred. The alarm variable must be specified by its one character identifier. Valid alarm variables include user variables A, B, C, D, and E, program variables F, H, and L and regions of interest Q, R, S, T, U, V, W, X, Y, and Z.

If the alarm variable is to be checked against a reference variable then REF_VAR specifies the variable to be used. Variables which may be used as reference variables are the same as those used for the alarm variable. See the list above. In addition to specifying REF_VAR, the user must specify the SCALE factor. The reference variable is multiplied by the scale factor before it is compared with the alarm variable. If scaling is not desired, the user may set SCALE to 1.00. If REF_VAR is not used (the alarm variable is to be compared with a fixed alarm limit), the user must enter REF_VAR = (return key) and then must set .SCALE equal to the fixed limit desired.

"N of M" checking is used to specify how many times (N) an alarm condition must hold true in M checks before the alarm will be posted. For example, 1 of 1 specifies that the first time the alarm condition is detected, the alarm will be posted. "N of M" equal to 3 of 3 specifies that the alarm condition must hold true for three consecutive checks before the alarm will be posted. ALARM(n).N is used to specify N and ALARM(n).OF_M to specify M.

The strip chart display associated with each alarm set point plots the alarm variable and its reference value versus time.
ALARM(n).MIN_SCALE and ALARM(n).MAX_SCALE specify the minimum and maximum values needed to scale the graph. These values must be entered in units equal to those specified for the alarm variable.

The mode byte is used to specify the following information. Bit 7 is set if "N of M" is something other than "l of 1". Bit 6 is set if the alarm variable will be compared to a fixed alarm limit and cleared if the reference level is a variable. Bit 5 specifies if the reference (alarm) level is a upper or lower boundary. If Bit 5 is set the reference is a lower boundary and an alarm will be posted if the alarm variable falls below the boundary. If Bit 5 = 0, then the reference is an upper boundary and an alarm will be posted if the alarm variable exceeds the boundary. If bit 3 is set, the alarm is checked only once a minute instead of every update. This is useful in N of M checking where marginal alarms must be held for a longer time before they are posted. (The default plutonium slow alarm uses this feature). Bit 4 is an ignore bit which if set specifies that if the alarm condition being checked is true, the alarm set points of lower priority will not be checked. Bits 2, 1 and 0 are set if the rotating beacon, bell and fail relay, respectively, should be activated on alarm.

MODE BYTE

B7 =	1	N OF M IN USE
	0	1 of 1 IN USE
B6 =	1	FIXED ALARM REF.
	0	VAR. ALARM REF.
B5 =	1	ALARM IF LOWER THAN
	0	ALARM IF HIGHER THAN
B4 =	1	IGNORE LOWER PRIORITY
	0	CHECK LOWER PRIORITY
B3 =	1	CHECK EACH MINUTE
	0	CHECK EACH UPDATE

B2 =	1	BEACON RELAY FUNCTION
	0	NOT BEACON FUNCTION
B1 =	1	BELL RELAY FUNCTION
	0	NOT BELL FUNCTION
B0 =	1	FAIL RELAY FUNCTION
	0	NOT FAIL FUNCTION

Of the nine parameters given, only the scale value (ALARM(n).SCALE may be changed from the ALPHA-6A-1 keyboard under MENU, 2, 1, SET ALARM PARAMETERS.

In the absence of a hardware failure, the monitor will check each active alarm set point beginning with alarm 1. An active set point is one which has an alarm variable defined for it. Each time the spectrum is updated, the alarm variable is compared against the reference value. If an alarm has occurred, the alarm name will be posted on the status line and the message light and beeper will turn on. The monitor will also turn on the rotating beacon and the bell and will de-actuate the fail relay if specified by bits 0, 1, and 2 of the alarm MODE byte.

The operator may acknowledge an alarm with any key (the beeper and the bell will be silenced). The monitor will check the next alarm set point and the next until all the alarms have been checked. If more than one alarm exists, the operator must acknowledge them one at a time until all have been acknowledged. Each time an alarm is acknowledged, the status line will post the next alarm, if one exists. After all alarms have been posted and acknowledged, the status line will re-post the highest priority alarm.

If the monitor is connected to a printer, it will automatically print the time and date followed by the alarm name and the word ALARMED each time an alarm occurs. When the alarm condition is cleared, the monitor will print the same information followed by the word “normal”. When the alarms have been cleared the message light and the beacon will be turned off. Also, if the fail relay was de-actuated on alarm, it will be re-actuated once the alarm has cleared.

3. Warnings

The lowest priority group of alarm conditions are the warnings. Warnings are hardware-related conditions which include filter door open, P2 counters halted by command and low battery. In the absence of hardware failures and user alarms, the monitor will check for warning conditions beginning with the door check. If the filter door is open, the P2 counters will be halted immediately. Once the door is closed, P2 will reset its counters (zero the spectrum), zero the air flow volume register and resume counting. Following the door check, the monitor checks to see if P2 has been halted and checks the battery.

If a warning condition is detected, it will be posted on the display and the message light and beeper will be turned on. The operator may acknowledge the warning with any key and the beeper and light will turn off. If more than one warning exists, the operator must acknowledge them one at a time just as described for failures and user alarms above. When all warning conditions have been cleared the message light will turn off.

C. HISTORY FILES

The ALPHA-6A-1 maintains one-second, one-minute, one-hour and one-day history files of 64 data points each for each user variables, regions of interest 1 through 9, the flow volume and their time stamps. Each time a second elapses, P1 will save the current value of these variables in the appropriate one-second file. When a minute elapses, the current value of each is stored in its one-minute history file. The one-hour and one-day values are stored in the same manner.

The history files may be called up by the operator and displayed, printed, or listed on a remote terminal. They provide information regarding trends in values such as isotope count rate, flow rate and counts due to noise. The history files are also important for the strip chart displays described in Section 111.13.2.

D. SERIAL PORTS

1. Printer Port (RS-232C/ASCII)

The ALPHA-6A-1 is designed for use with an optional serial printer. If a printer is connected, the monitor will automatically log alarms when they occur and when they are cleared. Also, the operator may print history files, region of interest data and the current monitor status if desired.

If a printer is connected and on-line, the ALPHA-6A-1 will automatically log information to the printer on AC power up. This information indicates how long the monitor was "out of service" and when it resumed operation. The operator may also choose to automatically print the calculated value of any variable at regular intervals. These auto-log intervals may be selected via the SYSTEM SETUP menu or may be specified via the remote port using the LOG command, see Appendix A. The default auto-log interval for all variables is NEVER.

If a printer is not connected, the ALPHA-6A-1 will automatically timeout the first time it tries to send a message to the printer. The monitor will then set a flag which indicates the printer interface is not operable. If a printer is connected sometime later, the ALPHA-6A-1 will sense this and clear the flag. The monitor will also timeout if a printer is connected but not responding. If the operator attempts to print data and the timeout flag is set, the monitor will display "PRINTER OFF-LINE" or "PERIPHERAL FAILURE". The timeout flag will be cleared automatically when the printer comes back on-line.

The printer port has a set of configuration parameters which are listed in Table A-1 of Appendix A. These parameters are configured by default as shown in the table, but may be edited by the operator. Most printer port parameters may be edited at the keypad, see Section 11I.C.3. All of the parameters may be edited from a remote terminal using the SET command. See Appendix A for details.

2. Remote Port (RS-232C/ASCII or Binary)

The ALPHA-6A-1 will communicate with an external device over is remote port (Port 2). The monitor will accept any properly formatted command, perform the task specified and send the proper response.

The ALPHA-6A-1 supports two types of remote port communications. ASCII and binary. The ASCII protocol is used by default, but the binary protocol may be selected instead. See the SET REMOTE PROTOCOL menu in Section H.C.3. for details. The ASCII protocol uses messages which are made up of ASCII characters only. The binary protocol, on the other hand, uses messages which include an address byte, a message length byte, and a task byte followed by other bytes required to complete the message. The information provided below and in Appendix A pertains to the use of ASCII communications. For information regarding use of the binary protocol, please refer to Eberline document 13000-A13. Contact Eberline for a copy of the document.

A standard ALPHA-6A-1 is shipped from Eberline set up to communicate with a remote device using the ASCII commands listed below:

ACCESS	DEFINE	LIST	SET
BOOT	DETAIL	LOG	STATUS
COUNT	DISPLAY	PRINT	TIME
DATE	EVAL	RESET	VERSION

Each of these commands must be properly formatted and any data sent as part of the command must conform to the specific guidelines in Appendix A.

The remote port has a set of configuration parameters which are listed in Table A-2. These parameters are configured by default as shown in the table, but may be edited by the operator. Most of the parameters may be edited at the keypad, see Section H.C.3. All of the parameters may be edited from a remote terminal using the SET command. See Appendix A.

To establish communications over the remote port, connect the ALPHA-6A-1 to the remote terminal or to a computer running a "terminal emulation" program using a cable as described in Figure 3-2. Set up the terminal parameters to match those of the ALPHA-6A-1. The default parameters are shown in Appendix Table A-2, but if they have been changed, most setting can be observed using the ALPHA-6A-1 menu, [MENU] [3] [4].

Press the terminal RETURN or ENTER key. The ALPHA-6A-1 should return its prompt (defaulted ALPHA6A>) to indicate that the link is established. If not, return to menu [MENU] [3] [4] [8] and observe the address number of the ALPHA-6A-1. If it is not in the range of 1 to 9, enter a number in that range and then, on the terminal, press the ESC (escape) key followed by that number key. Press the return key and observe the ALPHA-6A-1 prompt.

Figure 3-2. Communications Cable

The cable shown below may be used to interconnect the ALPHA-6A- I and a printer or the ALPHA-6A-1 and a remote terminal or computer.

```
                          PIN #                 PIN #

GND                       1 >---------------------------< 1         GND

TxD    DATA OUT           2 >---------------------------< 3         DATA IN RxD

RxD    DATA IN            3 >---------------------------< 2         DATA OUT TxD
       ___                                                          ___
       RTS                4 >----              ----< 4              RTS
                                |             |
       ___                      |             |                     ___
       CTS                5 >----              ----< 5              CTS
       ___                                                          ___
       DSR                6 >--------------------------< 20         DTR

       GND                7 >--------------------------< 7          GND
       ___                                                          ___
       DTR                20 >------------------------< 6           DSR

                          DB-25P*               DB-25P*
```

NOTE: Either end of the cable may be connected to the back of the ALPHA-6A-1.

*The DB25P connector mates with the ALPHA-6A-1. If the printer or terminal has a DB25S connector, the DB-25P on the cable will make the connection. If not, an appropriate connector should be installed, using the functions shown as a guide.

SECTION IV. THEORY OF OPERATION

The ALPHA-6A-1 monitor is comprised of a power supply board, a pre-amplifier board and a main board which provides battery backup, a 256 channel analyzer, a mass air flow measurement system and a real time clock. The monitor also provides a keypad, an LCD display, a filter assembly with door, a solid state detector, two RS-232 ports and various annunciators.

A. POWER SUPPLY

The AC power connection is made through A303, an AC input module containing a line filter, a fuse and a line voltage selecting printed circuit board. The linear power supply circuits generate five regulated DC voltages and one unregulated line to drive the relays. The power supply board distributes power to the main board, the detector amplifier, the bell, and the beacon. The ALPHA-6A-1 will accept 50 Hz to 60 Hz power at 120 or 240 nominal volts. Only one circuit card in the AC input module need be changed when selecting the other AC input voltage.

B. BATTERY BACKUP

The battery backup circuitry includes a 3 volt lithium coin cell battery (BT1), a voltage reference/comparator (A32) and a dual voltage comparator (A33). If the + 5VD line fails, the output at A32-4 switches to high impedance and R11 pulls the pin high. This high output passes through A14 (also battery powered) and pulls the chip enable (CE) pins (20) of RAMs A7 and A8 high, isolating them from the rest of the circuit and preserving their data. When A32-4 goes high, A33-6 also goes high and A33-7, which is connected to the real time clock chip select, A34-15 (CS1), goes low. This isolates the clock and it continues to run. (A33 is not battery powered but while the + 5VD line is down, R17 holds the clock chip select pin down.)

The main processor, P1, continually monitors the status of the battery. The battery is connected to A33-3 and if its voltage falls below that of the reference at pin 2, A33-1 goes low. Pin I pulls A1-4 low, indicating a low battery.

C. DETECTOR AND FILTER ASSEMBLY

A door on the ALPHA-6A-1 front panel provides easy access to the filter assembly which is mounted on the door. The standard 47 mm filter (Eberline recommends a 47 mm millipore SM^{R} or equivalent) is held in place by a slip-on retaining ring. The solid state detector is a silicon diffused junction type with an area of 490 mm^2. When the door opens, a switch removes the voltage from the detector and sends a signal to Al Pin 6 of the main processor which halts the counting. When the door closes the channel counters and the air volume register are reset to zero and counting is restarted.

An optional 25 mm filter holder is also available. See I.B.4.b.

D. PRE-AMPLIFIER

A transistor (Q101) and an operational amplifier (A101) on the pre-amplifier board comprise a charge-sensitive pre-amplifier whose output is proportional to the charge input from the detector. The sensitivity of this circuit is determined by a 4.7 pF capacitor, C106. The bias current for Q101 is set by CR101. The output from A101 is amplified twice and the output of the second stage is connected to a Darlington emitter follower capable of driving a 50 Ω load. A potentiometer (R110) provides gain adjustment for the amplifier and A103 provides 12 Vdc which operates both the "Pre-Amplifier" and "Amplifier" sections.

E. MICROPROCESSORS

The ALPHA-6A-1 main board is equipped with two 80C31 8-bit microprocessors. Processor 1 (Al) has 64K EPROM (A4, A5) and 64K RAM (A7, A8). Processor 2 (A2) has 32K EPROM (A3) and 32K RAM (A6). Processor 1 is responsible for the overall operation of the monitor. See "INSTRUMENT OPERATION" section for details. Processor 2 is dedicated to servicing the detector and to sorting the data used to acquire a 256 channel spectrum. Both processors operate at 12 MHz and communicate with one another over a dedicated serial bus at 187.5K baud.

F. 256 CHANNEL ANALYZER

The 256 channel analyzer is comprised of a threshold comparator (A39-5), a peak detector (A39-3), a zero cross comparator (A39-11) and a sample/hold (S/H) circuit (A40). Various other components, including latches, an 8 bit tristate counter and a constant current circuit complete the analyzer.

The incoming signal feeds the threshold comparator (A39-7), the S/H circuit (A40-2) and the peak detect comparator (A39-2). The S/H amplifier operates as a voltage follower and it feeds the other input (A39-1) of the peak detect comparator. The pulse output of the S/H is slightly time delayed and is still at its peak when the incoming signal starts down from peak. The comparator senses this cross over of voltages and the peak detect signal is generated (A39-3). The peak signal sets flip flop 1 (FI71) in A42 which removes the counter reset (A44- 10), enables the counter (A44-12), sets the S/H circuit to hold and activates the constant current circuit. The counter counts the 12 MHz clock signal while the constant current discharges C41, the holding capacitor of the S/H. (The higher the detector pulse, the greater the beginning charge on C41.) When the S/H output reaches zero volts the zero cross signal is generated at comparator A39-11.

This signal clocks FF2 of A42 which stops the counter and sends an interrupt signal to the processor, A2. The processor responds with a signal (A2-14) which resets both flip-flops and activates the counter outputs. The processor then reads the counter output and ends the interrupt.

The threshold circuit sets the minimum detectable pulse height. It is used to exclude the processing of low level noise signals. A feedback circuit to A39-2 prevents the peak detect comparator from oscillating on noise. A fourth comparator (A39-13) assures that FF1 of A42 is in the proper state at power-up.

G. FLOW MEASUREMENT

The air flow measurement system consists of an air manifold with adjustable valve, a mass air flow sensor (A26), a sensor heater controller (A27-1), an amplifier (A28), and an 8 bit analog-to-digital converter (A29). The mass air flow sensor outputs a signal that is amplified and fed directly into the A/D converter. The converter then outputs an 8-bit value for the flow which is used by the main processor. Only a small percentage of the air flows through the sensor and an adjustable valve on the air manifold trims the amount of air that is diverted through it. The hose from this valve connects to the front of the air flow sensor. The NULL adjustment potentiometer (R6 is used to zero the output when there is no air flow. The FLOW CAL control (R7) sets the full scale analog voltage for the A to D converter. The ALPHA-6A-1 will measure air flow in the range 0.5 to 2.0 cfm (14 to 57 lpm).

H. REAL-TIME CLOCK

The real-time clock circuit includes the clock chip itself (A34) and a 32768 Hz oscillator crystal M). The real-time clock is sustained by V_{BAT} and access to the clock is disabled on AC failure.

I. LCD DISPLAY

A 256 x 64 dot matrix display is located on the ALPHA-6A-1 front panel. The viewing angle and contrast may be adjusted with the VIEW potentiometer (R23) located on the main board.

J. KEYBOARD

The ALPHA-6A-1 provides a 20-key membrane-type keypad (A302) which is supported by a key encoder (A25). The encoder asserts the “data available” line each time a key is pressed. This line is input to the main processor on the Timer 0 interrupt Pin Al-14. The processor responds to the interrupt by reading in the 5-bit value output by the encoder. This 5-bit value is the code associated with the key pressed.

K. EXTERNAL COMMUNICATIONS

The ALPHA-6A-1 supports two serial ports, one for a printer and another for communicating with a remote terminal. Each interface is comprised of an Asynchronous Serial Interface or UART (A9, A10), RS-232 driver/receivers (A30, A31, A38) and a rear panel connector (J301, J302).

L. ANNUNCIATORS

The ALPHA-6A-1 has four annunciators, all of them controlled by the main processor, Pl. The beacon, bell, message, lamp, and the fail relay are operated through driver/latch A37. The beeper is driven directly by two inverters of A17. The beacon and bell are powered through separate relays. Typically, both come on when a plutonium high alarm is given and the bell (acknowledge) relay drops out when any key is pressed. Parallel sets of relay contacts are brought to the rear panel from the beacon (alarm) and failure relays. These contacts do not receive power from the ALPHA-6A-1. They just provide switch closures.

The ALPHA-6A-1 has a power lamp which remains on while the instrument is powered.

SECTION V. MAINTENANCE

A. SET-UP/CALIBRATION

1. Nominal DC Voltage Settings

CONTROL	NAME	POSITIVE POINT	NEGATIVE POINT	NOMINAL VOLTAGE
R49	THRESH	A39-6	A39-8	0.100
R6	NULL	A29-1	A29-11	0.00 (NO FLOW)
R7	FLOW CAL	A29-12	A29-11	3.00

The THRESH control sets a minimum pulse height for pulses to be counted. When set at 0.1 volts, the first 25 channels should be zero or very nearly so. The setting excludes alphas with 1.7 MeV or less energy. The setting of the threshold control is not critical, as long as extraneous noise is excluded and significant alphas are not.

The ENGY CAL control R57, is used to correlate alpha energy to channel location on the spectrum display. When nominally calibrated, the resistance across this control will be approximately 26K ohms (power off) and, if desired, that resistance may be preset. The resistance of R57 may be measured between Q1 emitter and the upper lead of either R60 or CR12.

The NULL control is used to zero out any offsets in the air flow system when there is no air flow. The FLOW CAL control sets the full range DC level for the airflow A to D converter. It should remain close to three volts for best flow accuracy but a small variation is allowed when calibrating the system.

2. OFFSET Control

This control, R56, is used to balance the offset of the sample/hold amplifier, A40.

a. Connect A40 pin 2 to A40 pin 13, using a short jumper.

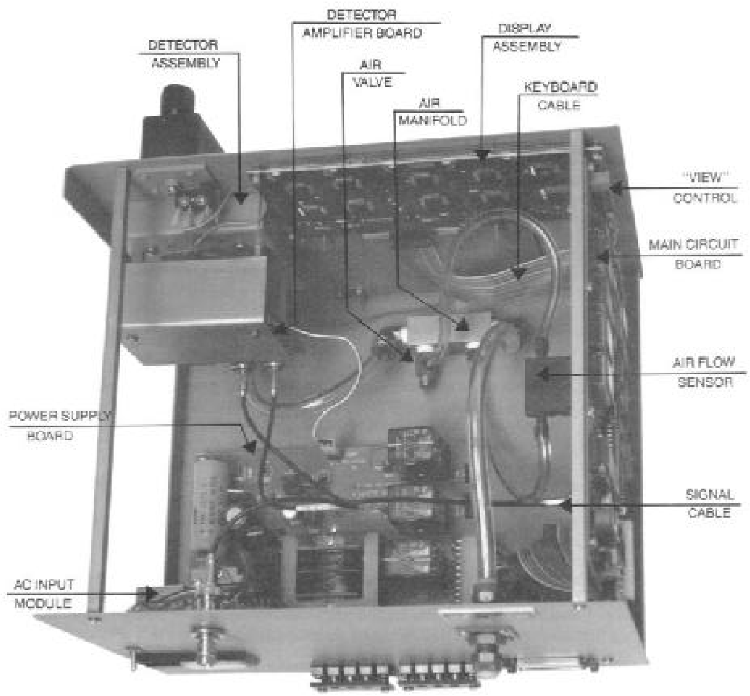
b. Connect a digital volt meter (DVM) between A40 pin, and A40 pin 13.

c. Adjust the offset control (R56) for a reading of zero volts on the DVM.

d. Remove the DVM and jumper.

Figure 5-1. ALPHA-6A-1, Rear View

Figure 5-2. ALPHA-6A-1, Internal View



3. Alpha Energy and Efficiency Calibration

a. Energy Calibration

Two controls are used to set the relationship of the alpha energy to the analyzer channel. The first is the GAIN control, R110, on the detector amplifier board and the second is the ENGY CAL control, R57, on the main board.

A high quality ^{239}Pu source is needed for accurate calibration of the ALPHA-6A-1, one which emits alphas with minimal internal energy attenuation. A one inch diameter centered active area should be provided, either by source design or by using a mask over the top of the source.

1) Place the ^{239}Pu source in the filter holder. (Include the one inch diameter mask if the active area diameter is more than one inch.)

2) Connect an oscilloscope to the SIGNAL OUT connector on the rear panel.

3) Adjust the GAIN control, R110, on the detector amplifier board to obtain a positive pulse of between 0.45 and 0.5 volts for the brightest part of the trace.

4) Disconnect the scope.

5) Reset the counters ([MENU], [2], [5], [ENTER], [VIEW]) and watch the spectrum begin to grow. The ^{239}Pu peak should grow into channel 116 (see Figure 2-1). If the calibration needs a large adjustment, this can be noticed rather quickly and time need not be spent trying to accurately find the present peak location.

   Adjust the ENGY CAL control, R57, as needed (cw to increase amplitude) to bring the ^{239}Pu peak to channel 116. Reset the counters and watch the peak grow again. Repeat steps 3 and 4 as needed to bring the peak near channel 116.

   When within 5 channels of nominal, the final adjustment may be made quickly by adjusting the resistance of R57. Set the ALPHA-6A-1 power switch OFF and measure the resistance between Q1 emitter and the upper lead of R60 or CR12. To raise the peak location, raise the resistance of R57 by 220 ohms per channel. To lower the peak, decrease the resistance by 220 ohms per channel.

6) Remove the resistance meter and turn on the ALPHA-6A-1. When the ^{239}Pu peak lies in channel 115, 116, or 117, calibration is acceptable. These channels stated in this procedure apply to a high quality source. The final confirmation should always be the location of the radium C' peak when the ALPHA-6A-1 is in operation. This peak should be set at channel 178, $\pm$ one channel. Re-adjust R57, if necessary, to meet this requirement once a radon progeny pattern is obtained. Any necessary adjustment here may also be made by the use of a resistance meter as described in step 5. above.

Substitute 150 ohms per channel in place of 220 ohms when locating channel 178.

When the ALPHA-6A-1 is in operation, it is most likely generating a radon daughter pattern (unless it is being used where the air is highly filtered). As long as the RaC' peak (^{214}Po) remains at channel 178 ± one channel, no operational benefit is gained by repeating this energy calibration procedure during periodic or routine maintenance.

b. Detector Efficiency Calibration

The ALPHA-6A-1 must be well calibrated to alpha energy before applying this procedure. See step a. above.

This procedure also requires a high quality alpha calibration source with a one inch diameter emission area. The thickness of the source plate win probably move the ^{239}Pu closer to the detector than that on a filter because of the additional o-ring compression. A two channel allowance is about right to account for this apparent increase in alpha energy.

1) Establish a region (Section II.B.1c.) from channel 106 to 122 so that history files are kept on the plutonium up-count region, shifted upward two channels to account for the source thickness. Region 9 is not originally in use. If no unused region is available, take any region after recording its boundaries and restore it to its original limits after calibration.

2) Place the ^{239}Pu source in the filter holder. The ALPHA-6A-1 will begin counting when the door is closed.

3) Review the one minute history file of the region established in step 1 above. The increase in each minute is the cpm recorded by the ALPHA-6A-1 for that source. Divide that number by the cpm emission rate coming from the one inch diameter active area being used to obtain the efficiency value. The 4Π efficiency should be about 19% of DPM under these conditions (38% of 2Π). (These efficiency values, taken only from the plutonium up-count region, will be slightly lower than would be obtained if gross count from the plutonium source were used.)

   Set User Constant (4) to the 4Π value obtained. See Section II.C.2. 4.

4. Background Subtraction Trimming

The default ALPHA-6A-1 program for ^{239}Pu includes "User Constant [3]" which is the background subtraction multiplying constant. Its default value is approximately correct for all ALPHA-6A-1 instruments but it may be trimmed for individual ALPHA-6A-1 units. The determination of whether an adjustment is needed can only be made over a longer period of time while the unit is in operation.

Strip chart presentations three and four (VIEW .3 or VIEW .4) plot the computed plutonium counts per minute values from the CPM history files. If Pu is absent from the filter, the average of the cpm computations should be around the zero line. If an average negative bias seems apparent, the subtraction constant, user constant [3], should be slightly decreased. This can be done from the ALPHA-6A-1 keyboard ([MENU], [2], [3], [new value], [ENTER], [VIEW] or over the REMOTE communications line. The new value to be used may be estimated by using the formula for CPM in Section III.A.3. and setting cpm = zero, no plutonium. In this case,

$$\text{CONST (3)} = \frac{\text{(ROI 1 gain)(ROI 4 gain)}}{\text{(ROI 2 gain)(ROI 3 gain)}}$$

The region gains can be taken from the region history files. Be sure to use the same time period for all four region gain values.

If the average computed cpm value seems to be biased above the zero line, in a positive direction, first make sure it is not due to a minute amount of Pu on the filter. If no Pu is present, use the procedure given above to slightly increase CONST 3.

5. Flow Measurement

The air system measures mass flow, independent of temperature and pressure. A mass flow standard should be used to calibrate the ALPHA-6A-1 measuring system.

a. With no air flow, adjust R6 for zero volts and adjust R7 for 3.00 volts. See A.1. of this section.

b. Connect the mass flow standard meter to the hose connector on the ALPHA-6A-1 rear panel. Connect a low pressure source to the standard meter and adjust the air flow for a reading of 1 cfm on the standard.

c. Use a small screwdriver to adjust the air valve on the ALPHA-6A-1 air manifold for a reading near 1.00 cfm on the ALPHA-6A-1 display. (This is a very sensitive adjustment, the valve being almost closed. The display update period is at least 5 seconds, so wait that long after each adjustment before taking a reading.)

d. When the adjustment in c. above results in a reading within 0.02 cfm of 1.00 cfm, the final settings may be made by adjusting R7. See A.1. of this section. To increase the reading, decrease the voltage on A29-12 about 60 millivolts per 0.01 cfm change. To decrease the reading, increase the voltage about 60 millivolts per 0.01 cfm change.

6. Power Fail Sense, P.SENS

The P.SENS control, R39 (installed on later ALPHA-6A-1 main boards), is used to calibrate the circuit which monitors the +5Vdc power line. If the power fails, the circuit quickly shuts down the ALPHA-6A-1 operation. A separate adjustable power supply capable of one half amp output is required for this calibration.

a. Set the ALPHA-6A-1 power switch to OFF.

b. Set the adjustable power supply to approximately 5 volts.

c. Connect the power supply to J4-5, positive, and to J4-6, negative. Connect a digital voltmeter to these points also. The tone generator may be silenced by pressing any key.

d. With another voltmeter, monitor the voltage at A32-4. This point is low when the +5Vdc line is normal.

e. Set the power supply output to 4.58 volts.

f. If necessary, adjust R39 in a cw direction until A32-4 is low. Then adjust R39 in a ccw direction until A32-4 just goes high to over 4 volts.

g. Remove the power supply and voltmeters.

B. AIR SYSTEM INTEGRITY

Several o-rings are used in the detector and filter holder assemblies and when the door is closed the two must mate without air leaks.

Four slots in the rear detector bracket allow the detector assembly to move to provide optimum coupling with the filter holder. A good way to make this adjustment is to:

1. Loosen the screws in the slots.

2. Latch to door shut.

3. Turn on air flow.

4. Lift off the intake screen assembly and slowly block off the intake.

5. Let the vacuum pull the assemblies together and tighten the four screws before slowly removing the intake blockage.

6. Replace the intake filter assembly.

To check for air in-leakage, measure the air flow rate at the intake stack and compare it with the flow rate at the rear panel hose connector. Ten percent or less in-leakage is usually acceptable.

C. AC POWER INPUT CONVERSION

The power input module, A303, has provisions for four nominal input voltages, 100, 120, 220, and 240, but in order to utilize all four, a three primary power transformer is needed. The ALPHA-6A-1 transformer only has two primaries, so only the 120 and 240 circuits are active. When the module circuit board shows 120, the input voltage range is 110 to 125 volts. With the board showing 240, the input range is 220 to 250 volts. To convert from one voltage range to the other, unplug the power cord, slide open the window, remove the fuse and remove the circuit board. Re-insert the board with the proper voltage showing and re-assemble the module. With either voltage range, the frequency may be from 50 to 60 cycles.

D. DISASSEMBLY AND REASSEMBLY

1. Cover

To take off the cover, remove the four screws holding it, lift off the intake screen assembly and lift the cover straight up. The beacon and bell connectors will pull free of the power supply board.

To remove the bell, remove the single screw near the bottom of the bell which holds the outer assembly to the mounting plate. Pull the assembly outward to disengage the connector and lift off. This provides full access to the screws holding the mounting plate to the cover.

To remove the beacon, unscrew and remove the band holding the lens. Remove the lens. Remove the two screws holding the beacon to cover and lift off the beacon. When re-installing the beacon, do not over tighten the two screws holding it to the cover, so that the cover becomes warped.

When re-installing the cover to the chassis, hold the cover close and re-connect the bell and beacon to the connectors on the power supply board. They are coded by pin count and cannot be installed backwards.

2. Power Supply Board

Unplug all connections to the board. Remove the five screws holding it and lift out the board. When re-installing the board, all connectors are coded by pin count except the two plugs going to J6. These plugs go to the nearest three pins, they do not cross. Make sure all plugs mate the receptacles evenly, not offset, exposing a free pin.

3. AC Input Module

To remove the module assembly, unplug it from the power supply board, disconnect the ground lead, dismount the power switch from the rear panel, compress the mounting springs at both sides of the module and pull the assembly from the rear panel.

4. Main Board

a. On the back of the board, remove the hoses from the air sensor and disconnect the signal cable.

b. Unplug all the cables from the edges of the board.

c. Remove the eight screws holding the board and slide the board rearward to disconnect it from the display plug. The MESSAGE and POWER lamps slip out of the holes in the front panel.

d. When re-installing the board, have the two lamps in place and guide them into the holes as the board is moved forward to engage the display connector. Bend the lamp leads around to the front of their connectors to prevent their movement to the rear. Re-install the 8 screws.

e. Re-install all of the connectors and hoses on the front and back of the board.

1) The front hose on the sensor goes to the hose fitting on the valve.

2) The cable from the PRINTER connector goes to the lower 12 pins of J5 and the cable from the REMOTE connector goes to the upper 12 pins. One pin between them remains vacant.

3) The cable from the keyboard connects to the upper 9 pins of J3 and the single contact connector from the door switch goes to the bottom pin of J3. One pin between them remains vacant. When the cable to the keyboard is properly installed, the top wire at the board goes to the keyboard pin nearest the main board.

5. Display

To remove the display, remove the eight screws holding the main board and slide the board to the rear to disengage the display connector. (No cables or hoses need be disconnected from the main board.)

Remove the four locknuts and remove the display. The protective window is also free. When re-installing the display, lay the protective window on top of the keyboard and slip the display over the four studs. Check the positions of the inner nuts on the studs. The display board should just touch the window and the nuts at the same time so that the display board is not warped when the outer nuts are tightened. Set the outer nuts snug, not very tight.

6. Keyboard Assembly

For easier access to the keyboard, first remove the two screws holding the air manifold assembly to the chassis floor. The manifold is freed to move out of the way.

Disconnect the cable from the keyboard. Remove the four outer nuts from the assembly and slide the assembly back off of the studs and lift it out. Remove the four inner nuts to separate the keyboard from the mounting plate. When reassembling, make sure the insulating sheet is placed between the keyboard and the mounting plate. Pull all eight nuts only snug, not very tight. Don't warp the mounting plate. When the cable is installed, the top wire at the main board goes to the keyboard pin nearest the main board.

7. Detector Assembly

a. Detector Amplifier Board Removal

1) Remove the two screws holding the shield over the board. Remove the shield.

2) Disconnect the two BNC cables and unsnap the BNC connector from the detector.

3) Unplug the power connection, P202, from J202 on the power supply board.

4) If the board is to be completely removed, unsolder the three wires coming from the door switch.

5) Remove the two spacers and the two screws holding the board in place. Remove the board (or move it aside, out of the way).

6) When re-installing the board, guide the BNC connector onto the detector. The spacers are used to hold the top of the board and the screws the bottom. Snap the BNC onto the detector.

7) If removed, solder in the wires from the door switch. The bottom switch terminal connects to C on the board, the middle to A, and the top one to B.

8) If a new board is to be installed, transfer the two-wire power cable from the old board to the new one. With the connector plugged on to the power supply board, the wire nearest to the three relays goes to D on the detector board. The other wire goes to E.

9) Connect the BNC cable from the main board to the detector board connector nearest to the main board. Connect the cable from the rear panel to the other connector on the detector board.

10) Re-install the shield over the detector board.

b. Detector Replacement (Use care not to damage the surface of the detector.)

1) Remove the detector amplifier board per 7.a. above. Do not unsolder any wires. Swing the board to the outside of the chassis.

2) Open the door for added access.

3) Remove the upper two screws from the slotted holes. Loosen slightly the bottom two screws in the slotted holes.

4) Remove the two screws which hold the detector mount (with intake pipe) to the rear bracket.

5) Rotate the assembly downward toward the back and remove the detector mount.

6) Pull the old detector from the mount.

7) Rub a film of o-ring lubricant on the o-ring and insert the new detector.

8) Re-install the detector mount in the rear bracket using the two screws and lockwashers.

9) Install the rear bracket into the front bracket using the four screws and flat washers. Do not fully tighten these four screws yet.

10) Reinstall the amplifier board assembly per 7.a. above.

11) Close the door and latch it firmly.

12) Turn on the air flow and slowly close off the intake stack and allow the vacuum to draw the parts together. While maintaining the vacuum, tighten the four screws in the slots. Slowly unblock the intake stack.

c. Door Switch Adjustment

The switch actuator leaf has a small adjustable screw through it. Make the adjustment so that the switch actuates and deactuates when the door is between 1/16 and 1/8 inch from the front panel. Make sure the actuator assembly does not bind on the front panel. Moderate bending of the leaf is acceptable to assure free movement and to make the final adjustment.

E. ROUTINE MAINTENANCE

The ALPHA-6A-1 requires very little routine maintenance. The software continuously checks for a low battery condition, therefore the operator should not have to change out the battery unless notified.

It is necessary to periodically change out the filter. The operator should first turn off air flow to the monitor and open the front panel door. This will cause the counters in P2 to be halted and spectrum acquisition to be suspended. The monitor will enter an alarm condition due to the lack of air flow and the opened door. The operator may silence the alarm by pressing any key. To switch out the filter, remove the retaining ring, remove the old filter, place a new filter on the filter head assembly, replace the retaining ring and close the door. The monitor will reset P2 counters to clear the spectrum, reset the air volume register and resume counting.

When the detector face becomes visibly dirty, it may be cleaned with a very gentle application of trichlorethylene or methanol. Avoid Freon^R sprays and others which may contain the fluorine ion.

F. TROUBLESHOOTING

1. CLK Fail

This failure occurs if the date or time acquired from the clock is not valid or ff the clock data does not change. First reset the clock via the System Setup Menu and if this fails to correct the problem replace the clock chip and/or the oscillator (A34, Y2).

2. LO Counts

This failure occurs when the detector processor does not receive any counts from the detector for two minutes. This may indicate that the detector itself has failed. Make sure the coaxial cable from the detector is connected.

3. P2 Fail

This condition exists when the detector processor (P2) is not responding to polls from the main processor. At very high count rates it is possible that a P2 FAIL will occur momentarily, but the condition should clear immediately. If the condition persists, verify that P2 is seated in its socket (A2) correctly and check for bent pins. The problem may be related to Port 3 on the main processor which is used to transmit and receive messages to and from P2. Try a hardware reset on P2 by momentarily jumpering A2, Pin 40 to A2, Pin 9 while the power is on.

4. Noise Alarm

This alarm may have occurred due to line noise or due to other external events. The ALPHA-6A-1 software relies heavily on proper operation of the door switch to prevent noise counts due to light leaks. Check to make sure the door switch is operating properly (see the "DISASSEMBLY AND REASSEMBLY" section for details).

5. False Alarms

If an apparent false alarm continues to occur, check for a shift in the radon spectrum location, or for counts due to noise. If the monitor is not operating in the default configuration, it may be that the regions of interest, user variables and alarm setpoints are not defined properly to correctly measure contamination. If the default configuration is being used, re-perform the steps listed in SECTION V.A.3., Alpha Energy and Efficiency Calibration, to assure that the spectrum is positioned properly.

6. Low Battery

The battery voltage has dropped low enough to trigger a low battery warning, it is recommended that the battery be replaced immediately.

7. Air Flow Measurement

Check A26, A27, A28, A29 and the settings of R6 and R7. See V.A.5. Check the condition and installation of the air hoses. The hose from the detector door goes to the barb on the air manifold nearest the door. The other end of the manifold connects to the rear panel. The small barb on top of the air valve connects to the front of the sensor on the main board. The back of the sensor connects to the other small barb installed directly on the manifold.

8. Other If it is difficult to identify or isolate what is actually causing problems with the monitor, try to investigate areas of the monitor one functional block at a time. A list of functional blocks which might need to be checked are listed below.

Pre-Amplifier: See the pre-amplifier board schematic, 11285-C03.

Power Supply: See the power supply board schematic, 11410-1301.

Spectrum Acquisition/256 Channel Analyzer. Check A39, A40, A41, A42, A43, A44, A2, A6, A3 and A12 (main board).

RS232 Communication Printer Port (Port #1): Check A10, A31 and J302 (main board).

Remote Port (Port #2): Check A9, A30, two gates on A38 and J302 (main board).

Address Decoding: Check Al, A19, A24, A15 (main board).

Main Processor and Memory: Check Al, A4, A5, A7, A8 (main board).

Keyboard: Check A302, A25, and one gate on A18 (main board).

Alarm Annunciators: Check A37 (main board) and the power supply board.

Real Time Clock: Check A34, Y2, and one gate on A33 (main board).

Battery Backup: Check A32, A33, BT1 (main board).

SECTION VI. PARTS LIST

The following table lists the electronic items incorporated in the ALPHA-6A-1 and should contain any part necessary for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

1 . ALPHA-6A-1 Main PC Board, EIC P/N YP11527003

Al, A2	Integrated Circuit	CMOS Processor	Intel 80C31	ICCMA8OC31(8)
*A3, A4, A5	Integrated Circuit	CMOS EPROM	Intel D27C256	ICCMA27256(l)
A6, A7, A8	Integrated Circuit	RAM 32KX8 CMOS	150 NS, L0 I	ICCM43C256(3)
A9, A10	Integrated Circuit	ASYNC SER COMM	Intel 82510	ICCMA82510(8)
A12, A13	Integrated Circuit	Octal Buffer	74HC373	ICHCA74373(2)
A14, A15, A41	Integrated Circuit	Quad 2-IN OR		74HC321CHCA00032(0)
A17	Integrated Circuit	Hex Invertor	74HC04	ICHCA04(0)
A18, A43	Integrated Circuit	Quad 2-IN NAND	74HC00	ICHCA00(8)
A19	Integrated Circuit	Dual 4-IN NAND	74HC20	ICHCA20(6)
A23	Integrated Circuit	Dual Monostable	74HC4538	ICHCA4538(3)
A24	Integrated Circuit	3 to 8 Line	74HC138	ICCMAHC138(5)

*Programmed with ALPHA-6A-1 software.

A25	Integrated Circuit	20 Key Encoder	74C923	ICCMA923(1)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
A26	Air Flow Sensor	Mass Air Flow Sensor	Microswitch AWM2100V	MTTM18(1)
A27	Integrated Circuit	Dual Op Amp	LM358N	ICAOA00358(7)
A28	Integrated Circuit	Instrumentation Amplifier	Burr-Brown INA102	ICAAA102(2)
A29	Integrated Circuit	8 Bit A/D Converter	Analog Devices AD7820	ICCMA7820(1)
A30, A31, A38	Integrated Circuit	RS-232 Driver/ Receiver	Motorola MC145406	ICCMA45406(2)
A32	Integrated Circuit	1.15 V, 8 Pin Ref/Compar.	Intersil ICLS212	ICACA8212C(2)
A33	Integrated Circuit	Dual Comparator, CMOS	T.I. TLC372	ICACA372(3)
A34	Integrated Circuit	CMOS Real Time Clock	OKI MSM6242RS	ICCM6242(6)
A37	Integrated Circuit	Quad Relay Driver	Sprague UCN5800A	ICXXA5800A(6)
A39	Integrated Circuit	Quad Comparator	Motorola MC3430P	ICACAC3430(3)
A40	Integrated Circuit	Sample/Hold	Harris HA3-2425-5	ICSHA2425(9)
A42	Integrated Circuit	Dual D FF	74HC74	ICHCA74(3)
A44	Integrated Circuit	8 Bit Counter	T.I. SN74HC590AN	ICHCA590(4)
A45	Integrated Circuit	Volt Reference	National LM113H	ICAVC0113H(7)
BT1	Battery	Coin, No Leads	Lithium 2450B	BTXX3(l)
Cl, C7, C31	Capacitor	1.0 F, 35 V, 10%	Sprague 196D	CPXX11(9)
C2, C44	Capacitor	.01 F, 50 V, 10% or 20%		CPCE103P3N(9)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
C3, C4	Capacitor	120 F, 10 V, 10%	150D/T110	CPTAl2lM3F(4)
C5	Capacitor	33 F, 10 V, 10%	Sprague 196D	CPXX12(8)
C6, C13, C16, C23, C30, C33, C38, C39, C46	Capacitor	.1 F, 50 V, 10%	CW20C104K	CPCE104P3N(7)
C8, C9	Capacitor	18 pF, 100 V, 10%	ET05	CPCE180P3P(5)
C15, C34, C35, C37, C40, C43, C45	Capacitor	10 F, 16 Vdc 20%		CPTAl00M4X(3)
C17, C36	Capacitor	33 pF, 100 V, 10% or 20%		CPCE330P3P(6)
C18	Capacitor	22 pF, 200 V, 10%		CPCE220P3R(7)
C24, C25, C27	Capacitor	22 F, 15 V, 20%	196D/T362	CPTA220M4H(0)
C28, C32, C41	Capacitor	1000 pF, 100V, 10%	CRL CN20	CPCE102P3P(9)
C29	Capacitor	.0047 F, 80 V	192P4729R8	CPPF472P30(5)
CR1, CR9, CR10, CR11	Diode		1N4148	CRSIlN4148(7)
CR2, CR5, CR7, CR8	Diode		1N5817	CRSClN5817(0)
CR3, CR4, CR6	Diode		1N5711	CRSI1N5711(1)
CR12	Diode		ECG109	CRGEECG109(4)
DS1	Speaker	Micro-Buzzer	Citizen MEB-12-5	ADSS6(3)
J1	Connector		Molex 22-15-2206	COMR120(7)
J2, J7	Connector		Molex 22-15-2026	COMR502(6)
J3	Connector		Molex 22-05-3111	COMR211(4)
J4	Connector		Molex 09-75-1118	COMR411(0)
J5	Connector		Molex 22-05-3251	COMR525(7)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
J6	Connector	BNC PC Mount Receptacle		CXBN23(2)
Q1, Q2	Transistor		2N5088	TRSN2N5088(3)
R1	Resistor	150 ohm, 1%, 1/4 W	RN55D	RECE151B12(1)
R2	Resistor	1.8k, 5%, 1/4 W		RECC182B22(6)
R3	Resistor	22M, 5%, 1/8 W		RECC226B21(2)
R4, R5	Resistor	24.3k, 1%, 1/4 W	RN55D	RECE243B12(6)
R6, R39, R56	Potentiometer	100k	Bourns 3299W-1-104	PTCE104B03(5)
R7	Potentiometer	5K	Bourns 3299W-1-502	PTCE502B33(4)
R10, R42	Resistor	1M, 5%, 1/8 W		RECC105B21(8)
R11	Resistor	100k, 5%, 1/4 W		RECC104B22(0)
R12	Resistor	390 Ω,5%,1/4 W		RECC391B22(3)
R13	Resistor	10M, 5%, 1/8 W		RECC106B21(6)
R14	Resistor	2M, 5%, 1/8 W		RECC205B21(6)
R15	Resistor	9.09k, 1%, 1/4 W	RN55D	RECE912B12(6)
R16, R17, R46, R52, R58, R59	Resistor	10k, 1%, 1/4 W	RN55D	RECE103B12(2)
R18, R51	Resistor	220 Ω, 5%,1/8 W		RECC221B21(3)
R21	Resistor	22k, 5%, 1/4 W		RECC223B22(8)
R22	Resistor	5.1k, 5%, 1/4 W		RECC512B22(4)
R23	Potentiometer	10k, 10%	Bourns 3299W-1-103	PTCE103B33(l)
R31	Resistor	120 S, 5%, 1/4 W		RECC121B22(4)
R32	Resistor	180 S, 5%, 1/4 W		RECC181B22(8)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
R33	Resistor	56k, 5%, 1/4 W		RECC563B22(7)
R34	Resistor	100 S, 5%, 1/8 W		RECC101B21(7)
R40	Resistor	10k, 5%, 1/8 W		RECC103B21(3)
R41, R61	Resistor	5.1k, 5%, 1/8 W		RECC512B21(5)
R43, R44, R54, R55	Resistor	100k, 5%, 1/8 W		RECC104B21(l)
R45	Resistor	510, 5%, 1/8 W		RECC511B21(7)
R47	Resistor	62k, 5%, 1/8 W		RECC623B21(0)
R48	Resistor	3.01k, 1%, 1/4 W		RECE302B12(0)
R49	Potentiometer	1k	Bourns 3299W-1-102	PTCE102B03(9)
R50	Resistor	1k, 1%, 1/8 W	RN50D	RECE102B11(5)
R53	Resistor	2k, 5%, 1/8 W		RECC202B21(3)
R57	Potentiometer	50k	Bourns 3299Y-1-503	PTCE503B23(4)
R60	Resistor	4.75k, 1%, 1/4 W		RECE472B12(1)
Y1	Crystal	12 MHz Quartz Crystal	M-TRON MP-1 HC-18/u	CYOS14(3)
Y2	Crystal	32.768 kHz Crystal	Valpey-Fisher NC38	CYOS13(4)

2. ALPHA-6A-1 Chassis

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
		Alpha Detector		CYDE6(2)
S101		Detector Door Switch		SWMI14(3)
		Keyboard Assembly		YP11410022(0)
		Keyboard Cable		VECA4(9)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
		RS-232 Communication Cables		VECA5(6)
A301	Display Assembly	LCD 256x64 Dot Matrix and Header		YP11410023(9)
	Display Window	Plastic Sheet		ZP11410029(1)
DS301		Message Lamp, Yellow		OPLP31(8)
DS304		Power Lamp, Green		OPLP32(7)
S301		Off/On Switch		SWTO3(5)
A303		AC Input Module		YP11410024(8)
		AC Power Cord	Belden 17250	WRAC4(4)
F301		1 Amp	Slo-Blo 313001	FUSB12(1)
	Cable	9" Long	BNC-BNC-RG174	CA-61-09(3)
		Air Flow Sensor Valve		FGBR56(3)
		Air Flow Valve Barb		FGBR57(2)
		Large Air Tubing		MMTU2(9)
		Small Air Tubing		MMTUl(l)
		Painted Bell		ZP10846060(7)
	Beacon	Red	Federal 121-S-120V	LPAS9(3)
J303		Signal Out Connector		CXBN24(l)
		Filter Disc	SMWP04700	FIFPl(9)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
C301	Capacitor	.01 F, 1 kV, 20%	5GA-Sl0	CPCEl03P4U(7)
	O Ring	Inside Intake Cap		ORBN2206(7)
	O Ring	Seals Detector Body		ORBN2027(4)
	O Ring	Largest, Seals to Clamp Ring		ORS12228(4)
	O Ring	Holds Clamp Ring on		ORBN2133(5)
	O Ring	Presses against the Filter		ORBN2031(8)
	O Ring	On Screws in the Door		ORBN2006(9)

3. ALPHA-6A-1 Preamplifier Board, EIC P/N YP11285000

A101	Integrated Circuit	Op Amp	RCA CA3140E	ICAOC3140S(l)
A102	Integrated Circuit	Op Amp	Motorola MC14575CP	ICAOA14575(5)
A103	Voltage 12 V Regulator		MC78L12CP	ICAVA78L12(6)
C102	Capacitor	6.8 F, 35 V	Epoxy	CPXX14(6)
C103	Capacitor	0.01 F, 200 V	Type 192P	CPPF103P3R(3)
C104, C108 C112	Capacitor	0.1 F, 50 V, 10%	CW20C104K	CPCE104P3N(7)
C105	Capacitor	2.2 F, 20 V, 10%	150D/T110	CPTA225P31(7)
C106	Capacitor	4.7 pF, 1 kV, 5%	10TCC-V47	CPCE472F2U(2)
C107	Capacitor	0.01 F, 80 V	Type 192P	CPPF103P3O(6)
C109, C110	Capacitor	15 F, 20 V, 10%		CPTA150M31(0)
C111	Capacitor	68 F, 20 V, 10%		CPTA680M31(6)
C113	Capacitor	3.3 F, 50 V, 10%		CPTA335P3N(7)
CR101	Diode	Current Source, 0.43 mA	1N5289	CRZR1N5289(7)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
Q101	Transistor	J-FET, N-Channel	2N4220	TRJN2N4220(9)
Q102	Transistor	Silicon, NPN	2N4124	TRSN2N4124(2)
Q103	Transistor	Silicon, NPN	2N4401	TRSN2N4401(6)
R101, R104	Resistor	5.11k, 1%, 1/4 W		RECE512B12(4)
R102, R107	Resistor	60.4k, 1%, 1/4 W		RECE603B12(1)
R103, R113	Resistor	1k, 1%, 1/4 W		RECE102B12(4)
R105	Resistor	402k, 1%, 1/4 W		RECE404B12(4)
R106, R108	Resistor	10k, 1%, 1/4 W		RECE103B12(2)
R109, R115	Resistor	20k, 1%, 1/4 W		RECE203B12(0)
R110	Potentiometer	200k	Bourns 3299W-1-204	PTCE204B13(1)
R111, R112	Resistor	100k, 1%, 1/4 W		RECE104B12(0)
R114	Resistor	10 S, 5%,1/4 W		RECC100B22(8)

4. ALPHA-6A-1 Power Supply Board Assembly, EIC P/N YP11408003

A201, A203	Bridge Rectifier	1A, 100 V, Dip Pack	Varo VM18	CRARVM18(3)
A202	Rectifier		Varo VS148	CRARVS0148(7)
A204	Integrated Circuit	24V Voltage Regulator	MC7824P	ICAVX7824P(9)
A205	Integrated Circuit	8 V Voltage Regulator	UA7808UC	ICAV7808(2)
A206	Integrated Circuit	+5 V Regulator	7805K	ICAV7805K(7)
A207	Integrated Circuit	Neg. Adjustable Regulator	LM337F	ICAV337T(3)
A208	Integrated Circuit	Neg. 5 V Regulator	7905CT	ICAV7905CT(0)
C201	Capacitor	680 F, 50 V	Type 513D	CPAL681M4N(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
C202	Capacitor	4000 F, 16 V	TVA 1175.4	CPAIA02MXH(6)
C203	Capacitor	220 F, 25 V	Type 513D	CPAL22lM4J(9)
C204, C205, C206, C207, C208	Capacitor	1.0 F, 35 V, 10%	Type 196D	CPXXll(9)
C209, C210	Capacitor	0.001 F, 1 kV, 10%	Z5R	CPCE102P3U(1)
C201	Diode	5 V Trans. Supp.	TVS505	CRZRTVS505(5)
J201	Connector	PC Connector	Molex 09-75-1118	COMR411(0)
J202	Connector	Connector Housing	Molex 09-60-1021	COMR802(0)
J203	Connector	Connector Housing	Molex 09-60-1031	COMR803(8)
J204	Connector	4 Pin Connector	Molex 09-60-1041	COMR304(7)
J205	Connector	5 Pin Connector	Molex 09-60-1051	COMR305(4)
J206	Connector	Connector Housing	Molex 09-60-1061	COMR406(0)
K201, K202, K203	Relay	24 Vdc	P&B KHU17Dll	RLGP2(2)
R201	Resistor	1.91k, 1%, 1/4 W	RN55D	RECE192B12(5)
R202	Resistor	226 S, 1%, 1/10 W		RECE22lBll(3)
R203	Resistor	100 S, 1%, 1/4 W	RN55D	RECE101B12(6)
R204	Resistor	750 S, 1%, 1/4 W	RN55D	RECE751B12(8)
R205, R206	Resistor	330 S, 5%,1/4 W		RECC331B22(9)
T201	Transformer		Hobart 60H1293	TFPO39(9)

APPENDIX A.   REMOTE PORT COMMANDS

The ALPHA-6A-1 supports the following remote port commands when configured for ASCII communication (when REMOTE.PROTCL = ASCII).

Command	Function
ACCESS	Control keypad security access
BOOT	Re-boot the ALPHA-6A-1, load the default configuration
COUNT	Start or stop the counters
DATE	Retrieve or edit the date
DEFINE	Download the equation used to evaluate a user variable or establish or change a region of interest
DISPLAY	Display a spectral graph or strip-chart graph on the ALPHA-6A-1 display
EVAL	Retrieve the value of a variable
LIST	Retrieve a text file
LOG	Set the auto-logging interval of a user variable, program variable, or region
PRINT	Print a text file
RESET	Reset the Counters, zero the air flow volume register
SET	Retrieve or edit a variable
STATUS	Retrieve the current monitor status
TIME	Retrieve or edit the time
VERSION	Retrieve firmware name and version number

This appendix provides a description of each command along with format information and examples. Please note that all command words must be entered in upper case and must have a blank separating the command word from the rest of the command line.

ACCESS

This command is used to allow or deny access to all the ALPHA-6A-1 functions from the keypad. (The SET command is used to change the security code.)

To allow access:
Format: **ACCESS** code
Example: **ACCESS** 1287

To deny access:
Format: **ACCESS** (return)
Example: **ACCESS**

BOOT

This command resets the main processor (Pl), clears non-volatile memory, re-initializes the ports, the processor clock, the keypad and the display and clears alarm flags. The detector processor (P2) and the real time clock are not affected.

Format: **BOOT**

COUNT

This command is used to control the channel counters maintained by the detector processor (P2).

Format: **COUNT** (start the counters)
COUNT STOP (stop the counters)

DATE

This command allows the operator to read or set the date.

Format: **DATE** [mm/dd/yy]

If mm/dd/yy is specified, the instrument will set the date accordingly, otherwise it will send the time and the date.

Example: **DATE** 06/24/88

DEFINE

This command is used to specify the equation used to calculate a user variable and to specify the channels which make up a region of interest (ROI).

Format: **DEFINE** var = expression

The expression used to define a user variable must be entered in Reverse Polish Notation (RPN) with commas used to denote a PUSH operation where a variable or previously evaluated sub-expression is saved on the stack for later use.

The expression may consist of the following elements:

USER VARIABLES	A, B, C, D, E
REGIONS OF INTEREST	Q, R, S, T, U, V, W, X, Y, Z
PROGRAM VARIABLES	F, H, I
USER CONSTANTS	CONST(l), CONST(2), CONST(3), CONST(4), CONST(5)

OPERANDS +, -, /, *, ^, ..,LN, SQRT, EXP, LOG, ABS

CONSTANTS integer or real, inside parenthesis, ( )

The caret symbol(^) is used to raise a variable or expression to the nth power where n may be a single digit only (0-9). The symbol represented as two dots (..) is used to designate a range of members in an array. For example, the expression CH(5..25) refers to channels 5 through 25. The asterisk (*) is the multiply symbol.

Several examples of Reverse Polish Notation are provided below:

<u>EXPRESSION</u>	<u>RPN EQUIVALENT</u>
$[(R \times S)^2 / (V + W)] + 1$	R,S*2^,V,W+/,(1)+
$[(A + B) \times (C / D)] / (R \times S)$	A,B+,C,D/*,R,S*/

The following expression is used by the default configuration to calculate the plutonium measurement sigma (user variable E).

$$\text{SIGMA(E)} = \sqrt{[R-R(59)] + \left[\text{CONST(3)} \times \frac{T-T(59)}{U-U(59)+1} \right]^2 \times [S-S(59)]}$$

The preceding expression would be expressed in a **DEFINE** command using Reverse Polish Notation as follows:

DEFINE E = R,R(59)-,CONST(3),T,T(59)-,U,U(59)-,(1)+/*2^,S,S(59)-*+SQRT

Variables R, S, T, and U represent the total counts currently accumulated in regions of interest 1, 2, 3, and 4 respectively. R(59), S(59), T(59), and U(59) are history file entries (counts) stored previously for regions 1, 2, 3, and 4. Array indices 0-63 specify one-second history file entries where 0 is the most recently stored data point. Therefore, R(59) represents the total counts accumulated in Region 1 one minute ago (History files are updated after the user variables are calculated. Therefore, R(59) was stored exactly sixty seconds ago). Array indices 64-127 are used to represent one-minute entries, 128-191 to represent one-hour entries and 192-255 to represent one-day entries.

A <u>region of interest</u> is defined by specifying its channel boundaries as follows:

DEFINE T = CH(2..42)

This example defines region of interest 3 (T) to be the block of channels beginning with channel 2 and ending with channel 42. The lower channel must be entered before the higher one.

DISPLAY

This command may be used to cause the ALPHA-6A-1 to display (on its own LCD display) a spectral graph of any region of interest (Regions 0-9) or the strip-chart graph of an alarm variable (Alarm Set points 1-6).

Format: **DISPLAY** Identifier

Identifier may be the ASCII characters Q-Z which represent regions of interest 0-9 or the ASCII digits 1-6 which represent Alarm Set points 1-6.

Examples: **DISPLAY** U (spectral graph for ROI 4)
DISPLAY 2 (strip-chart for Alarm Set point 2)
DISPLAY Q (spectral graph for ROI 0, the entire spectrum)

The monitor will respond by displaying the graph or strip-chart specified.

EVAL

This command is similar to the SET command, but allows the operator to retrieve the current value of a variable with no possibility of inadvertently modifying it. Table A-3 lists the variables which may be used in the **EVAL** command.

Format: **EVAL** variable

Examples: **EVAL** ALARM(3).ALM_NAME
EVAL A.NAME
EVAL PRINTER.BAUD
EVAL ORDER

The monitor will return the current value of the variable specified.

LIST

This command may be used to retrieve a text file from the ALPHA-6A-1. The files which may be acquired are listed in Table A-4.

Format: **LIST** filename

Examples: **LIST** A.SEC
LIST F.HOU
LIST U.DTL
LIST U.MIN

LOG

This command is used to set the auto-logging interval for the user-variable, program variable or region counts specified. The operator may choose to print the value every minute, every hour, every day, or not at all.

Format: **LOG** user variable EVERY interval
LOG user variable NEVER

Valid user variables are A, B, C, D, and E.

Valid program variables are F, G, H, and I.

Valid regions are Q through Z.

Valid intervals are MIN, HOUR, DAY, and NEVER.

Examples: **LOG** A EVERY MIN
LOG B NEVER
LOG D EVERY DAY
LOG I EVERY HOU
LOG Q EVERY HOU

The default auto-log interval for all items is NEVER.

PRINT

This command may be used to print a text file. The files which may be printed are listed in Table A-4.

Format: **PRINT** filename

Examples: **PRINT** Q.DTL
PRINT C.DAY
PRINT F.HOU
PRINT Z.MIN
PRINT Z.DTL

RESET

This command resets the detector processor (P2) which clears the channel counters and zeros the spectrum. It also resets the air flow volume to zero.

Format: **RESET**

SET

This command allows the operator to view and edit the variables listed in Table A-3.

Format: **SET** variable [= value]

If the "[= value]" is omitted, the present value is returned. (For present value information, the EVAL command may be preferred to avoid making an accidental change.)

If a value is assigned, the monitor will set the variable to the value specified. The value sent must conform with the type indicated for that variable in Table A-3.

The variable types listed in the table are described below:

STRING (N) An ASCII string of maximum length N

BYTE 0-255, entered in decimal (21) or binary (00010101B) format, no decimal points

INTEGER Positive, 0-32767, no decimals, no commas

CHAR Single ASCII character

DIGIT Single ASCII numeric character

REAL	Positive or negative, 0.0001 - 9999999, entered in decimal (625) or exponential (6.25E2) format, no commas, decimal points are permitted, integer exponents (positive or negative), 7 places of precision (23432.778 = 23432.780), values that are too large are represented by a row of asterisks.

Many of the parameters which may be **SET** are record elements and they must be referenced by entering the record name followed by a "dot" and the parameter name. For example:

SET REMOTE.BAUD = 9600
SET A.UNITS = CPM
SET CONST(l).VALUE = 1.0
SET CONST(l).NAME = NOM.FLOW

Parameters which are not record elements are set as follows:

SET PROMPT = ID
SET CODE = 2468
Security access code is now 2468
SET DETAIL(2) = M
Strip chart number 2 time scale is now minutes
SET DETAIL(4) = D
Strip chart number 4 time scale is now days

The **SET** command is used to configure printer port and remote port parameters as shown below:

SET PRINTER.BAUD = 2400
SET PRINTER.PARITY = NONE
SET PRINTER.DATABIT = 8
SET PRINTER.STOPBIT = 1
SET PRINTER.TERM = CRLF
SET PRINTER.HNDSHK = DTR
SET PRINTER.TIMEOUT = 2000
SET PRINTER.EOF = 10

SET REMOTE.BAUD = 9600
SET REMOTE.PARITY = EVEN
SET REMOTE.DATABIT = 7
SET REMOTE.STOPBIT = 1
SET REMOTE.TERM = CR
SET REMOTE.ECHO = ON
SET REMOTE.PROTCL = ASCII
SET REMOTE.ADDRESS = 1
SET REMOTE.HNDSHK = DTR
SET REMOTE.PROMPT = ID
SET REMOTE.ERRCHK = NONE
SET REMOTE.TIMEOUT = 0
SET REMOTE.EOF = 4

Table A-1 provides a complete list of the printer port parameters which may be edited using the **SET** command. It also includes a list of valid settings for each parameter and the default setting assigned to each parameter on a cold start. Table A-2 provides the same information for the remote port parameters.

The **SET** command is also used to select the ALPHA-6A-1 prompt. The type of prompt used is selected as follows:

SET PROMPT = CHAR (use a single character, P_CHR)
SET PROMPT = ADDR (use a 3 digit address, UNIT_ADDR)
SET PROMPT = ID (use an ASCII identifier, ID)

In addition to selecting the type of prompt, the operator must select the values for P_CHAR, UNIT_ADDR, and ID as follows:

SET P_CHAR = 62	(enter the decimal value of the ASCII character desired)
SET ID = ALPHA-6A-1	(enter up to 8 ASCII characters)
SET UNIT_ADDR=001	(enter 3 digit address, 001-255), (1-9 if ASCII protocol is used).

The **SET** command is used to set the parameters associated with an alarm set point, as shown below for user alarm 3.

SET ALARM(3).ALM-NAME = Fast Alm
SET ALARM(3).ALM_VAR = A
SET ALARM(3).REF_VAR = E
SET ALARM(3).SCALE = 6.0
SET ALARM(3).N = 1
SET ALARM(3).OF_M = 1
SET ALARM(3).MIN_SCALE = 20.0
SET ALARM(3).MAX_SCALE = 100.0
SET ALARM(3).MODE = 00000110B

STATUS

This command retrieves the current status of the instrument.

Format: **STATUS** [/P]

The monitor responds by sending a list of failure, alarm and warning conditions checked by the ALPHA-6A-1 and statements which indicate if the conditions are true or not. If the (space)/P switch is entered, the monitor will direct the output to the printer.

TIME

This command allows the operator to read or set the real time clock in the ALPHA-6A-1.

Format: **TIME** [hhmmss]

Example: **TIME** 13:45:00

If hhmmss is specified, the instrument will set the time accordingly, otherwise it will send the time and date.

VERSION

This command causes the ALPHA-6A-1 to send the instrument's firmware name and version number. If the (space)/P switch is specified the monitor will direct the output to the printer.

Format: **VERSION** [/P]

TABLE A-1. PRINTER PORT CONFIGURATION PARAMETERS

PARAMETER	VALID SETTINGS	DEFAULT SETTING
BAUD	300, 1200, 2400, 4800, 9600	2400
PARITY	NONE, EVEN, ODD	NONE
DATABIT	7,8	8
STOPBIT	1,2	2
TERM	CRLF, CR	CR
HNDSHK	DTR, X-ON/X-OFF	DTR
TIMEOUT	0-32767	2000
EOF	0-255	10

NOTES:

TERM — Specifies the character(s) used to terminate each line output to the printer.

TIMEOUT — Specifies the amount of time (in 1/100's of a second), the ALPHA-6A-1 will wait in attempt to send a character to the printer before setting a parameter timeout flag.

EOF — Specifies the decimal representation of the character to be appended at the end of each file output to the printer. The user can select ASCII characters which cause a desired affect at the printer. For instance, the EOF can be set to the <FF> form feed character to cause a page eject after printing a file. The default EOF is a <LF> fine feed character which inserts a blank line between files.

TABLE A-2. REMOTE PORT CONFIGURATION PARAMETERS

PARAMETER	VALID SETTINGS	DEFAULT SETTING
BAUD	300, 1200, 2400, 4800, 9600	9600
PARITY	NONE, EVEN, ODD	EVEN
DATABIT	7,8	7
STOPBIT	1,2	1
TERM	CRLF, CR	CR
ECHO	OFF, ON	ON
PROTCL	ASCII, BINARY	ASCII
ADDRESS	1-255	1
HNDSHK	DTR, X-ON/X-OFF	DTR
PROMPT	CHAR, ADDR, ID	ID
ERRCHK	NONE, CHKSUM, CRC16	NONE
TIMEOUT	0-32767	0
EOF	0-255	4

NOTES:

TERM — Specifies the character(s) used to terminate each line output from the remote.

ECHO — Specifies whether the ALPHA-6A-1 will echo the characters it receives at the remote port.

PROTCL — Indicates if the ALPHA-6A-1 will communicate according to its ASCII or BINARY protocol.

ADDRESS — Specifies the monitor address.

PROMPT — Specifies the type of prompt to be used by the ALPHA-6A-1 during remote port communication.

TIMEOUT — Specifies the amount of time (in 1/100's of a second) the ALPHA-6A-1 will wait for input from the remove device before setting a remote port timeout flag.

EOF — Specifies the decimal representation of the character appended to the end of each file output from the remote port. Some computer operating systems require special control characters (ASCII values between 0 and 31) to flag the end of a text file. For instance, the MS-DOS operating system requires a CTRL-Z character at the end of the file. The EOF character can be set to a CTRL-Z (value 26) to produce DOS compatible files.

TABLE A-3. SET/EVALUATE COMMAND TABLE

The variables listed below may be used with the **SET** and **EVALUATE** commands. Variables which are record elements must be referenced with the record name followed by a "dot"and the parameter name.

	RECORD	VARIABLE	TYPE
USER VARIABLES	A, B, C, D, E	.NAME	STRING(9)
and		.UNITS	STRING(9)
PROGRAM VARIABLE	F	.CONV	REAL
		.WIDTH	BYTE
		.PLACES	BYTE
		.VALUE	REAL
ALARM SET POINTS	ALARM(n)	.ALM_NAME	STRING(9)
	n = 1-6	.ALM_VAR	CHAR
		.REF_VAR	CHAR
		.MODE	BYTE
		.SCALE	REAL
		.N	BYTE
		.OF_M	BYTE
		.MIN_SCALE	REAL
		.MAX_SCALE	REAL
USER CONSTANTS	CONST(n)	.VALUE	REAL
	n = 1-5	.NAME	STRING(9)
PORT PARAMETERS	PRINTER	.BAUD	STRING(4)
		.PARITY	STRING(4)
		.STOPBIT	DIGIT
		.DATABIT	DIGIT
		.TERM	STRING(4)
		.TIMEOUT	INTEGER
	REMOTE	.BAUD	STRING(4)
		.PARITY	STRING(4)
		.STOPBIT	DIGIT
		.DATABIT	DIGIT
		.ECHO	STRING(3)
		.TERM	STRING(4)
		.ERRCHK	STRING(6)
		.TIMEOUT	INTEGER
		.PROTCL	STRING(6)
MISCELLANEOUS	CODE		STRING(4)
	P_CHR		CHAR
	UNIT_ADDR		STRING(3)
	ID		STRING(8)
	ORDER		STRING(18)
	DETAIL(n) n = 1-6		CHAR
	PROMPT		STRING(4)

TABLE A-4. LIST/PRINT FILE NAMES

The files listed below may be used in conjunction with the **LIST** and **PRINT** remote port commands:

USER VARIABLES HISTORY FILES

A.SEC
A.MIN
A.HOU
A.DAY

Also for B, C, D, and E

PROGRAM VARIABLES HISTORY FILES

F.SEC
F.MIN
F.HOU
F.DAY

REGIONS OF INTEREST HISTORY FILES

R.SEC
R.MIN
R.HOU
R.DAY

Also for S, T, U, V, W, X, Y, and Z

REGION OF INTEREST CHANNEL DATA FILES

Q.DTL

Also for R, S, T, U, V, W, X, Y, and Z

APPENDIX B. SOFTWARE OPTIONS

A. ALPHA-6A-1 Configuration for Radon Measurements

This option configures the ALPHA-6A-1 to measure radon gas concentration, working levels and gross alpha counts. Only the default computer software has been changed. The ALPHA-6A-1 hardware and circuitry remain unchanged.

The five "user variables" have been structured as follows:

USER VARIABLE	NAME	UNITS
1	Radon Con	pCi/L 222
2	Radon Dau	Work Lvl.
3	Total WL	Work Lvl.
4	Gross cpm	cpm alpha
5	Thoron Dau	Work Lvl.

The radon gas concentration determination is based on the amount of RaA particulate collected on the filter. Cross correlation between the ALPHA-6A-1 and radon gas measunng instruments indicates that the collectable quantity of airborne RaA is about 85% of the equilibrium amount. A correction factor is used in the radon computation to account for the disequilibrium. The factor, stored in “user constant” number 5, is readily adjustable by the user to fit average local conditions. In spaces which are heavily filtered to remove airborne particulates, the extreme disequilibriurn will render this gas evaluation inoperative. Also, the flow from typical radon standard generators is heavily filtered and cannot be used to verify the performance of the ALPHA-6A-1 configured for the measurement of radon gas.

Even though “working level” is only defined for the daughters of ^{222}Rn, the ALPHA-6A-1 is configured as though the definition also applies to thoron daughters, the daughters of ^{220}Rn. This measurement, defined in “user variable” number 5, is complicated because the first significant alpha emitting daughter has an apparent ten hour half-life. The working level computed for “thoron” daughters represents average conditions over a longer period of time, compared to the more immediate answer provided by the shorter half-lives of the “radon” daughters, computed by user variable 2. The “Total WL”, computed by user variable 3, sums the “thoron” and the “radon” working levels.

The history files provide data to be used in the various computations. Data up to one hour old are used to compute radon concentration and working levels, so one hour must elapse after the last reset of the counters before these computations become valid. The gross cpm value becomes valid one minute after reset.

All of the versatility of the standard ALPHA-6A, which allows the user to communicate with or alter the operation of the ALPHA-6A, has been retained.

The specific configuration of the ALPHA-6A-1 software for this radon function includes:

USER VARIABLE	NAME	UNITS	DECIMAL PLACES	ASSOCIATED ALARM
1 (A)	Radon Con	pCi/L 222	3	No. 3
2 (B)	Radon Dau	Work Lvl.	5	No. 4
3 (C)	Total WL	Work Lvl.	5	No. 6
4 (D)	Gross cpm	cpm alpha	0	No. 2
5 (E)	ThoronDau	Work Lvl.	5	No. 5
PROGRAM VAR.				
(H)	Variance	cfm	2	No. 1

USER CONSTANT	NAME	VALUE	USAGE
1	Nom. Flow	1.00	cfm reference
2	Interval	5.00	update interval, 5 seconds
3	Equ.Const	613,500	Used in user variable 2 equation
4	Eff.<4pi>	0.25	Detector efficiency, gross count
5	Equil.Con	0.85	Equilibrium constant

REGION STRUCTURE

ROI	RANGE	
0 Q	000-255	Entire spectrum
1 R	100-142	6 MeV RaA, ThC
2 S	147-188	7.68 MeV RaC’
5 V	189-224	8.78 MeV ThC’
8 Y	000-255	Entire spectrum

Regions 3(T), 4(U), 6(W), 7(X), and 9(Z) are not active.

ALARM STRUCTURE

Alarm	Name	Alarm Variable	Max. Scale	Scale (Alarm Point)	Alarm Delay
1	Flow Alm	H (Variance)	0.1	0.05	3 out of 3 updates
2	Gross cpm	D (Gross cpm)	2500	2200	None
3	222 RnCon	A (Radon Con)	10.0	8.0	None
4	Rn Dau WL	B (Radon Dau)	0.10	0.08	None
5	Th Dau WL	E (Thoron Dau)	0.10	0.08	None
6	Total WL	C (Total WL)	0.10	0.08	None

All minimum scales are at zero.

EQUATIONS

Unless otherwise indicated, all region count increases and air flow volume increases are for a one hour period.

USER VARIABLE l (A), Radon Con. pCi/L 222

When equilibrium conditions exist, the concentration of radon in air (pCi/L) equals that of RaA (^{218}Po) and the maximum RaA activity collectible on a filter is Imax = QCt[1].

In this discussion:

Imax	the maximum collectible activity, in pCi
Q	the flow rate, in liters per minute
C	the concentration of collectible material in air, in pCi/L
t	the mean isotope life, in minutes. (4.4 minutes for RaA)

For RaA, $$C = \frac{I_{max}}{Qt} = \frac{I_{max}}{\text{CFM} \times 28.317 \text{ liters/ft}^3 \times 4.4}$$

Assuming steady state conditions in the ALPHA-6A,

$$I_{max}, \text{pCi} = \frac{\text{cpm}}{\text{Eff.}} / 2.22$$

where

$$\frac{\text{CPM}}{\text{Detector Eff}} = \text{dpm}$$ and one pCi yields 2.22 dpm.

$$C = \frac{\text{RaA cpm}}{\text{Eff} \times 2.22 \times \text{CFM} \times 28.317 \times 4.4} = \frac{\text{RaA cpm}}{\text{Eff} \times \text{CFM} \times 276.6}$$, at equilibrium.

Under actual conditions, equilibrium between the radon gas and the airborne RaA daughter does not exist. Typically, 85% of equilibrium is assumed and this is accounted for in the ALPHA-6A- 1 by using constant No. 5 for the equilibrium constant. It is defaulted to 0.85 but it may be reset by the user to fit known conditions.

The alpha energies of RaA and ThC (^{212}Bi) coincide at 6 MeV but the generation of ThC is in direct proportion to that of ThC'(^{212}Po) which has a much higher, non-interfering, energy of 8.8 MeV. The ratio is 0.5625, so that proportion of the 8.8 MeV count is subtracted from the total 6 MeV count, leaving only the RaA.

$$\text{RaA C} = \frac{(6 \text{ MeV cpm, ROI 1}) - (0.5625 \times \text{ThC' cpm, ROI 5})}{\text{Const}(4) \times \text{CFM} \times 276.6 \times \text{Const}(5) + 1} = \text{Radon concentration}$$

User constant (4) is the 4 Pi detector efficiency. The "+1" in the denominator prevents division by zero when the air flow is stopped. It is immaterial in normal operation.

This equation may be entered from a remote terminal as follows:

Define A = R(64),R(124)-,(.5625),V(64),V(124)-*-,F(64),F(124)-,CONST(4)*,(276.6)*,Const(5)*, (1)+/

(1) EVANS, ROBLEY D., Engineer's Guide to the Elementary Behavior of Radon Daughters, Health Physics Journal, VOL 17, 1969.

USER VARIABLE 2 (B), Radon Dau, Work Lvl.

A concentration of one working level is defined as any combination of RaA, RaB, RaC and RaC' (^{218}Po, ^{214}Pb, ^{214}Bi, ^{214}Po) in one liter of air which will result in the "ultimate emission" of 1.3 x 10^5 MeV of alpha energy. (1.3 x 10^5 MeV is approximately the ultimate alpha energy of daughters in equilibrium with 100 pCi of ^{222}Rn. The alpha emission of RaF(^{210}Po), delayed by a 21 year half life, is excluded from the "ultimate emission" definition.)

Only two alpha emitting isotopes are involved, RaA and RaC', at 6 and 7.68 MeV respectively. Since the ALPHA-6A-1 readily recognizes the two energy peaks, a separate energy factor is applied to each. The number of disintegrations at each energy is then related to the flow volume to determine the working level concentration directly.

For RaA,

$$\text{WL} = (6 \text{ MeV cnts, ROI 1}) - \frac{(0.5625 \times 8.78 \text{ MeV cnts, ROI 5}) \times 6 \text{ MeV}}{(\text{Air vol., l}) \times \text{Eff.} \times (1.3 \times 10^5 \text{ Mev / WL})}$$

For RaC,

$$\text{WL} = \frac{(7.68 \text{ MeV cnts, ROI 2}) \times 7.68 \text{ MeV}}{(\text{Air vol., l}) \times \text{Eff.} \times (1.3 \times 10^5 \text{ MeV / WL})}$$

adding the two obtains:

$$\text{Radon WL} = \frac{(\text{ROI 1 cnts} - 0.5625 \times \text{ROI 5 cnts}) \times 6 + \text{ROI 2 cnts} \times 7.68}{\text{ft}^3 \times 28.317 \times \text{Eff.} \times 1.3 \times 10^5}$$

$$= \frac{6 \times (\text{ROI 1} - 0.5625 \times \text{ROI 5} + \text{ROI 2} \times 1.28)}{\text{ft}^3 \times \text{Eff.} \times 3.681 \times 10^6}$$

$$= \frac{\text{ROI 1} - (0.5625 \times \text{ROI 5}) + (\text{ROI 2} \times 1.28)}{\text{ft}^3 \times \text{Eff.} \times 6.135 \times 10^5}$$

The "-0.5625 x ROI 5" expression removes the thoron daughter contribution to the 6 MeV peak as explained above. The detector efficiency value is stored as user constant 4 and the 6.135 x 10^5 value is stored as user constant 3.

This equation may be entered from a remote terminal as follows:

Define B =
R(64),R(124)-,V(64),V(124)-,(.5625)*-,S(64),S(124)-,(1.28)*+,F(64),F(124)-,Const(4)*,Const(3)*/

USER VARIABLE 3 (C), Total WL, Work Lvl.

The total working level computation uses all of the alpha peaks, multiplies the total number of alphas detected by their energies then converts the result to working levels as described above.

$$\text{Total WL} = \frac{(6 \times \text{ROI 1 cnts}) + (7.68 \times \text{ROI 2 cnts}) + (8.78 \times \text{ROI 5 cnts})}{ft^3 \times 28.317 \times \text{CONST(4)} \times 1.3 \times 10^5}$$

$$= \frac{6 \times [\text{ROI 1} + (1.28 \times \text{ROI 2}) + (1.463 \times \text{ROI 5})]}{ft^3 \times \text{CONST(4)} \times 3.681 \times 10^6}$$

$$= \frac{\text{ROI 1} + (1.28 \times \text{ROI 2}) + (1.463 \times \text{ROI 5})}{ft^3 \times \text{CONST(4)} \times 6.135 \times 10^5}$$

This equation may be entered from a remote terminal as follows:

Define C =
R(64),R(124)-,S(64),S(124)-,(1.28)*+,V(64),V(124)-,(1.463)*+,F(64),F(124)-,Const(4)*,Const(3)*/

Constant (3) is 6.135×10^5.

USER VARIABLE 4 (D) Gross cpm alpha

Gross cpm = ROI 8 gain in the last 60 seconds, computed at each update. ROI 8 includes the entire spectrum, Channels 0 through 255.

This equation may be entered from a remote terminal as follows:

Define D = Y,Y(59)-

USER VARIABLE 5 (E) Thoron Dau, Work Lvl.

The definition of the working level for ^{222}Rn daughters was also applied to ^{220}Rn thoron daughters. (See user variable 2 above.) The alpha emission from the first daughter is ignored since its half-life is 150 milliseconds. The remaining two alpha emitters have 10+ hour virtual half-lives and occur in a 36%(6.05 MeV) to 64%(8.78 MeV) ratio. The 8.78 MeV peak is isolated in the spectrum and its region only will be used in the equation.

$$\text{Thoron WL} = \frac{(8.78 \text{ MeV cnts} \times 8.78 \text{ MeV} + 36/64 \times 8.78 \text{ MeV cnts}) \times 6 \text{ MeV}}{(\text{liters of air}) \times (\text{Eff., cnts/disint.}) \times (1.3 \times 10^5 \text{ Mev / WL})}$$

$$= \frac{(\text{ROI 5} \times 8.78 \text{ MeV}) + (0.5625 \times 6.05)}{ft^3 \times 28.317 \times \text{CONST(4)} \times 1.3 \times 10^5}$$

$$= \frac{12.18 \times \text{ROI 5}}{ft^3 \times \text{CONST(4)} \times 3.681 \times 10^6}$$

$$= \text{ROI 5} / [ft^3 \times \text{CONST(4)} \times 3.02 \times 10^5 + 1]$$

The (+1) in the denominator prevents division by zero when the air flow is stopped. This equation may be entered from a remote terminal as follows:

Define E = V(64),V(124)-,F(64),F(124)-,Const(4)*,(302E3)*,(l)+/

CALIBRATION

Essentially, follow the procedure given in Section V of the ALPHA-6A-1 Technical Manual. If performing step V.A.3.b.l. to obtain an efficiency value, use region 8 instead of a region from channels 96 through 116 as stated. The efficiency number will then be based on the entire spectrum, not a tightly fitted region as required for the plutonium measurement.

B. ALPHA-6A-1 Configuration for Mixed Uranium

This option configures the ALPHA-6A-1 to detect mixed Uranium instead of the standard default configuration for ^{239}Pu. The measured energy range extends from 3.5 MeV to 5 MeV and includes ^{233}U, ^{234}U, ^{235}U, ^{236}U, and ^{238}U. The ALPHA-6A-1 is physically unchanged. Only the software is modified.

Three of the software changes affect the ALPHA-6A-1 operation. They are:

1. Region of Interest (ROI) number 1 was shifted from channels 96 through 116 to channels 70 through 109. This was done because of the lower energies of Uranium compared to ^{239}Pu.

2. The value of user constant number 3 was changed from the default value of 0.17 to 0.15, because Uranium is located farther from the radon/thoron energies than is ^{239}Pu, requiring less background subtraction.

3. The value of user constant number 4 was changed from the default value of 0.22 to 0.25.

The remaining changes are name revisions only, from Pu to U, and they do not affect the actual operation. They are:

1. User variable 1 name was changed from Pu239 to Uranium. This is used for cpm.

2. User variable 2 name was changed from Pu239 to Uranium. This is used for integrated counts.

3. User variable 3 (concentration) units was changed from pCi/L PU to pCi/L U.

4. User constant 3's name was changed from Pu Const to U Const.

APPENDIX C. HARDWARE OPTIONS

A. Remote Detector, Option 1.

Eberline Part Number ALPHA6A OPT1(0)

1. Description

The Remote Detector Option allows the ALPHA-6A-1 detector and air sampling system to be located away from the microcomputers and display. The items and functions now residing in the remote assembly include the detector, the detector preamplifier circuit board, the air flow sensor and its supporting amplifiers. An alarm light and an audible alarm are also included in the remote assembly.

The attached schematic shows the circuits in the detector assembly. The flow sensor, A26, the control amplifier, A80 and the flow signal amplifier, A81 were located on the main board as A26, A27 and A28. A26 and A28 were removed from the main board, but one half of A27 drives the flash reference, so a new LM358N was installed in the detector assembly. The NULL control, R6, was also removed from the main ALPHA-6A-1 board. The flow signal is sent back to the input of A29 on the main board, A29-1.

The detector amplifier board is mounted behind the detector as it is in the standard ALPHA-6. The detector signal from the amplifier is sent back to the ALPHA-6A-1 main board over one of the shielded pairs in the interconnecting cable.

The alarm circuit in the remote assembly consists of a front panel mounted light and a bottom mounted Sonalert. They are activated when the alarms on the ALPHA-6A-1 chassis are operating.

The filter holding mechanism is mounted on the door of the remote assembly. To gain access to the filter, open the door and lift off the clamp ring which retains the filter. After installing the new filter and clamp ring, close the door while making sure the three pins enter the groove in the clamp ring. Tighten the screw to hold the door closed.

The calibration procedures remain the same as for the standard ALPHA-6A-1 manual except that the NULL and GAIN controls are now located in the remote assembly. With no air flow, adjust NULL for zero volts between pins 8 and 9 of J81 on the circuit board in the remote assembly or between pins 1 and 11 of A29 on the main ALPHA-6A-1 board. Set the GAIN control according to the procedure given in the manual. Once set, these two controls should rarely require re-setting. The NULL zero adjust is quite stable and small gain change requirements can be handled by adjusting R20, the ENGY CAL control on the main board as described in the ALPHA-6A-1 technical manual.

The parts and materials used in the remote assembly are essentially the same as when used internally in the ALPHA-6A-1 chassis. The alpha detector has been changed to one with less light sensitivity since it is now more directly exposed to the environment. The new detector is Eberline part number CYDE6. The original ALPHA-6 detector, CYDE2, will work satisfactorily in most applications where the ambient light is not intense.

PARTS LIST

The following table lists the electronic items incorporated in the ALPHA-6A-1 Remote Detector and should contain any part necessary for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
CR101	Alpha Detector	1 in. Aluminum Seal	Quantrad 500-PNC-BNC-ALUM	CYDE6(2)
	Pilot Lamp Housing	Red, Sealed	Dialco 101-5030-0971-203	LPAS31(5)
DS101	LED Miniature Lamp	24V, Red	Data Display MF200-R24-6	OPLP52(2)
S101	Door Switch		E61-30HG	SWMI14(3)
	Filter		Millipore SMWP04700	FIFP1(9)
	Porous Support, 1 in. o.d.			ZP11410032(6)
	O-Ring	Buna N or Neoprene	2-008	ORBN2008(7)
	O-Ring	Buna N or Neoprene	2-152	ORBN2152(1)
	O-Ring	Buna N or Neoprene	2-131	ORBN2131(7)
	O-Ring	Buna N or Neoprene	2-030	ORBN2030(9)
	O-Ring	Buna N or Neoprene	2-310	ORBN2310(0)
	O-Ring	Buna N or Neoprene	2-027	ORBN2027(4)
	O-Ring	Teflon	2-110	ORTF2110(6)
	O-Ring Screw	6-32 X 3/8 SS	Seel Skrew	SCOR0606(6)
	Connector	3/8 Tube	Parker 68P-6-2	FGPL16(5)
	Gasket	Can Seal		ZP11410082(5)
	Adapter	1/8 Hose to 1/8 MPT	Cajon B-2-HC-1-2	FGBR53(6)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
	Valve	1/8 MPT to 10-32, Slot Adjustment	Clippard MNV-1P	FGBR56(3)
	Hose Barb	10-32 X 1/8 ID	Clippard 11752-1	FGBR57(2)
	Knob	Alco KN-700B		HDKN2(7)
	Foot		McMaster-Carr 9540K23	MMRU78(9)
	Air Manifold			ZP11410004(0)
	Spring		Associated Spring C0360-026-0500S	SGCO4(8)
DS102	Audible Alarm	Sonalert	Mallory SC616CA	ADAM10(9)
J101	Connector		Amphenol 165-12	COMC312(7)
	Bulkhead Union	3/8 Tubing	Parker 62PBH-6	FGPL14(7)
P101	Connector	BNC	Amphenol 31-315	CXBN11(6)
	Shoulder Screw			ZP11410065(6)
S102	Switch	SPDT 1A @ 120 vac or 28 vdc	C & K 8121-S-Y4-Z-GE	SWPB14(3)
	Switch Boot		Amp-Hexseal N5040	MMRU2(8)
Remote Detector Board. YP11495000(7)				
Al	Integrated Circuit	Instrumentation Amplifier	Burr-Brown INA102	ICAAA102(2)
A2	Integrated Circuit	Dual Operational Amplifier	LM358N	ICAOA00358(7)
A3	Integrated Circuit	Mass Air Flow Sensor	Microswitch AWM2100V	MTFM18(l)
A4	Integrated Circuit	Dual D Flip-Flop	74HC74	ICHCA74(3)
A5	Integrated Circuit	Hex Invertor	74HC04	ICHCA04(0)
A6	Integrated Circuit	5 Volt Regulator	78L05	ICXX9(5)
C1, C8	Capacitor	10 F, 35V	Sprague 199D	CPTA100M3L(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
C2	Capacitor	10 F, 20V, 10%	CS13B	CPTA100M31(5)
C3	Capacitor	0.01 F, 50V, 20%	CW15C103M	CPCE103P3N(9)
C4, C5, C6, C7	Capacitor	0.1 F, 50V, 10%	CW20C104K	CPCE104P3N(7)
C9	Capacitor	1 F, 35V, 10%	CS13B	CPTA105P3L(6)
CR1, CR2	Diode	Silicon	1N4148	CRSI1N4148(7)
K1, K2	Reed Relay	SPDT, 24 vdc		RLGP29(3)
R1, R3	Resistor	1K, 1/8 W, 5%		RECC1021321(5)
R2	Resistor	1.8K, 1/4 W, 5%		RECC182B22(6)
R4, R5	Resistor	24.3K, 1%, 1/4W	RN55D	RECE2431312(6)
R6	Potentiometer	100K	Bournes 3299W-1-104	PTCE1041303(5)
R7, R10, R16	Resistor	10K, 1/4 W, 5%		RECC103B22(2)
R13, R14, R15	Resistor	100K, 1/4 W, 5%		RECC1041322(0)
R8, R9, R11, R12	Resistor	24K, 1/4W, 5%		RECC2431322(6)
Q1, Q3	Transistor	Silicon (NPN)	2N4124	TRSN2N4124(2)
Q2, Q4	Transistor	Silicon (PNP)	2N4403	TRSP2N4403(2)

B. RS-485 Communication Interface, Option 2

Eberline Part Number ALPHA6A OPT2(9)

1. General Description

This option allows the ALPHA-6A-1 to operate over an RS-485 multi-drop communication interface.

In its standard configuration the ALPHA-6A-1 has a serial RS-232C communication interface. The output of the RS-232C serial communication channel, on the ALPHA-6A-1 main board, is connected to an RS-232C to RS-485 converter board. Note that this option replaces the normal RS-232C remote port. The RS-2-32C printer port is unaffected.

The operation of the interface board is covered in the following section.

The two PORT 2 DB25S connectors on the back of the ALPHA-6A-1 provide the RS-485 communications. These connectors are wired in parallel to allow "daisy-chaining" of units. The outputs are:

Pin 1	Chassis Ground
Pin 2 & 3	Bus Data
Pin 7	Data Common

Various ways to configure the system are shown on Figure XXX, RS-485 Network.

The ALPHA-6A-1 can only communicate in the binary mode at 9600 baud. To communicate over the RS-485 bus in ASCII mode all units must have the same protocols set, i.e. baud, stop bits, data bits, parity, term, echo and protocol and each unit must have a unique address. If the baud rate is changed the RS-485 board baud rate switch in each unit must be changed. If any communication protocols are changed, it is necessary to turn the unit off and back on to force acceptance of the new protocols.

Bus terminators plugs should be installed in the unused RS-485 sockets of each ALPHA-6A. A bus terminator plug consists of a DB25P connector with a 4000 ohm resistor connected between pins 2 and 3.

For most computers, an interface to convert RS-485 to RS-232C will be required. Eberline makes an interface, Part Number YP11503000, which is used externally to the computer. A cable is needed to connect the computer to the RS-232C to RS-485 interface. The cable is wired per the following sketch.

Computer Cable for PC/XT

```
                      PIN #                   PIN #

GND                   1 >-----------------------< 1        GND
TxD   DATA OUT        2 >-----------------------< 2        DATA IN RxD
RxD   DATA IN         3 >-----------------------< 3        DATA OUT TxD

      RTS             4 >---┐               ┌---< 4        RTS
                            |               |
      CTS             5 >---┘               └---< 5        CTS

      GND             7 >----------------------< 7         GND

      DSR             6 > ----┐              ----< 20      DTR
                              |             |
      DTR             20 >----┘             └-----< 6      DSR

Computer              DB-25S*                 DB-25P*      Interface
```

Computer Cable for PC/AT

```
                      PIN #                   PIN #

GND                   1 >-----------------------< 1        GND
TxD   DATA OUT        3 >-----------------------< 2        DATA IN RxD
RxD   DATA IN         2 >-----------------------< 3        DATA OUT TxD

      RTS             7 >----               ----< 4        RTS
                            |              |
      CTS             8 >----              └----< 5        CTS

      GND             5 >----------------------< 7         GND

      DSR             6 >---┐             ----< 20         DTR
                            |            |
      DTR             4 >---┘            └----< 6          DSR

Computer              DB-9S*                  DB-25P*      Interface
```

2. RS-232C to RS-485 Interface Board, Eberline Part Number YP11451000(0)

a. Board Description

This printed circuit board provides conversion of an RS-232C interface to a interface. It supports bi-directional half duplex communication.

The RS-232C transmit signal is input at J2 pin 2 and converted to TTL by (MAX233). This signal is then converted to RS-485 levels by A102 (DS3695). The RS-485 communication protocol requires that, if a device is not transmit transmitter must be turned off. This is accomplished by comparator A101 (TLC372C) used as a one-shot. Each time a high level character bit is sent by the transmitter, the one shot will turn on the transmitter for the duration required to send one character. The baud rate must be selected by switches SW1-SW4. Resistors R2 and R7, in conjunction with C4, provide the time constant during which the transmitter is turned on. The same comparator which enables the transmitter also disables the receiver.

Baud Rate Selection SW1-4

SW1-4	**Closed***	**Baud Rate**
1	X	4800
2	X	9600
3	X	19.2K
4	X	8.4K

*All others open.

The RS-485 transmitter and Receiver (A102) is protected by two spark gaps GT-1 and GT-2 and surge suppressors CR1-CR4. A high voltage on either of the RS-485 communication lines initially is clamped by CR1 to CR4 and current limit by R12 & R13. GT-l and GT-2 provide protection after voltage breakdown has occurred. A grounding lug is provided on the chassis of units that use this board. This lug should be connected to a good earth ground by at least 14 gauge copper wire for best operation of the protection circuit.

If this board is to be used with an unregulated power supply, regulator A103 and C1 may be added and jumper JP-1 cut.

The RS-485 communication protocol defines only the voltage levels of transmission and the electrical characteristics of the transmitters and receivers. The protocol, baud rate, number of character bits, stop bits, and parity must be selected to match in both transmitters and receivers.

PARTS LIST

The following table lists the electronic items incorporated in the RS-232C to RS-485 Interface board and should contain any part necessary for normal electronic repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation , value and Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturer's part number is not available.

RS-232C to RS-485 Interface, YP11451000(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
A100	Integrated Circuit	RS-232C to TTL	Maxim MAX233	ICXXMAX233(8)
A101	Integrated Circuit	Dual Comparator	Texas Inst. TLC372C	ICACA372(3)
A102	Integrated Circuit	RS-485 Transceiver	National DS3695	ICXXAS3695(9)
A103	Integrated Circuit	Voltage regulator	National LP2950CZ	ICAVA2950C(9)
R1	Resistor	27K, 1/4W 5%	Carbon	RECC273B22(3)
R2, 3, 8, 9, 11	Resistor	48.7K, 1/4W 1%	RN55D	RECE483B12(8)
R4	Resistor	200K, 1/4W 1%	RN55D	RECE204B12(8)
R5	Resistor	100K, 1/4W 1%	RN55D	RECE104B12(0)
R6	Resistor	51.1K, 1/4W 1%	RN55D	RECE513B12(2)
R7	Resistor	24.9K, 1/4W 1%	RN55D	RECE253B12(5)
R10	Resistor	249K, 1/4W 1%	RN55D	RECE244B12(4)
R12, R13	Resistor	4 ohm, 5% 3W	Wirewound	REWW30126(0)
C1	Capacitor	0.1 F, 50V 10%		CPCE104P3N(7)
C2	Capacitor	33 F, 10V 10%	Sprague 196D	CPXX12(8)
C3	Capacitor	100 pF, 500V	CM15	CPM1101P3X(2)
C4	Capacitor	0.015 F, 33V 2.5%		CPPF153P1K(9)
C5	Capacitor	0.047 F, 50V		CPCE473P4N(4)
CR1 to CR4	Diode	Transient Suppressor	Unitrode LCE6.5 SEMI. TVS	CRXXLCE65(6)
GT-1, GT-2	Spark gap		Clare CC90L	VETU2(4)

C. In Line Remote Detector, Option 4.

Eberline Part Number ALPHA6A OPT4(7)

1. Description

The Remote Detector Option allows the ALPHA-6A-1 detector and air sampling system to be located away from the microcomputers and display. The items and functions now residing in the remote assembly include the detector, the detector preamplifier circuit board, the air flow sensor and its supporting amplifiers.

The attached schematic shows the circuits in the detector assembly. The flow sensor, A26, the control amplifier, A80 and the flow signal amplifier, A81 were located on the main board as A26, A27 and A28. A26 and A28 were removed from the main board, but one half of A27 drives the flash reference, so a new LM358N was installed in the detector assembly. The NULL control, R6, was also removed from the main ALPHA-6A-1 board. The flow signal is sent back to the input of A29 on the main board, A29-1.

The detector amplifier board is mounted under the detector. The detector signal from the amplifier is sent back to the ALPHA-6A-1 main board over one of the shielded pairs in the interconnecting cable.

The filter holding mechanism is mounted on the door of the remote assembly. To gain access to the filter, open the door and lift off the clamp ring which retains the filter. After installing the new filter and clamp ring, close the door. Tighten the screw to hold the door closed.

The calibration procedures remain the same as for the standard ALPHA-6A-1 except that the NULL and GAIN controls are now located in the remote assembly. With no air flow, adjust NULL for zero volts between pins 8 and 9 of J1 on the circuit board in the remote assembly or between pins 1 and 11 of A29 on the main ALPHA-6A-1 board. Set the GAIN control according to the procedure given in the manual. Once set, these two controls should rarely require re-setting. The NULL zero adjust is quite stable and small gain change requirements can be handled by adjusting R20, the ENGY CAL control on the main board as described for the standard ALPHA-6A.

The parts and materials used in the remote assembly are essentially the same as when used internally in the ALPHA-6A-1 chassis.

PARTS LIST

The following table lists the electronic items incorporated in the ALPHA-6A-1 Remote Detector and should contain any part necessary for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

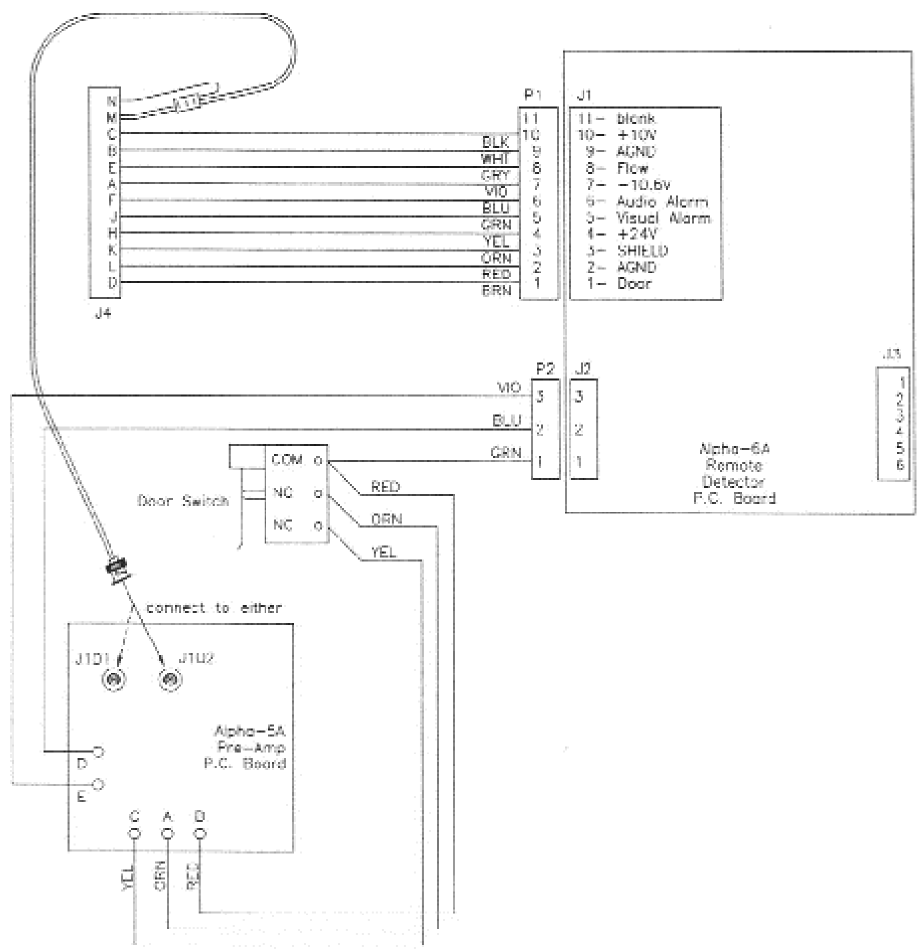
Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
CR101	Alpha Detector 1 in.		Quantrad 500-PNC-M	CYDE8(8)
S101	Door Switch		E61-30HG	SWMI14(3)
	Filter		Millipore SMWP04700	FIFP1 (9)
	Porous Support, 1 in. o.d.			ZP11410032(6)
	Porous Support, 1 1/2 in. o.d.			ZP114179023(2)
	O-Ring	Buna N or Neoprene	2-008	ORBN2008(7)
	O-Ring	Buna N or Neoprene	2-131	ORBN2131(7)
	O-Ring	Buna N or Neoprene	2-030	ORBN2030(9)
	O-Ring	Buna N or Neoprene	2-310	ORBN2310(0
	O-Ring	Buna N or Neoprene	2-027	ORBN2027(4)
	O-Ring	Teflon	2-110	ORTF2110(6)
	Connector	3/8 Tube	Parker 68P-6-2	FGPL16(5)
	Adaptor	1/8 Hose to 1/8 MPT	Cajon B-2-HC-1-2	FGBR53(6)
	Valve	1/8 MPT to 10-32, Slot Adjustment	Clippard MNV-1P	FGBR56(3)
	Hose Barb	10-32 X 1/8 ID	Clippard 11752-1	FGBR57(2)
	Knob	Alco KN-700B		HDKN2(7)
	Air Manifold			ZP11410004(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
	Spring		Associated Spring C0360-026-0500S	SGC04(8)
J101	Connector		Amphenol 165-12	COMC312(7)
	Bulkhead Union	3/8 Tubing	Parker 62PBH-6	FGPL14(7)
P101	Connector	BNC	Amphenol 31-315	CXBN11(6)
	Switch Boot		Amp-Hexseal N5040	MMRU2(8)

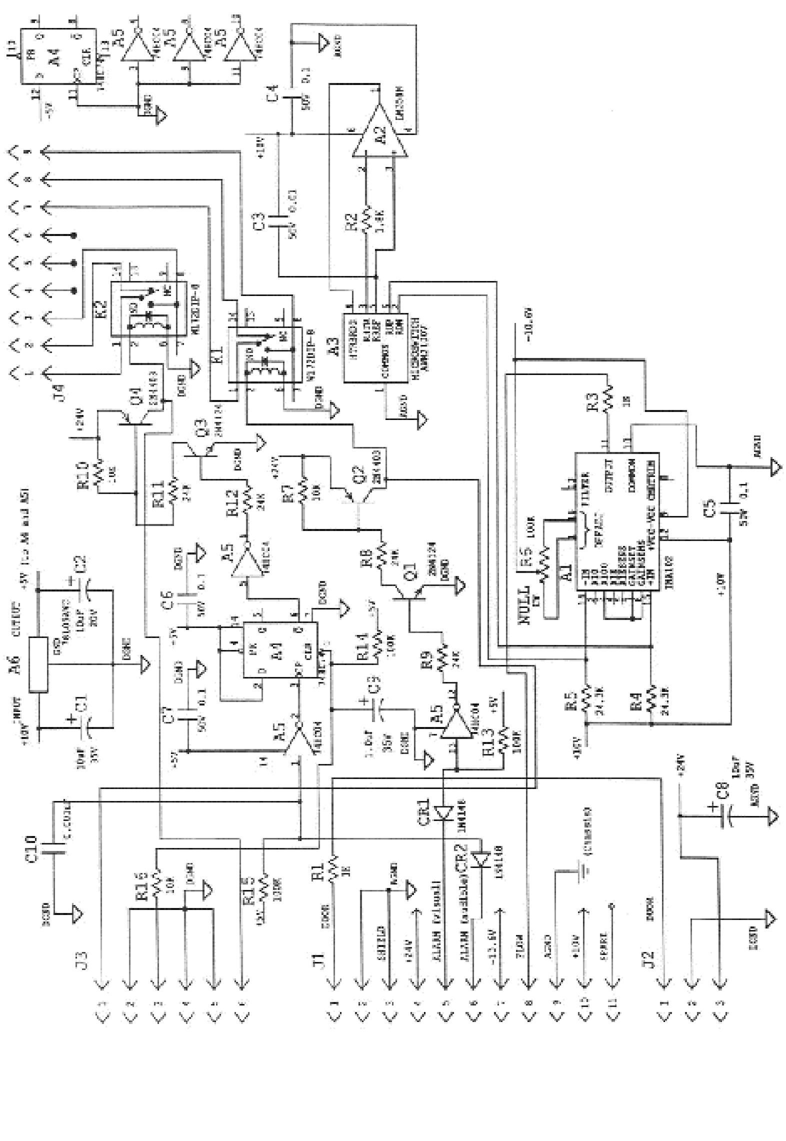
Remote Detector Board. YP11495000(7)

Al	Integrated Circuit	Instrumentation Amplifier	Burr-Brown MA102	ICAAA102(2)
A2	Integrated Circuit	Dual Op Amp	LM358N	ICAOA00358(7)
A3	Integrated Circuit	Mass Air Flow Sensor	Microswitch AWM2100V	MTFM18(1)
A4	Integrated Circuit	Dual D Flip-Flop	74HC74	ICHCA74(3)
A5	Integrated Circuit	Hex Invertor	74HC04	ICHCA04(0)
A6	Integrated Circuit	5 Volt Regulator	78L05	ICXX9(5)
C1, C8	Capacitor	10 F, 35V	Sprague 199D	CPTA100M3L(0)
C2	Capacitor	10 F, 20V 10%	CS13B	CPTA100M3I(5)
C3	Capacitor	0.01 F, 50V 20%	CW15C103M	CPCE103P3N(9)
C4, C5, C6, C7	Capacitor	0.1 F, 50V 10%	CW20CI04K	CPCE104P3N(7)
C9	Capacitor	1 F, 35V 10%	CS13B	CPTAl05P3L(6)
CR1, CR2	Diode	Silicon	1N4148	CRS11N4148(7)
K1, K2	Reed Relay	SPDT, 24 vdc		RLGP29(3)
R1, R3	Resistor	1K, 1/8 W 5%		RECC102B21(5)
R2	Resistor	1.8K, 1/4 W, 5%		RECC182B22(6)
R4, R5	Resistor	24.3K, 1%, 1/4W	RN55D	RECE243B12(6)

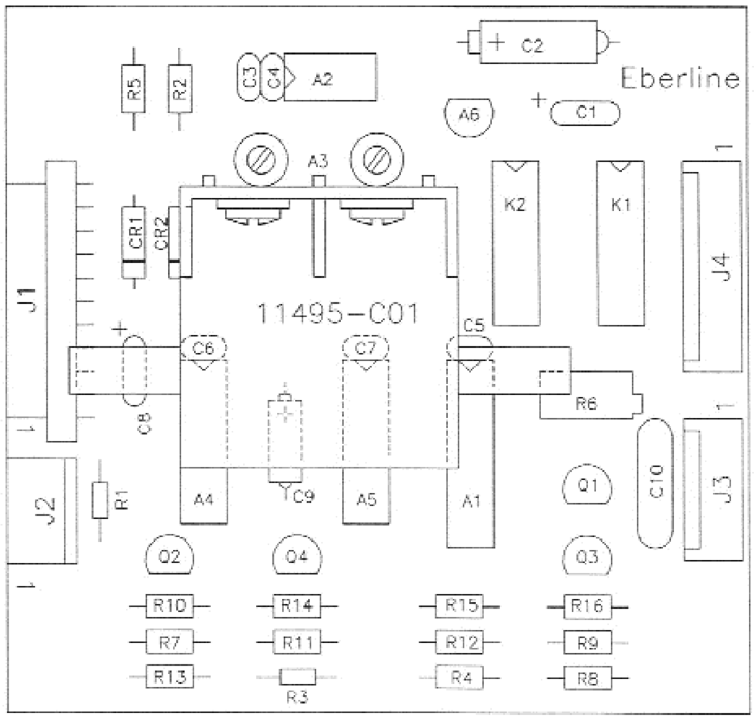
Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
R6	Potentiometer	100K	Bournes 3299W-1-104	PTCE104B03(5)
R7, R10, R16	Resistor	10K, 1/4 W, 5%		RECC1031322(2)
R13, R14, R15	Resistor	100K, 1/4 W, 5%		RECC104B22(0)
R8, R9, R11, R12	Resistor	24K, 1/4W, 5%		RECC2431322(6)
Q1, Q3	Transistor	Silicon (NPN)	2N4124	TRSN2N4124(2)
Q2, Q4	Transistor	Silicon (PNP)	2N4403	TRSP2N4403(2)



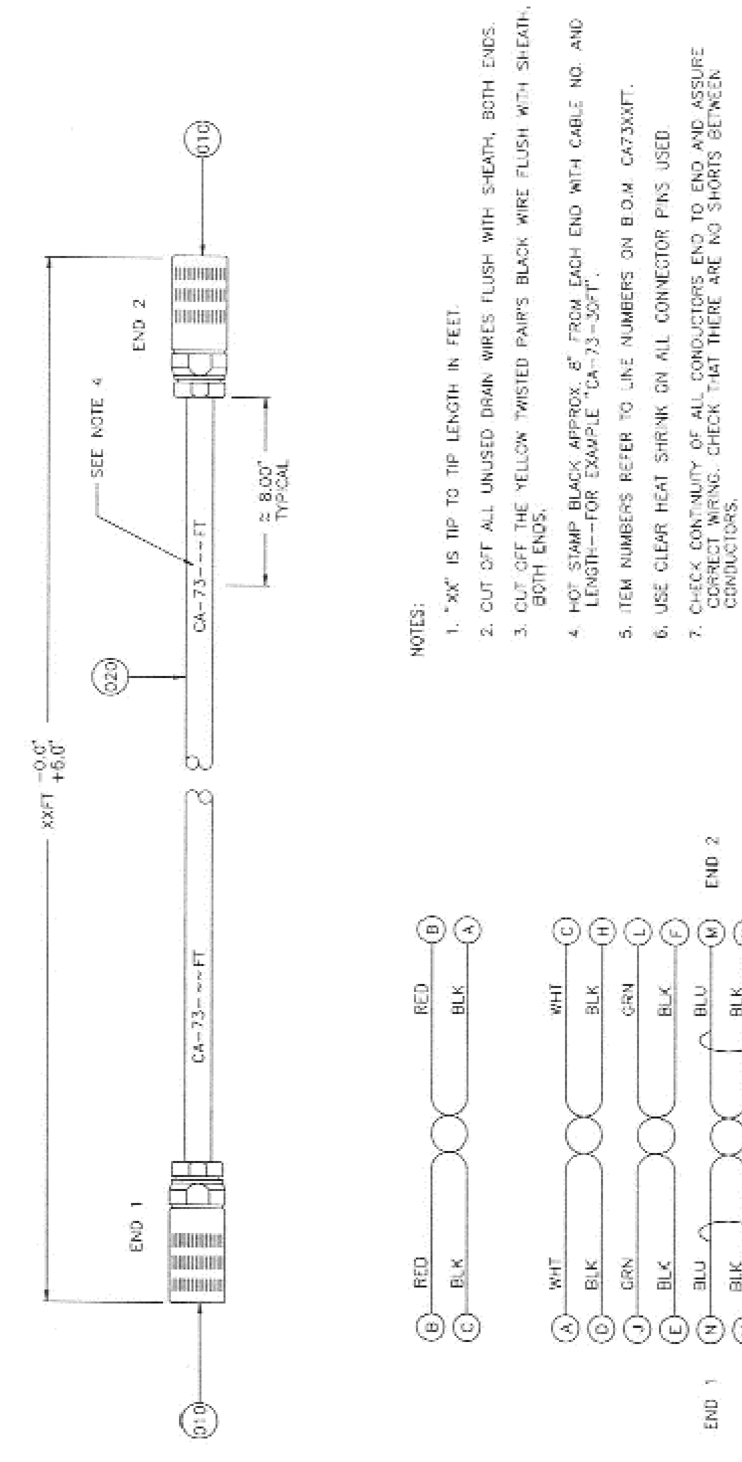
ALPHA-61-1 Remote Head Schematic and Wiring Diagram, 11410-C96



ALPHA-6A-1, Remote Detector Board, 11495-C03



ALPHA-6A-1 Remote Detector Board Layout, 11479-C66



ALPHA-6A-1 Remote Detector Interconnection Cable, 11105-C58

APPENDIX D. GLOSSARY

Access Code
A 4-digit ASCII code entered at the ALPHA-6A-1 keypad or over the remote which allows an operator to access all menus and functions.

Alarm Variable
A variable (usually a user variable), that is calculated and then checked against an alarm level each time new counter data is acquired.

Alarm Set Point
A group of variables which completely define a user alarm. Each set point has an alarm variable which is checked against a constant alarm level or against another variable called a reference variable. The set point also specifies limits needed for the strip-chart display and miscellaneous parameters which determine the conditions which trigger an alarm.

ASCII Protocol
A remote port communications specification supported by the ALPHA-6A-1 which uses messages made up entirely of ASCII characters.

Auto-Log Interval
The interval (MIN, HR, DAY, NEVER) specified for each item of information which determines how often the calculated value is automatically output to a printer.

Binary Protocol
A remote port communication specification supported by the ALPHA-6A-1 and designed for a network environment. The messages used include an address byte followed by a message length byte, a task byte, miscellaneous bytes and 2 CRC check bytes.

Cold Start
A routine performed by the ALPHA-6A-1 when it first becomes operational (when new PROMs have been installed) or when the LOAD DEFAULTS menu item is executed. On a cold start the monitor initializes all variables as required for the default configuration and clears all history files. The ALPHA-6A-1 will not perform a cold start if AC power is removed and then restored.

Cursor
A small line located just below the horizontal axis on the spectrum display which may be moved using the left and right arrow keys or the CH[ ] key to view channel data and to define a region of interest.

Default Configuration
A set of parameters which allow the ALPHA-6A-1 to measure airborne activity due to ^{239}Pu. The parameters are automatically loaded on a cold start or if the LOAD DEFAULTS menu item is executed.

Detail
A six character string that specifies if one-second, one-minute, one-hour, or one-day history file data will be displayed on the strip-chart for each of the 6 alarm set points. Detail(l) specifies the time detail for the strip-chart associated with alarm set point 1, Detail(2) specifies the detail for set point 2, etc. Valid settings for each character in the string are S, M, H, and D for seconds, minutes, hours, and days.

Equation

An equation which is downloaded into the ALPHA-6A-1 and therefore used to calculate the value of a specified user variable.

Failure

A condition which prevents the ALPHA-6A-1 from performing reliable measurements, such as a detector failure or real-time clock failure.

History File

A set of 64 data points maintained by the ALPHA-6A-1 and updated every second, every minute, every hour, or every day. The ALPHA-6A-1 maintains 4 history files for each of 5 user variables, 9 regions of interest, and the sample volume, one file for each of the 4 time intervals.

Order

An ASCII string that specifies the order in which the ALPHA-6A evaluates the variables it calculates. See Table 3-1.

P2

The name assigned to the second processor on the ALPHA-6A main board which is dedicated to acquiring and filing counts received from the detector. P2 is also referred to as the detector processor.

Printer Port Protocol

A set of parameters which configure port I on the ALPHA-6A so that the monitor may output data to an optional serial printer.

Program Variable

A value computed by an equation which cannot be changed by the user. Examples: Flow rate, Sample volume.

Prompt

An ASCII character or ASCII string which the ALPHA-6A outputs through its remote port to signal a remote device that it is ready to receive a command.

Reconfiguration

A process in which ALPHA-6A parameters are altered so that the monitor will measure the airborne activity due to a particular isotope. The ALPHA-6A is configured by default to measure ^{239}Pu activity and must be re-configured to measure another isotope.

Reference Variable

A variable that serves as the alarm limit to which an alarm variable is compared to determine if a user alarm has occurred.

Region of Interest

A series of consecutive channels treated as a unit. An important value associated with each region of interest is the total number of counts in the region.

Remote Port Protocol

A set of parameters which configure Port 2 on the ALPHA-6A-1 so that it may communicate with a remote device.

Sample Volume

The volume of air which is pulled through the filter assembly over a period of time when the ALPHA- 6A is performing measurements. The flow rate on the other hand, is the instantaneous air flow at a given point in time.

Spectrum

A radiological data array which results from a process by which incoming pulses to a detector are sorted according to pulse height. The occurrence of each pulse is recorded by incrementing 1 of 256 counters. The result is a 256 element array which may be used to determine the airborne activity due to a particular isotope.

Spectrum Display

A display which presents spectral data in graphical format with channel numbers along the horizontal axis and channel counts along the vertical axis. A cursor is provided which may be moved along the horizontal axis to view channel data or to define a region of interest.

Strip-Chart

A Display which presents side-by-side graphs of an alarm variable and the level to which it is compared when checking for an alarm.

User Alarms

A set of 6 alarm set points which may be defined by the operator to alarm on the occurrence of certain events. User alarms are different from failures and warnings which are always checked regardless of how the monitor is configured.

User Variable

A variable which is calculated each time the spectrum is updated and stored in history files every second, every minute, every hour, and every day. A user variable is defined by an equation which may be downloaded over the remote port. A user variable is completely defined by the operator who specifies the equation, the name, the units, and other details associated with it. A user variable may be used as an alarm variable or as a reference variable.

Warnings

Conditions which the ALPHA-6A-1 checks to assure proper monitor operation. Warnings are the lowest priority alarm group behind failures and user alarms. A warning condition exists if the filter assembly door is open, if the counters are halted or if the battery is low.

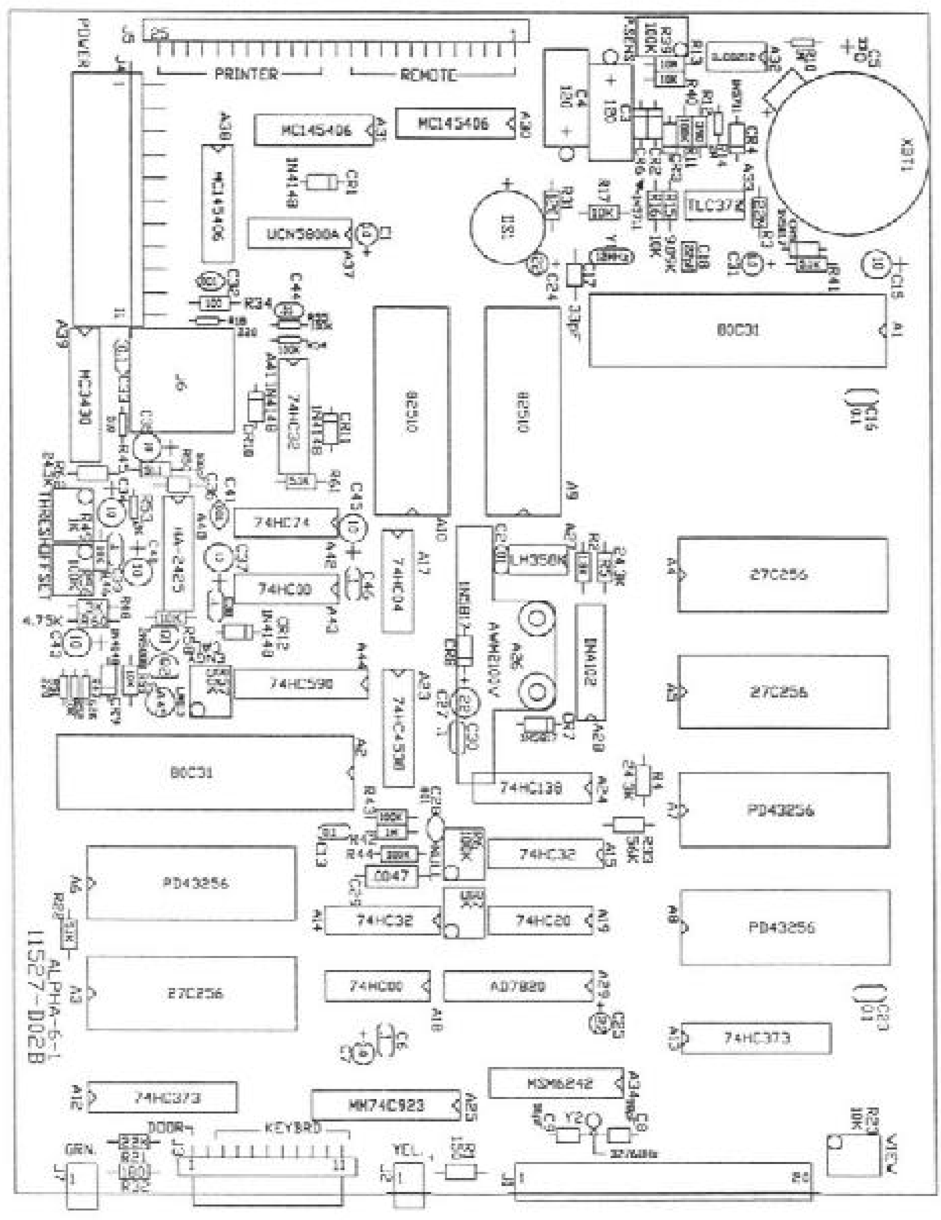
APPENDIX E. ERROR CODES

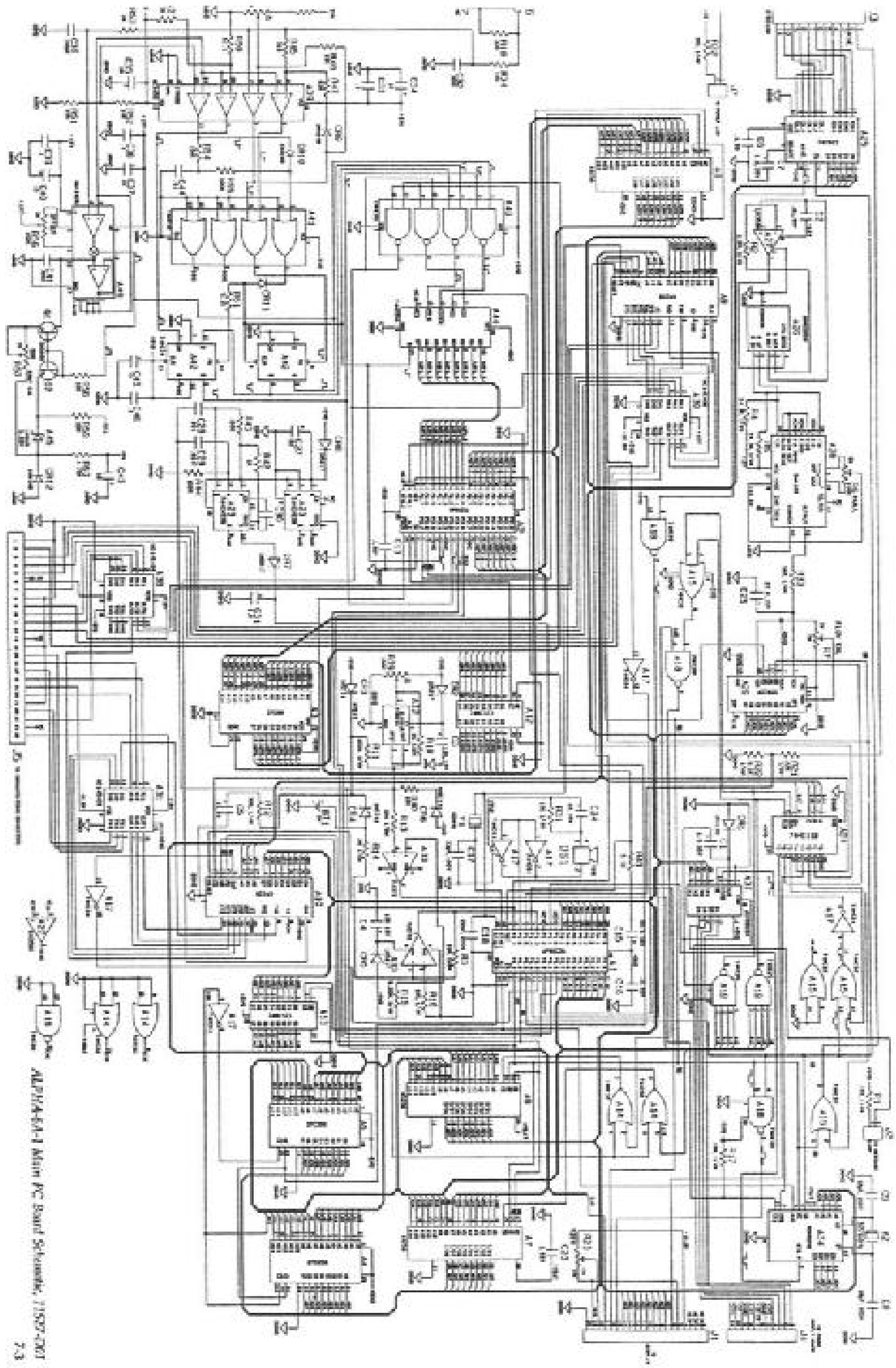
The ALPHA-6A-1 returns several error messages in coded form. The codes may appear on the ALPHA-6A-1 display or on a remote terminal.

CODE NUMBER	MESSAGE
001	Instrument failure
002	Hardware failure
003	Communication failure
004	Peripheral failure
010	Checksum error
011	CRC-16 error
012	Parity error
013	Framing error
014	Overrun failure
101	Command not recognized
102	Command not supported
103	Too many parameters
104	Missing parameters
105	Parameter not recognized
106	Parameter not supported
107	Switch not recognized
108	Switch not supported
109	Access denied (security)
201	Control not available
202	Value out of range
203	Requires integer value
204	Requires real value
205	Missing record variable
206	Index out of range
207	Value not defined
208	Illegal variable units
209	Requires units
210	Illegal time format
211	Illegal date format
212	Illegal format
213	Keyword not recognized
214	File not supported
215	Math overflow/underflow
216	No data
217	Variable cannot be set
218	Variable not recognized
219	Value not recognized
220	Channel not active
221	Variable not defined
222	Region not defined
223	File buffer in use
224	Syntax error

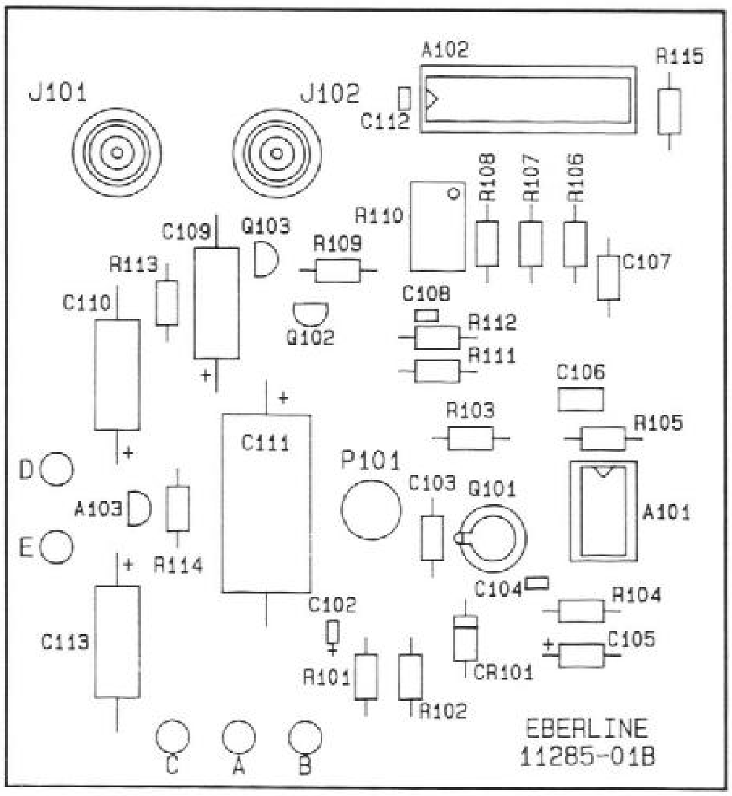
SECTION VII. DIAGRAMS

ALPHA-6A-1 Main Board Layout, 11527-D04

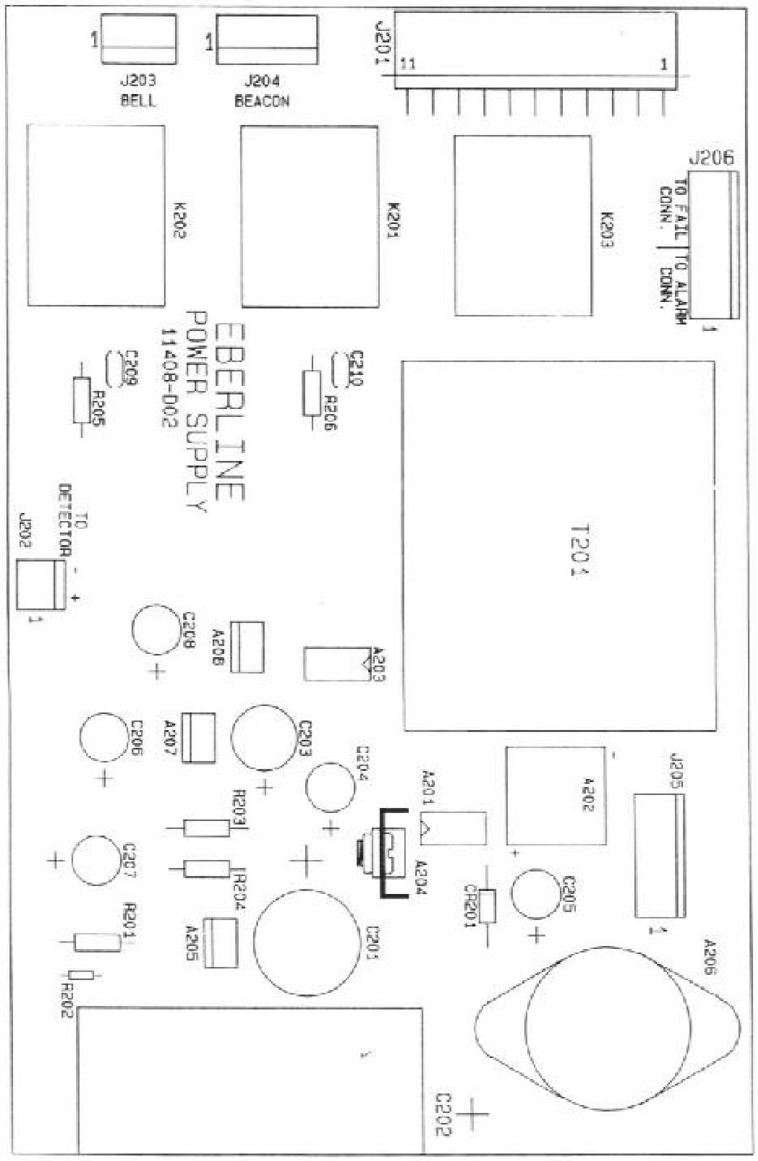



ALPHA-6A-1 Main PC Board Schematic, 11527-D01
7-3

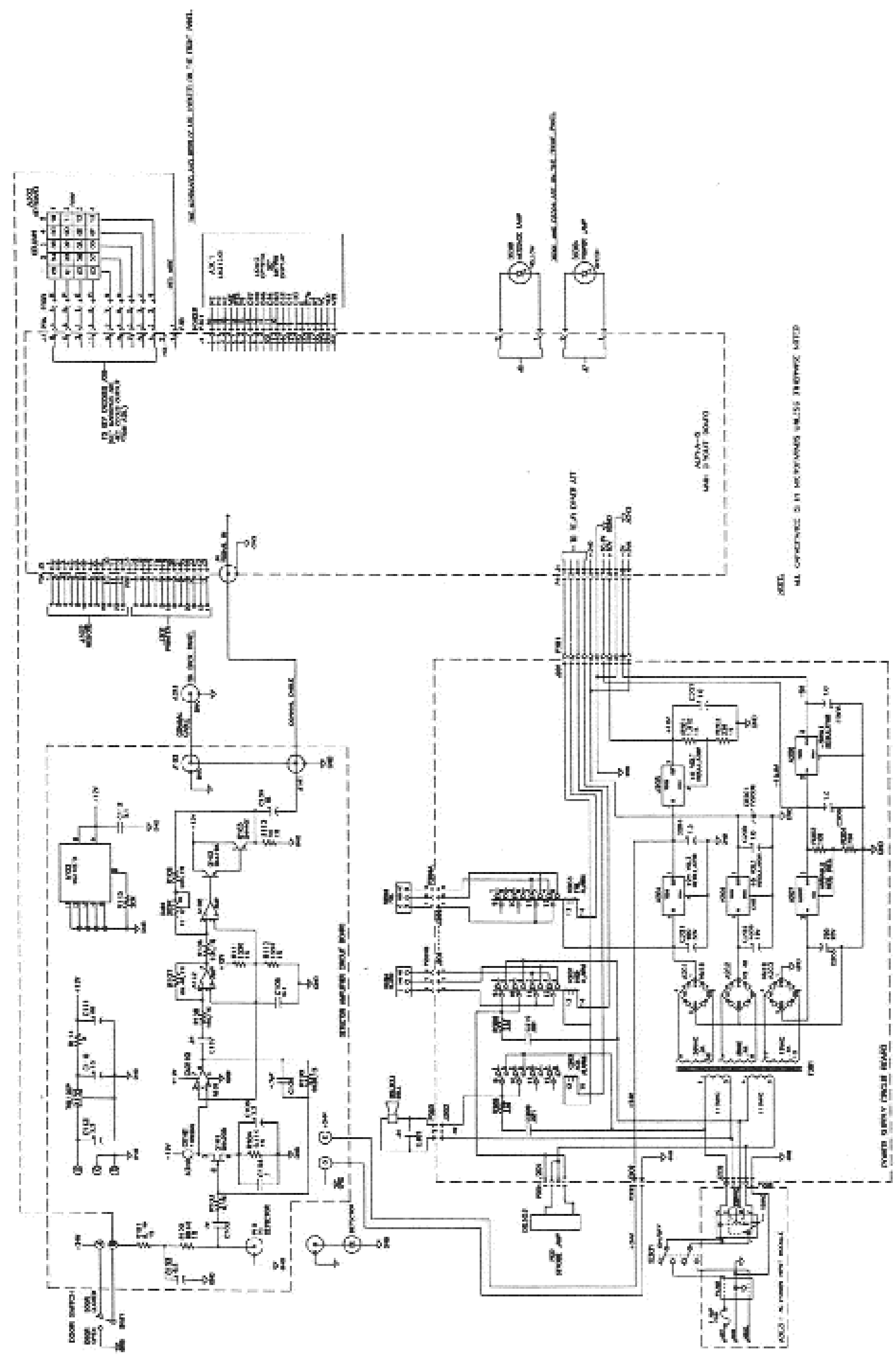
ALPHA-6A-1 Detector Board Layout, 11285-C04



ALPHA-6A-1 Power Supply Board Layout, 11408-C04



ALPHA-6A-1 Overall Schematic, 11410-D104



PARTS LIST

The following table lists the electronic items incorporated in the ALPHA-6A-1 Remote Detector and should contain any part necessary for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
CR101	Alpha Detector	1 in. Aluminum Seal	Quantrad 500-PNC-BNC-ALUM	CYDE6(2)
	Pilot Lamp Housing	Red, Sealed	Dialco 101-5030-0971-203	LPAS31(5)
DS101	LED Miniature Lamp	24V, Red	Data Display MF200-R24-6	OPLP52(2)
S101	Door Switch		E61-30HG	SWMI14(3)
	Filter		Millipore SMWP04700	FIFP1(9)
	Porous Support, 1 in. o.d.			ZP11410032(6)
	O-Ring	Buna N or Neoprene	2-008	ORBN2008(7)
	O-Ring	Buna N or Neoprene	2-152	ORBN2152(1)
	O-Ring	Buna N or Neoprene	2-131	ORBN2131(7)
	O-Ring	Buna N or Neoprene	2-030	ORBN2030(9)
	O-Ring	Buna N or Neoprene	2-310	ORBN2310(0)
	O-Ring	Buna N or Neoprene	2-027	ORBN2027(4)
	O-Ring	Teflon	2-110	ORTF2110(6)
	O-Ring Screw	6-32 X 3/8 SS	Seel Skrew	SCOR0606(6)
	Connector	3/8 Tube	Parker 68P-6-2	FGPL16(5)
	Gasket	Can Seal		ZP11410082(5)
	Adapter	1/8 Hose to 1/8 MPT	Cajon B-2-HC-1-2	FGBR53(6)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
	Valve	1/8 MPT to 10-32, Slot Adjustment	Clippard MNV-1P	FGBR56(3)
	Hose Barb	10-32 X 1/8 ID	Clippard 11752-1	FGBR57(2)
	Knob	Alco KN-700B		HDKN2(7)
	Foot		McMaster-Carr 9540K23	MMRU78(9)
	Air Manifold			ZP11410004(0)
	Spring		Associated Spring C0360-026-0500S	SGCO4(8)
DS102	Audible Alarm	Sonalert	Mallory SC616CA	ADAM10(9)
J101	Connector		Amphenol 165-12	COMC312(7)
	Bulkhead Union	3/8 Tubing	Parker 62PBH-6	FGPL14(7)
P101	Connector	BNC	Amphenol 31-315	CXBN11(6)
	Shoulder Screw			ZP11410065(6)
S102	Switch	SPDT 1A @ 120 vac or 28 vdc	C & K 8121-S-Y4-Z-GE	SWPB14(3)
	Switch Boot		Amp-Hexseal N5040	MMRU2(8)
Remote Detector Board. YP11495000(7)				
Al	Integrated Circuit	Instrumentation Amplifier	Burr-Brown INA102	ICAAA102(2)
A2	Integrated Circuit	Dual Operational Amplifier	LM358N	ICAOA00358(7)
A3	Integrated Circuit	Mass Air Flow Sensor	Microswitch AWM2100V	MTFM18(l)
A4	Integrated Circuit	Dual D Flip-Flop	74HC74	ICHCA74(3)
A5	Integrated Circuit	Hex Invertor	74HC04	ICHCA04(0)
A6	Integrated Circuit	5 Volt Regulator	78L05	ICXX9(5)
C1, C8	Capacitor	10 F, 35V	Sprague 199D	CPTA100M3L(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
C2	Capacitor	10 F, 20V, 10%	CS13B	CPTA100M31(5)
C3	Capacitor	0.01 F, 50V, 20%	CW15C103M	CPCE103P3N(9)
C4, C5, C6, C7	Capacitor	0.1 F, 50V, 10%	CW20C104K	CPCE104P3N(7)
C9	Capacitor	1 F, 35V, 10%	CS13B	CPTA105P3L(6)
CR1, CR2	Diode	Silicon	1N4148	CRSI1N4148(7)
K1, K2	Reed Relay	SPDT, 24 vdc		RLGP29(3)
R1, R3	Resistor	1K, 1/8 W, 5%		RECC1021321(5)
R2	Resistor	1.8K, 1/4 W, 5%		RECC182B22(6)
R4, R5	Resistor	24.3K, 1%, 1/4W	RN55D	RECE2431312(6)
R6	Potentiometer	100K	Bournes 3299W-1-104	PTCE1041303(5)
R7, R10, R16	Resistor	10K, 1/4 W, 5%		RECC103B22(2)
R13, R14, R15	Resistor	100K, 1/4 W, 5%		RECC1041322(0)
R8, R9, R11, R12	Resistor	24K, 1/4W, 5%		RECC2431322(6)
Q1, Q3	Transistor	Silicon (NPN)	2N4124	TRSN2N4124(2)
Q2, Q4	Transistor	Silicon (PNP)	2N4403	TRSP2N4403(2)

B. RS-485 Communication Interface, Option 2

Eberline Part Number ALPHA6A OPT2(9)

1. General Description

This option allows the ALPHA-6A-1 to operate over an RS-485 multi-drop communication interface.

In its standard configuration the ALPHA-6A-1 has a serial RS-232C communication interface. The output of the RS-232C serial communication channel, on the ALPHA-6A-1 main board, is connected to an RS-232C to RS-485 converter board. Note that this option replaces the normal RS-232C remote port. The RS-2-32C printer port is unaffected.

The operation of the interface board is covered in the following section.

The two PORT 2 DB25S connectors on the back of the ALPHA-6A-1 provide the RS-485 communications. These connectors are wired in parallel to allow "daisy-chaining" of units. The outputs are:

Pin 1	Chassis Ground
Pin 2 & 3	Bus Data
Pin 7	Data Common

Various ways to configure the system are shown on Figure XXX, RS-485 Network.

The ALPHA-6A-1 can only communicate in the binary mode at 9600 baud. To communicate over the RS-485 bus in ASCII mode all units must have the same protocols set, i.e. baud, stop bits, data bits, parity, term, echo and protocol and each unit must have a unique address. If the baud rate is changed the RS-485 board baud rate switch in each unit must be changed. If any communication protocols are changed, it is necessary to turn the unit off and back on to force acceptance of the new protocols.

Bus terminators plugs should be installed in the unused RS-485 sockets of each ALPHA-6A. A bus terminator plug consists of a DB25P connector with a 4000 ohm resistor connected between pins 2 and 3.

For most computers, an interface to convert RS-485 to RS-232C will be required. Eberline makes an interface, Part Number YP11503000, which is used externally to the computer. A cable is needed to connect the computer to the RS-232C to RS-485 interface. The cable is wired per the following sketch.

Computer Cable for PC/XT

```
                         PIN #                  PIN #

GND                      1 >------------------< 1        GND
TxD   DATA OUT           2 >------------------< 2        DATA IN RxD
RxD   DATA IN            3 >------------------< 3        DATA OUT TxD
       ___                                               ___
       RTS               4 >---┐           ┌---< 4       RTS
       ___                     │           │             ___
       CTS               5 >---┘           └---< 5       CTS

       GND               7 >-----------------< 7         GND
       ___                                               ___
       DSR               6 > ----┐          ----< 20     DTR
       ___                       │         │             ___
       DTR               20 >----┘         └-----< 6     DSR

Computer                 DB-25S*                DB-25P*  Interface
```

Computer Cable for PC/AT

```
                         PIN #                  PIN #

GND                      1 >------------------< 1        GND
TxD   DATA OUT           3 >------------------< 2        DATA IN RxD
RxD   DATA IN            2 >------------------< 3        DATA OUT TxD
       ___                                               ___
       RTS               7 >----┐          ----< 4       RTS
       ___                      │         │              ___
       CTS               8 >----┘         └----< 5       CTS

       GND               5 >-----------------< 7         GND
       ___                                               ___
       DSR               6 >----┐          ----< 20      DTR
       ___                      │         │              ___
       DTR               4 >----┘         └----< 6       DSR

Computer                 DB-9S*                 DB-25P*  Interface
```

2. RS-232C to RS-485 Interface Board, Eberline Part Number YP11451000(0)

a. Board Description

This printed circuit board provides conversion of an RS-232C interface to a interface. It supports bi-directional half duplex communication.

The RS-232C transmit signal is input at J2 pin 2 and converted to TTL by (MAX233). This signal is then converted to RS-485 levels by A102 (DS3695). The RS-485 communication protocol requires that, if a device is not transmit transmitter must be turned off. This is accomplished by comparator A101 (TLC372C) used as a one-shot. Each time a high level character bit is sent by the transmitter, the one shot will turn on the transmitter for the duration required to send one character. The baud rate must be selected by switches SW1-SW4. Resistors R2 and R7, in conjunction with C4, provide the time constant during which the transmitter is turned on. The same comparator which enables the transmitter also disables the receiver.

Baud Rate Selection SW1-4

SW1-4	Closed*	Baud Rate
1	X	4800
2	X	9600
3	X	19.2K
4	X	8.4K

*All others open.

The RS-485 transmitter and Receiver (A102) is protected by two spark gaps GT-1 and GT-2 and surge suppressors CR1-CR4. A high voltage on either of the RS-485 communication lines initially is clamped by CR1 to CR4 and current limit by R12 & R13. GT-l and GT-2 provide protection after voltage breakdown has occurred. A grounding lug is provided on the chassis of units that use this board. This lug should be connected to a good earth ground by at least 14 gauge copper wire for best operation of the protection circuit.

If this board is to be used with an unregulated power supply, regulator A103 and C1 may be added and jumper JP-1 cut.

The RS-485 communication protocol defines only the voltage levels of transmission and the electrical characteristics of the transmitters and receivers. The protocol, baud rate, number of character bits, stop bits, and parity must be selected to match in both transmitters and receivers.

PARTS LIST

The following table lists the electronic items incorporated in the RS-232C to RS-485 Interface board and should contain any part necessary for normal electronic repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation , value and Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturer's part number is not available.

RS-232C to RS-485 Interface, YP11451000(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
A100	Integrated Circuit	RS-232C to TTL	Maxim MAX233	ICXXMAX233(8)
A101	Integrated Circuit	Dual Comparator	Texas Inst. TLC372C	ICACA372(3)
A102	Integrated Circuit	RS-485 Transceiver	National DS3695	ICXXAS3695(9)
A103	Integrated Circuit	Voltage regulator	National LP2950CZ	ICAVA2950C(9)
R1	Resistor	27K, 1/4W 5%	Carbon	RECC273B22(3)
R2, 3, 8, 9, 11	Resistor	48.7K, 1/4W 1%	RN55D	RECE483B12(8)
R4	Resistor	200K, 1/4W 1%	RN55D	RECE204B12(8)
R5	Resistor	100K, 1/4W 1%	RN55D	RECE104B12(0)
R6	Resistor	51.1K, 1/4W 1%	RN55D	RECE513B12(2)
R7	Resistor	24.9K, 1/4W 1%	RN55D	RECE253B12(5)
R10	Resistor	249K, 1/4W 1%	RN55D	RECE244B12(4)
R12, R13	Resistor	4 ohm, 5% 3W	Wirewound	REWW30126(0)
C1	Capacitor	0.1 F, 50V 10%		CPCE104P3N(7)
C2	Capacitor	33 F, 10V 10%	Sprague 196D	CPXX12(8)
C3	Capacitor	100 pF, 500V	CM15	CPM1101P3X(2)
C4	Capacitor	0.015 F, 33V 2.5%		CPPF153P1K(9)
C5	Capacitor	0.047 F, 50V		CPCE473P4N(4)
CR1 to CR4	Diode	Transient Suppressor	Unitrode LCE6.5 SEMI. TVS	CRXXLCE65(6)
GT-1, GT-2	Spark gap		Clare CC90L	VETU2(4)

C. In Line Remote Detector, Option 4.

Eberline Part Number ALPHA6A OPT4(7)

1. Description

The Remote Detector Option allows the ALPHA-6A-1 detector and air sampling system to be located away from the microcomputers and display. The items and functions now residing in the remote assembly include the detector, the detector preamplifier circuit board, the air flow sensor and its supporting amplifiers.

The attached schematic shows the circuits in the detector assembly. The flow sensor, A26, the control amplifier, A80 and the flow signal amplifier, A81 were located on the main board as A26, A27 and A28. A26 and A28 were removed from the main board, but one half of A27 drives the flash reference, so a new LM358N was installed in the detector assembly. The NULL control, R6, was also removed from the main ALPHA-6A-1 board. The flow signal is sent back to the input of A29 on the main board, A29-1.

The detector amplifier board is mounted under the detector. The detector signal from the amplifier is sent back to the ALPHA-6A-1 main board over one of the shielded pairs in the interconnecting cable.

The filter holding mechanism is mounted on the door of the remote assembly. To gain access to the filter, open the door and lift off the clamp ring which retains the filter. After installing the new filter and clamp ring, close the door. Tighten the screw to hold the door closed.

The calibration procedures remain the same as for the standard ALPHA-6A-1 except that the NULL and GAIN controls are now located in the remote assembly. With no air flow, adjust NULL for zero volts between pins 8 and 9 of J1 on the circuit board in the remote assembly or between pins 1 and 11 of A29 on the main ALPHA-6A-1 board. Set the GAIN control according to the procedure given in the manual. Once set, these two controls should rarely require re-setting. The NULL zero adjust is quite stable and small gain change requirements can be handled by adjusting R20, the ENGY CAL control on the main board as described for the standard ALPHA-6A.

The parts and materials used in the remote assembly are essentially the same as when used internally in the ALPHA-6A-1 chassis.

PARTS LIST

The following table lists the electronic items incorporated in the ALPHA-6A-1 Remote Detector and should contain any part necessary for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

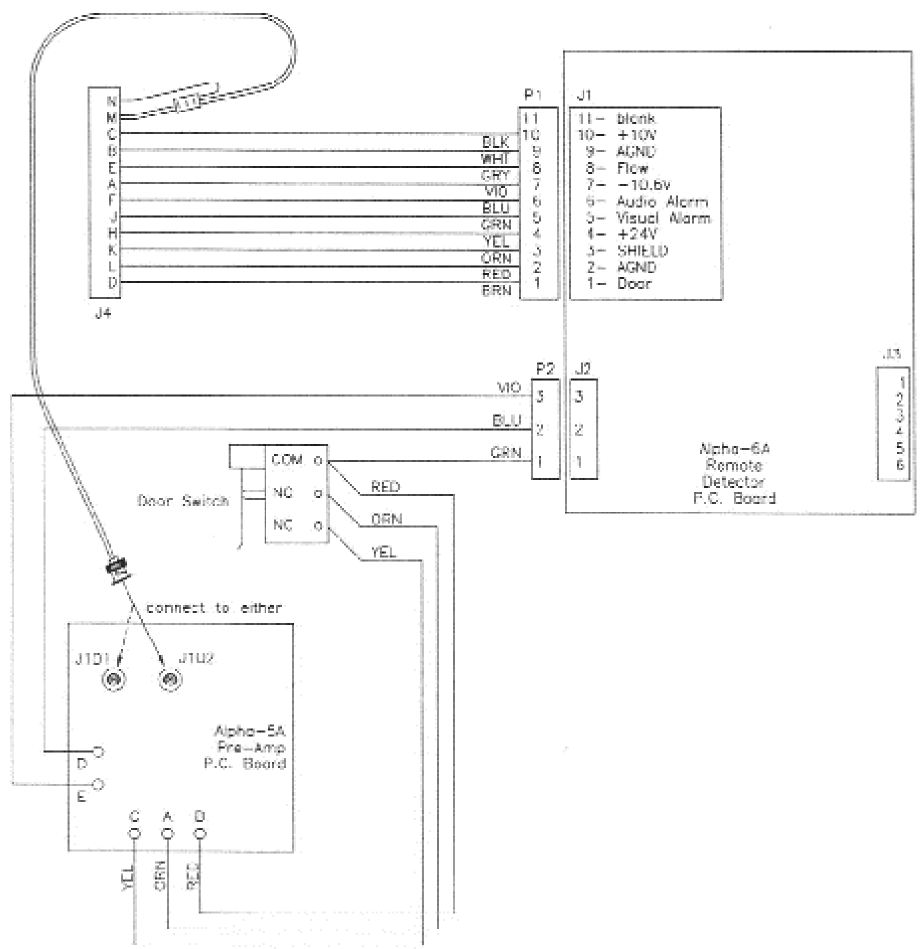
Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
CR101	Alpha Detector 1 in.		Quantrad 500-PNC-M	CYDE8(8)
S101	Door Switch		E61-30HG	SWMI14(3)
	Filter		Millipore SMWP04700	FIFP1 (9)
	Porous Support, 1 in. o.d.			ZP11410032(6)
	Porous Support, 1 1/2 in. o.d.			ZP114179023(2)
	O-Ring	Buna N or Neoprene	2-008	ORBN2008(7)
	O-Ring	Buna N or Neoprene	2-131	ORBN2131(7)
	O-Ring	Buna N or Neoprene	2-030	ORBN2030(9)
	O-Ring	Buna N or Neoprene	2-310	ORBN2310(0
	O-Ring	Buna N or Neoprene	2-027	ORBN2027(4)
	O-Ring	Teflon	2-110	ORTF2110(6)
	Connector	3/8 Tube	Parker 68P-6-2	FGPL16(5)
	Adaptor	1/8 Hose to 1/8 MPT	Cajon B-2-HC-1-2	FGBR53(6)
	Valve	1/8 MPT to 10-32, Slot Adjustment	Clippard MNV-1P	FGBR56(3)
	Hose Barb	10-32 X 1/8 ID	Clippard 11752-1	FGBR57(2)
	Knob	Alco KN-700B		HDKN2(7)
	Air Manifold			ZP11410004(0)

Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
	Spring		Associated Spring C0360-026-0500S	SGC04(8)
J101	Connector		Amphenol 165-12	COMC312(7)
	Bulkhead Union	3/8 Tubing	Parker 62PBH-6	FGPL14(7)
P101	Connector	BNC	Amphenol 31-315	CXBN11(6)
	Switch Boot		Amp-Hexseal N5040	MMRU2(8)

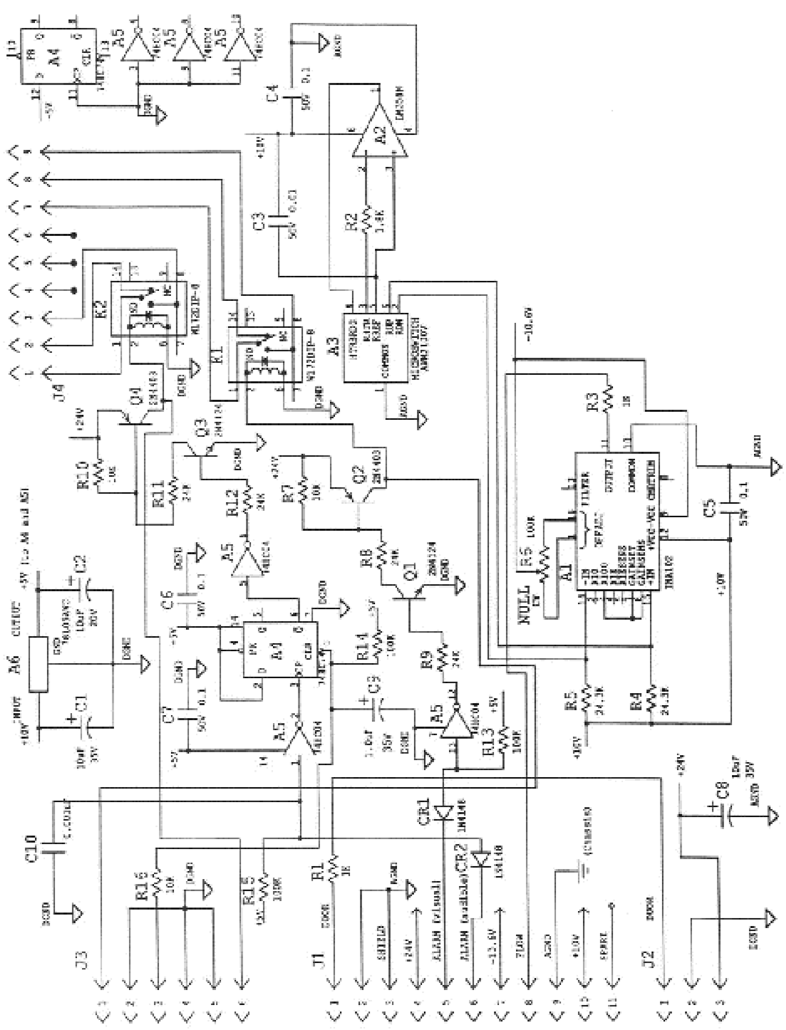
Remote Detector Board. YP11495000(7)

Al	Integrated Circuit	Instrumentation Amplifier	Burr-Brown MA102	ICAAA102(2)
A2	Integrated Circuit	Dual Op Amp	LM358N	ICAOA00358(7)
A3	Integrated Circuit	Mass Air Flow Sensor	Microswitch AWM2100V	MTFM18(1)
A4	Integrated Circuit	Dual D Flip-Flop	74HC74	ICHCA74(3)
A5	Integrated Circuit	Hex Invertor	74HC04	ICHCA04(0)
A6	Integrated Circuit	5 Volt Regulator	78L05	ICXX9(5)
C1, C8	Capacitor	10 F, 35V	Sprague 199D	CPTA100M3L(0)
C2	Capacitor	10 F, 20V 10%	CS13B	CPTA100M3I(5)
C3	Capacitor	0.01 F, 50V 20%	CW15C103M	CPCE103P3N(9)
C4, C5, C6, C7	Capacitor	0.1 F, 50V 10%	CW20CI04K	CPCE104P3N(7)
C9	Capacitor	1 F, 35V 10%	CS13B	CPTAl05P3L(6)
CR1, CR2	Diode	Silicon	1N4148	CRS11N4148(7)
K1, K2	Reed Relay	SPDT, 24 vdc		RLGP29(3)
R1, R3	Resistor	1K, 1/8 W 5%		RECC102B21(5)
R2	Resistor	1.8K, 1/4 W, 5%		RECC182B22(6)
R4, R5	Resistor	24.3K, 1%, 1/4W	RN55D	RECE243B12(6)

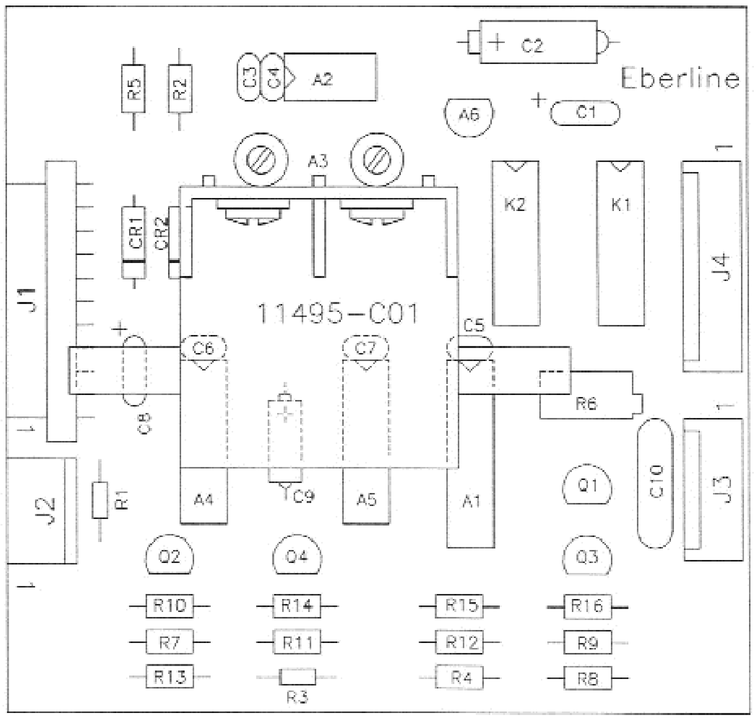
Ref. Desig.	Part	Description	Manufacturer & Part Number	Eberline Part Number
R6	Potentiometer	100K	Bournes 3299W-1-104	PTCE104B03(5)
R7, R10, R16	Resistor	10K, 1/4 W, 5%		RECC1031322(2)
R13, R14, R15	Resistor	100K, 1/4 W, 5%		RECC104B22(0)
R8, R9, R11, R12	Resistor	24K, 1/4W, 5%		RECC2431322(6)
Q1, Q3	Transistor	Silicon (NPN)	2N4124	TRSN2N4124(2)
Q2, Q4	Transistor	Silicon (PNP)	2N4403	TRSP2N4403(2)



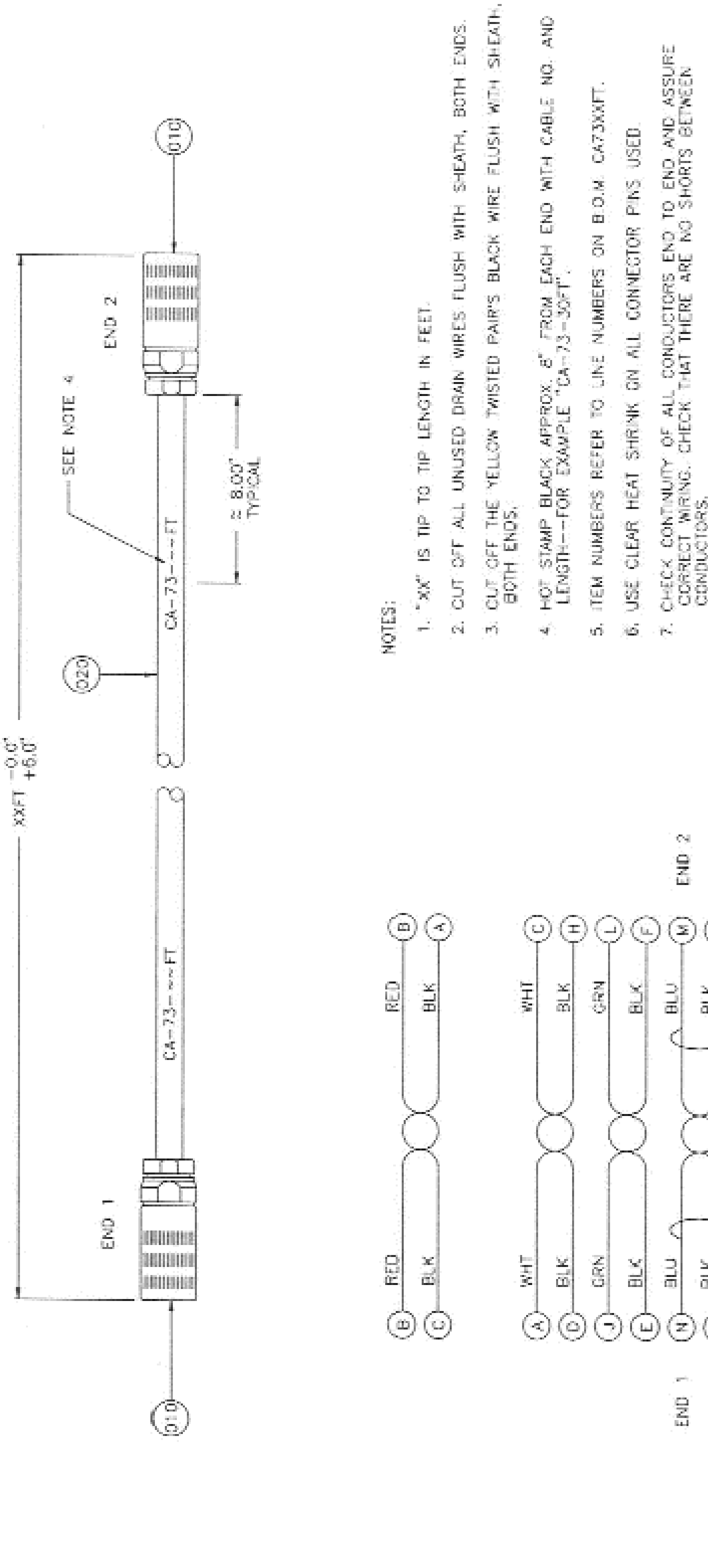
ALPHA-61-1 Remote Head Schematic and Wiring Diagram, 11410-C96



ALPHA-6A-1, Remote Detector Board, 11495-C03



ALPHA-6A-1 Remote Detector Board Layout, 11479-C66



ALPHA-6A-1 Remote Detector Interconnection Cable, 11105-C58

APPENDIX D. GLOSSARY

Access Code
A 4-digit ASCII code entered at the ALPHA-6A-1 keypad or over the remote which allows an operator to access all menus and functions.

Alarm Variable
A variable (usually a user variable), that is calculated and then checked against an alarm level each time new counter data is acquired.

Alarm Set Point
A group of variables which completely define a user alarm. Each set point has an alarm variable which is checked against a constant alarm level or against another variable called a reference variable. The set point also specifies limits needed for the strip-chart display and miscellaneous parameters which determine the conditions which trigger an alarm.

ASCII Protocol
A remote port communications specification supported by the ALPHA-6A-1 which uses messages made up entirely of ASCII characters.

Auto-Log Interval
The interval (MIN, HR, DAY, NEVER) specified for each item of information which determines how often the calculated value is automatically output to a printer.

Binary Protocol
A remote port communication specification supported by the ALPHA-6A-1 and designed for a network environment. The messages used include an address byte followed by a message length byte, a task byte, miscellaneous bytes and 2 CRC check bytes.

Cold Start
A routine performed by the ALPHA-6A-1 when it first becomes operational (when new PROMs have been installed) or when the LOAD DEFAULTS menu item is executed. On a cold start the monitor initializes all variables as required for the default configuration and clears all history files. The ALPHA-6A-1 will not perform a cold start if AC power is removed and then restored.

Cursor
A small line located just below the horizontal axis on the spectrum display which may be moved using the left and right arrow keys or the CH[ ] key to view channel data and to define a region of interest.

Default Configuration
A set of parameters which allow the ALPHA-6A-1 to measure airborne activity due to ^{239}Pu . The parameters are automatically loaded on a cold start or if the LOAD DEFAULTS menu item is executed.

Detail
A six character string that specifies if one-second, one-minute, one-hour, or one-day history file data will be displayed on the strip-chart for each of the 6 alarm set points. Detail(l) specifies the time detail for the strip-chart associated with alarm set point 1, Detail(2) specifies the detail for set point 2, etc. Valid settings for each character in the string are S, M, H, and D for seconds, minutes, hours, and days.

Equation

An equation which is downloaded into the ALPHA-6A-1 and therefore used to calculate the value of a specified user variable.

Failure

A condition which prevents the ALPHA-6A-1 from performing reliable measurements, such as a detector failure or real-time clock failure.

History File

A set of 64 data points maintained by the ALPHA-6A-1 and updated every second, every minute, every hour, or every day. The ALPHA-6A-1 maintains 4 history files for each of 5 user variables, 9 regions of interest, and the sample volume, one file for each of the 4 time intervals.

Order

An ASCII string that specifies the order in which the ALPHA-6A evaluates the variables it calculates. See Table 3-1.

P2

The name assigned to the second processor on the ALPHA-6A main board which is dedicated to acquiring and filing counts received from the detector. P2 is also referred to as the detector processor.

Printer Port Protocol

A set of parameters which configure port I on the ALPHA-6A so that the monitor may output data to an optional serial printer.

Program Variable

A value computed by an equation which cannot be changed by the user. Examples: Flow rate, Sample volume.

Prompt

An ASCII character or ASCII string which the ALPHA-6A outputs through its remote port to signal a remote device that it is ready to receive a command.

Reconfiguration

A process in which ALPHA-6A parameters are altered so that the monitor will measure the airborne activity due to a particular isotope. The ALPHA-6A is configured by default to measure ^{239}Pu activity and must be re-configured to measure another isotope.

Reference Variable

A variable that serves as the alarm limit to which an alarm variable is compared to determine if a user alarm has occurred.

Region of Interest

A series of consecutive channels treated as a unit. An important value associated with each region of interest is the total number of counts in the region.

Remote Port Protocol

A set of parameters which configure Port 2 on the ALPHA-6A-1 so that it may communicate with a remote device.

Sample Volume
The volume of air which is pulled through the filter assembly over a period of time when the ALPHA- 6A is performing measurements. The flow rate on the other hand, is the instantaneous air flow at a given point in time.

Spectrum
A radiological data array which results from a process by which incoming pulses to a detector are sorted according to pulse height. The occurrence of each pulse is recorded by incrementing 1 of 256 counters. The result is a 256 element array which may be used to determine the airborne activity due to a particular isotope.

Spectrum Display
A display which presents spectral data in graphical format with channel numbers along the horizontal axis and channel counts along the vertical axis. A cursor is provided which may be moved along the horizontal axis to view channel data or to define a region of interest.

Strip-Chart
A Display which presents side-by-side graphs of an alarm variable and the level to which it is compared when checking for an alarm.

User Alarms
A set of 6 alarm set points which may be defined by the operator to alarm on the occurrence of certain events. User alarms are different from failures and warnings which are always checked regardless of how the monitor is configured.

User Variable
A variable which is calculated each time the spectrum is updated and stored in history files every second, every minute, every hour, and every day. A user variable is defined by an equation which may be downloaded over the remote port. A user variable is completely defined by the operator who specifies the equation, the name, the units, and other details associated with it. A user variable may be used as an alarm variable or as a reference variable.

Warnings
Conditions which the ALPHA-6A-1 checks to assure proper monitor operation. Warnings are the lowest priority alarm group behind failures and user alarms. A warning condition exists if the filter assembly door is open, if the counters are halted or if the battery is low.

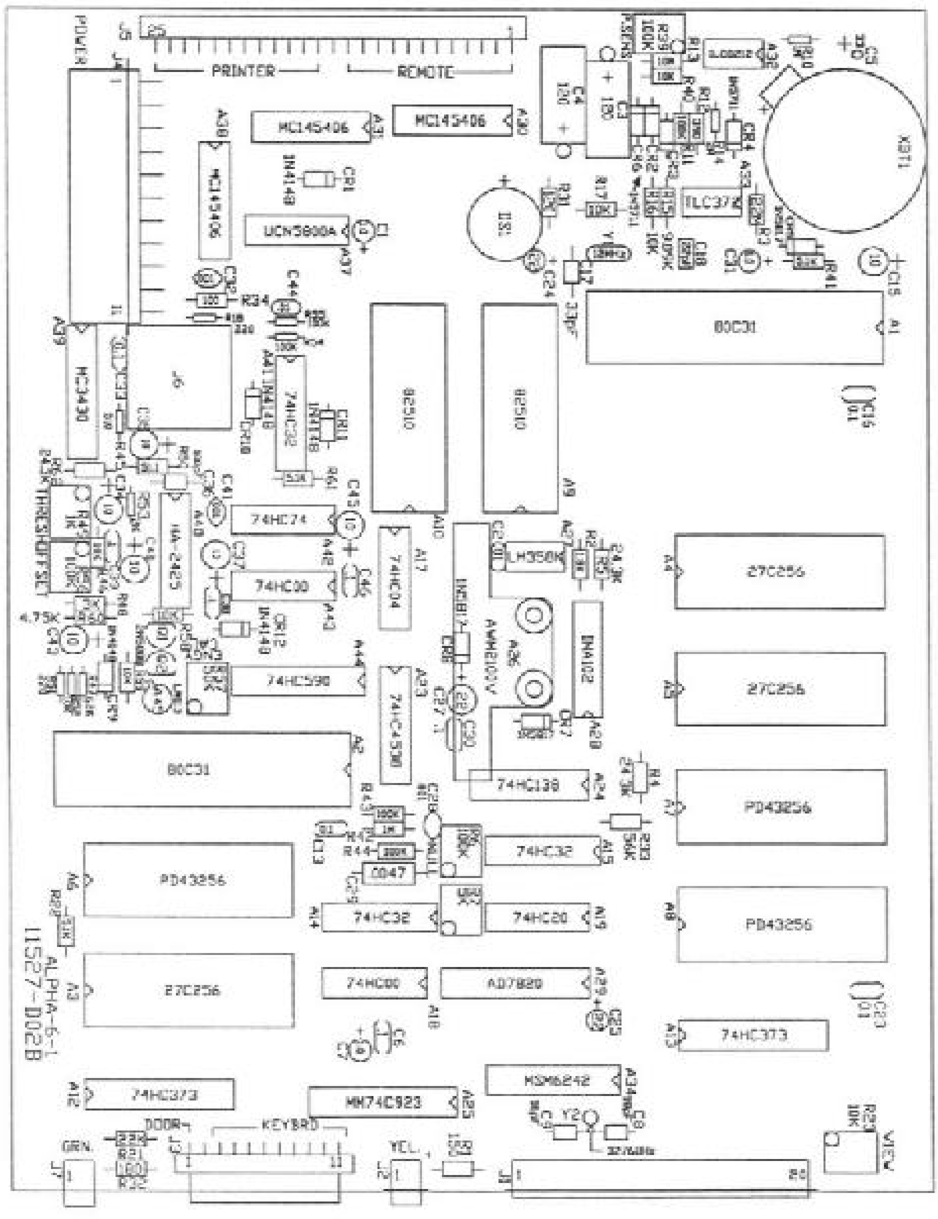
APPENDIX E. ERROR CODES

The ALPHA-6A-1 returns several error messages in coded form. The codes may appear on the ALPHA-6A-1 display or on a remote terminal.

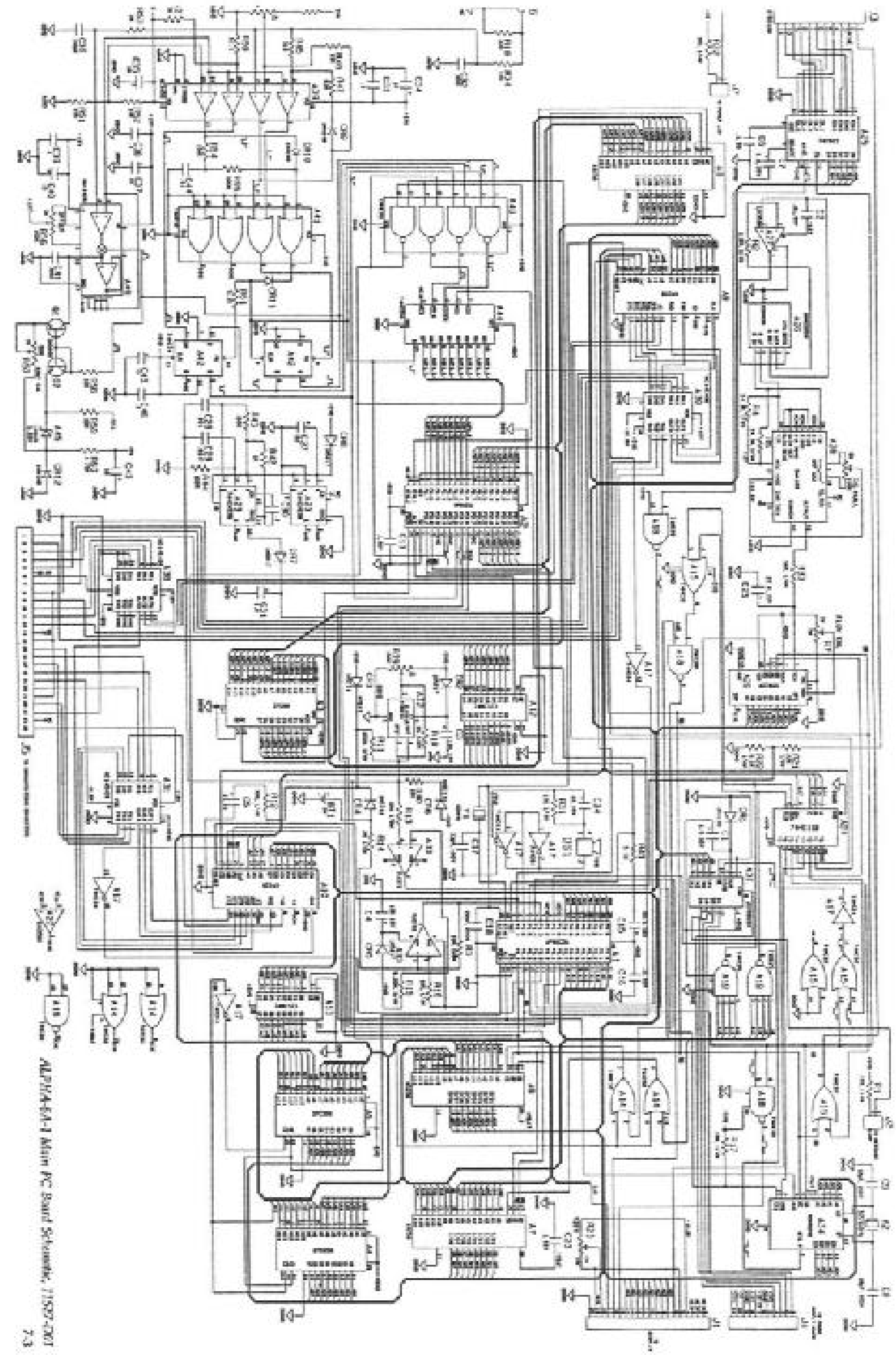
CODE NUMBER	MESSAGE
001	Instrument failure
002	Hardware failure
003	Communication failure
004	Peripheral failure
010	Checksum error
011	CRC-16 error
012	Parity error
013	Framing error
014	Overrun failure
101	Command not recognized
102	Command not supported
103	Too many parameters
104	Missing parameters
105	Parameter not recognized
106	Parameter not supported
107	Switch not recognized
108	Switch not supported
109	Access denied (security)
201	Control not available
202	Value out of range
203	Requires integer value
204	Requires real value
205	Missing record variable
206	Index out of range
207	Value not defined
208	Illegal variable units
209	Requires units
210	Illegal time format
211	Illegal date format
212	Illegal format
213	Keyword not recognized
214	File not supported
215	Math overflow/underflow
216	No data
217	Variable cannot be set
218	Variable not recognized
219	Value not recognized
220	Channel not active
221	Variable not defined
222	Region not defined
223	File buffer in use
224	Syntax error

SECTION VII. DIAGRAMS

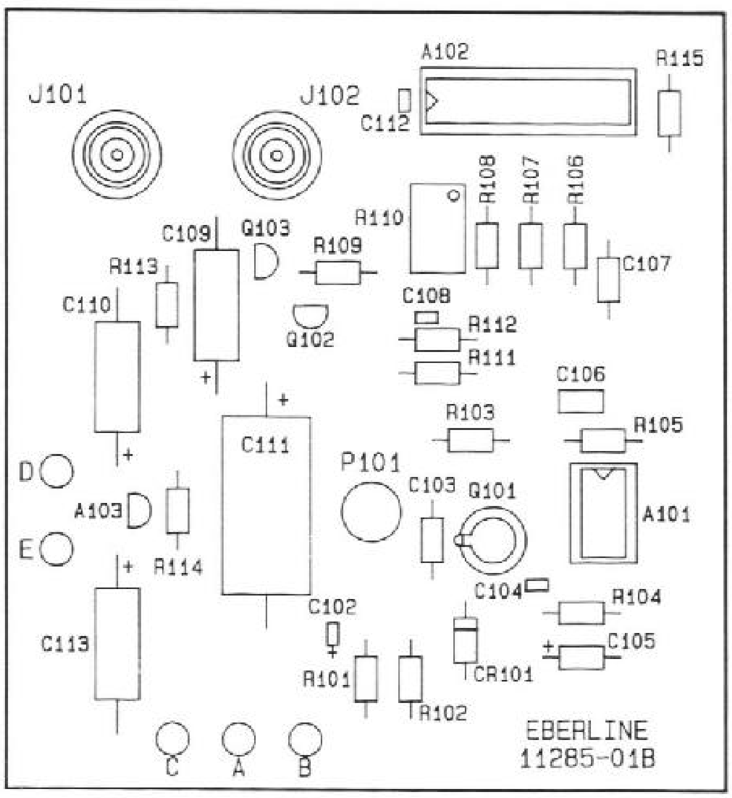
ALPHA-6A-1 Main Board Layout, 11527-D04



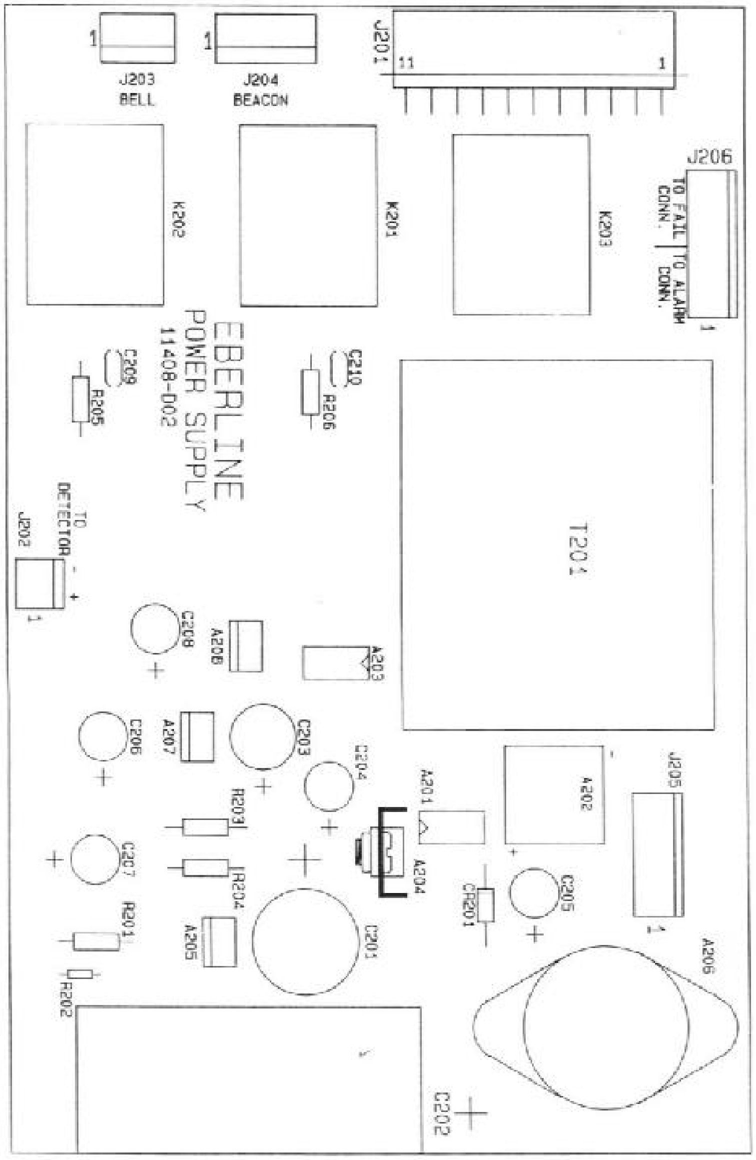
ALPHA-6A-1 Main PC Board Schematic, 11527-D01



ALPHA-6A-1 Detector Board Layout, 11285-C04



ALPHA-6A-1 Power Supply Board Layout, 11408-C04



ALPHA-6A-1 Overall Schematic, 11410-D104