



**SERIES 9100
COMPUTERIZED AMBIENT MONITORING
CALIBRATION SYSTEM**

OPERATING MANUAL



WARNING

READ THIS MANUAL CAREFULLY BEFORE USING THIS INSTRUMENT. FAILURE TO DO SO MAY VOID THE WARRANTY, DAMAGE THE INSTRUMENT, OR CAUSE SERIOUS INJURY OR DEATH.



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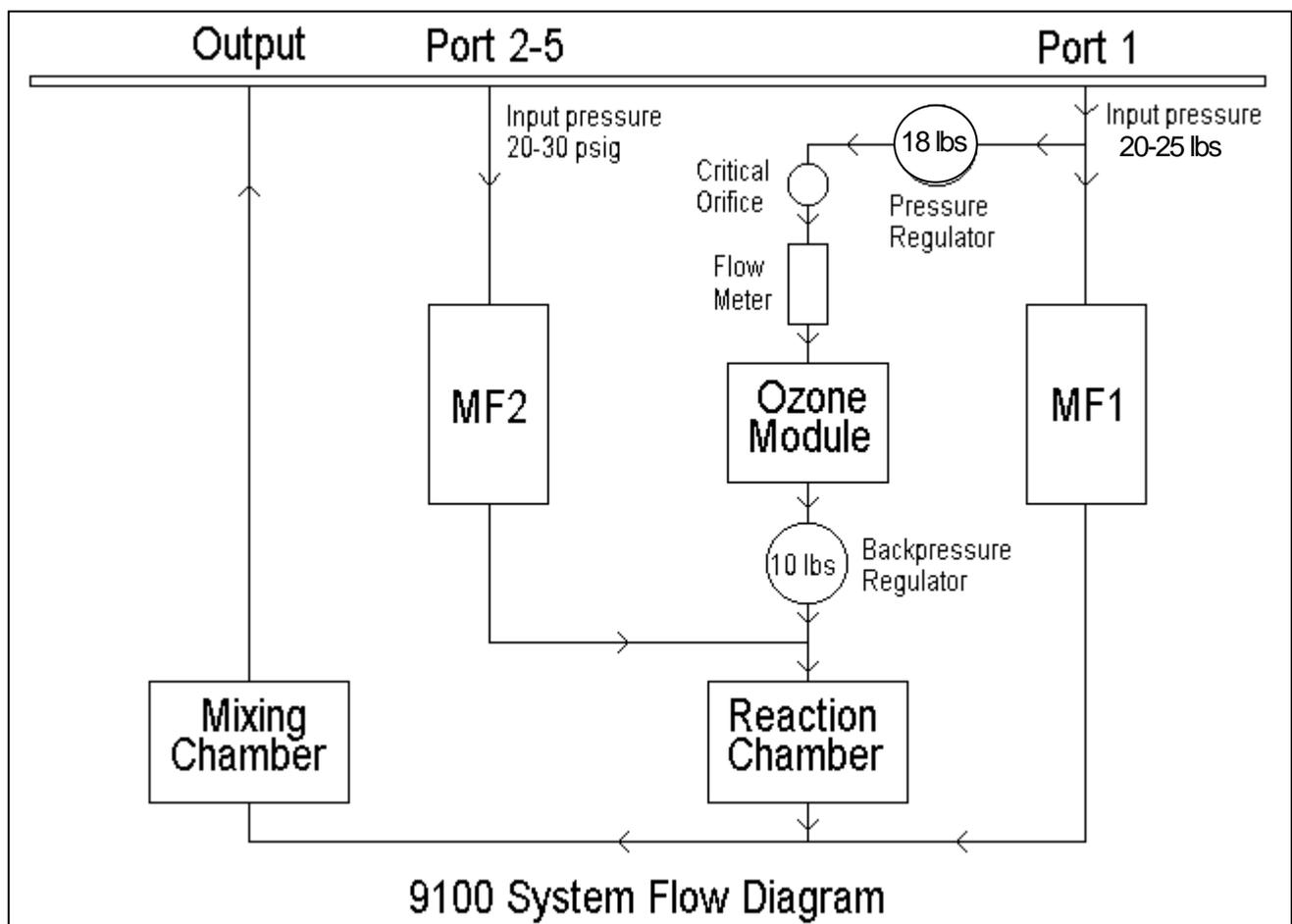
1 FORWARD

The Envionics Series 9100 Computerized Ambient Monitoring Calibration System (S-9100) was designed to be the finest instrument available for producing highly precise mixes of ozone and other gases. The system incorporates a powerful 32-bit microprocessor, user-friendly software, mass flow controllers (MFCs) and a custom designed ozone generator module.

Although the S-9100 is very easy to operate, we strongly suggest you read this manual completely. It describes all functions and operations of the system, along with providing system specifications and useful troubleshooting information.

Envionics is pleased to have supplied you with a quality instrument utilizing state of the art electronic technology. A knowledgeable service team is ready to assist you in the use of this instrument should the need arise.

2 THEORY OF OPERATION



The S-9100 was designed to precisely blend two or more gases with or without ozone. To produce accurate results and meet the needs of different operating conditions, many innovative designs were implemented.

The first operating condition to overcome was to compensate for extreme lengths of tubing connected to the output. These extreme lengths would change the backpressure to the system and could possibly affect the ozone. By using a pressure regulator set to 18 lbs. upstream of a critical orifice and a backpressure regulator set to 10 lbs. downstream of the orifice, the system maintains a 500 sccm flowrate through the ozone module. This backpressure regulator will also allow you to vary the total flow of the system while

maintaining a constant ozone flow and ozone level. With the flow through the ozone module accurately held, the ozone will remain the same regardless of the input pressure or backpressure, within limits. In addition, variation of total flow will be limited by the ozone calibration table if you have specified a specific total flowrate for calibration.

Measures were taken to insure the accurate production of ozone. Most of the electronics for controlling the ozone are contained within the temperature controlled ozone module to take advantage of reduced temperature variations. The pressure inside the ozone chamber is measured so the software can make adjustments to compensate for varying chamber pressures at which the system may be operating. Finally, the ozone module itself is installed before the back pressure regulator to maintain constant flow characteristics.

When the S-9100 is operating, ozone flows into the reaction chamber along with the gas from port 2, 3, 4 or 5. The volume and turbulence of the chamber gives the ozone time to react with the gas. The mix then flows to the optional mixing chamber where it is diluted with the gas from port 1. This process is also used to produce NO₂ (See the Gas Phase Titration section).

The flow through the S-9100 is controlled by industry standard mass flow controllers (MFCs), devices which control the mass flow of gas by measuring the thermal loss of a cross section of the gas flowing through it. By supplying a command voltage from 0 to 5 volts to the MFCs, different amounts of gas are allowed through.

The advanced software in the S-9100 allows you to perform complex blends of gas and ozone with accuracy and ease. By using the soft keys and on-screen menus, you can quickly and easily access the various operating modes.

3 UNPACKING and SETUP

The S-9100 is shipped completely assembled and ready to use. You only have to properly unpack and inspect the instrument and connect the appropriate gas sources to the gas inlet ports on the rear panel.

UNPACKING

The S-9100 should be removed from its shipping container and inspected for damage. Any damage to the shipping case should be noted and reported to the freight carrier immediately. Place the unit at the desired operating location, remove the top cover by removing the two small screws on each side of the top, and inspect the interior of the S-9100 for possible loose parts or visible damage. Also, check for any loose circuit boards and press down to reseat them before connecting power. Report any instrument damage to Environics or your local Environics distributor. If there is no visible damage, replace the cover and screws.

POWER CONNECTION

WARNING

OPERATING THE S-9100 AT AN INCORRECT LINE VOLTAGE WILL DAMAGE THE INSTRUMENT AND VOID THE MANUFACTURER'S WARRANTY. CHECK THE LINE VOLTAGE BEFORE YOU PLUG THE INSTRUMENT INTO ANY POWER SOURCE. LINE VOLTAGES BETWEEN 100-120 VAC (OPTIONAL 220-240 VAC) ARE ACCEPTABLE.

Insert the power cord into the power connector on the rear panel and insert the plug into a properly grounded outlet. The standard unit allows for 115 VAC (50/60 Hz) only — 230 VAC (50/60 Hz) input is optional. Turn the front panel rocker switch to the "ON" position. The instrument will run through a short self-test procedure and then indicate "READY". If "READY" appears on the screen, you should then turn the power switch to the "OFF" position and proceed to the section on gas connection. If there is no display, refer to the section on TROUBLESHOOTING.

Before connecting or disconnecting any cables, wiring harnesses or other sources of potential electrical impulse, be sure the unit is powered OFF. The RS-232 serial ports and the parallel printer port are especially susceptible to damage if the unit is powered ON while any computer or printer equipment is being connected or disconnected.

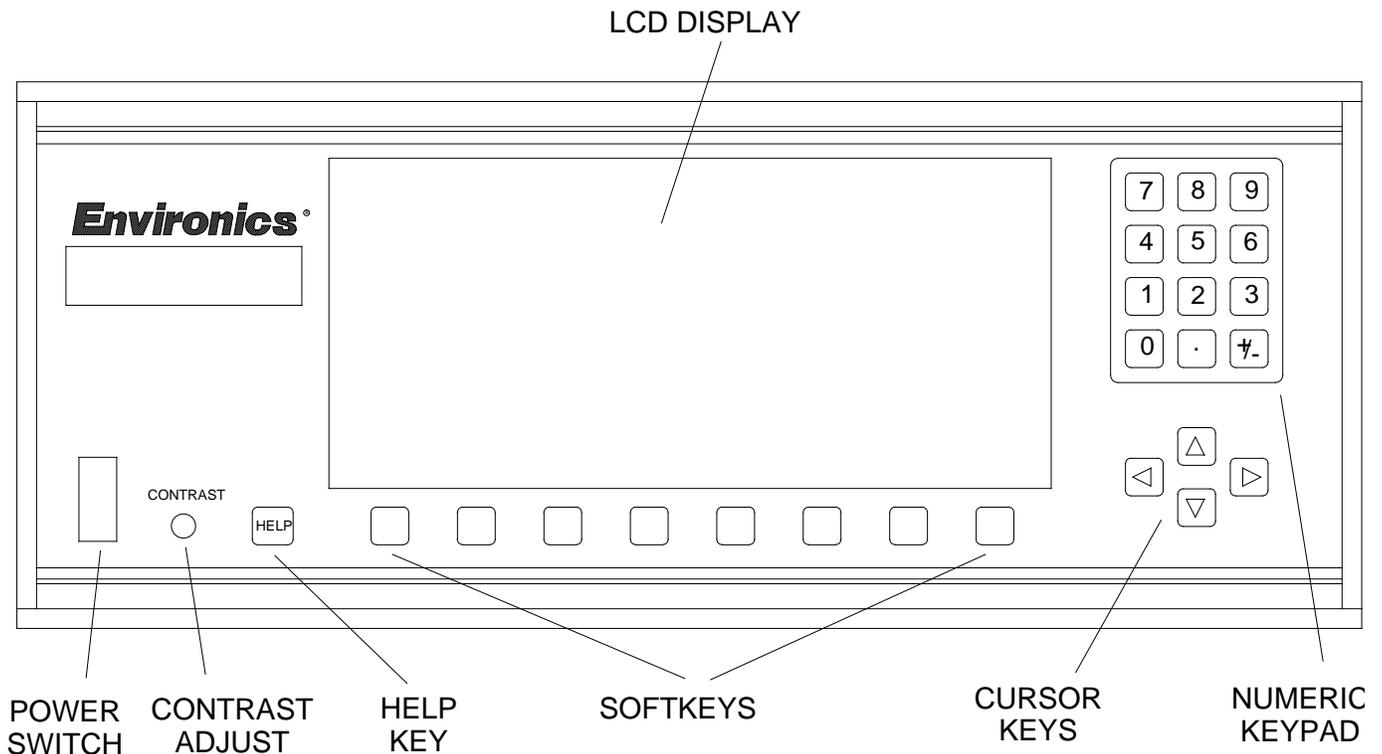
GAS CONNECTION

Connect a source of zero air, at a pressure between 25 and 30 PSIG, to PORT 1 (dilution gas port). Connect all span gases to PORT 2 through 5 (span gas ports) at a pressure between 20 and 30 PSIG. Connect the OUTPUT port to a vented manifold system. Be sure not to overpressurize the output of the system.

It is important that the gas pressures stay within the ranges specified for each gas port. Otherwise, the system may produce gas blends that fall outside the accuracy specifications of the system.

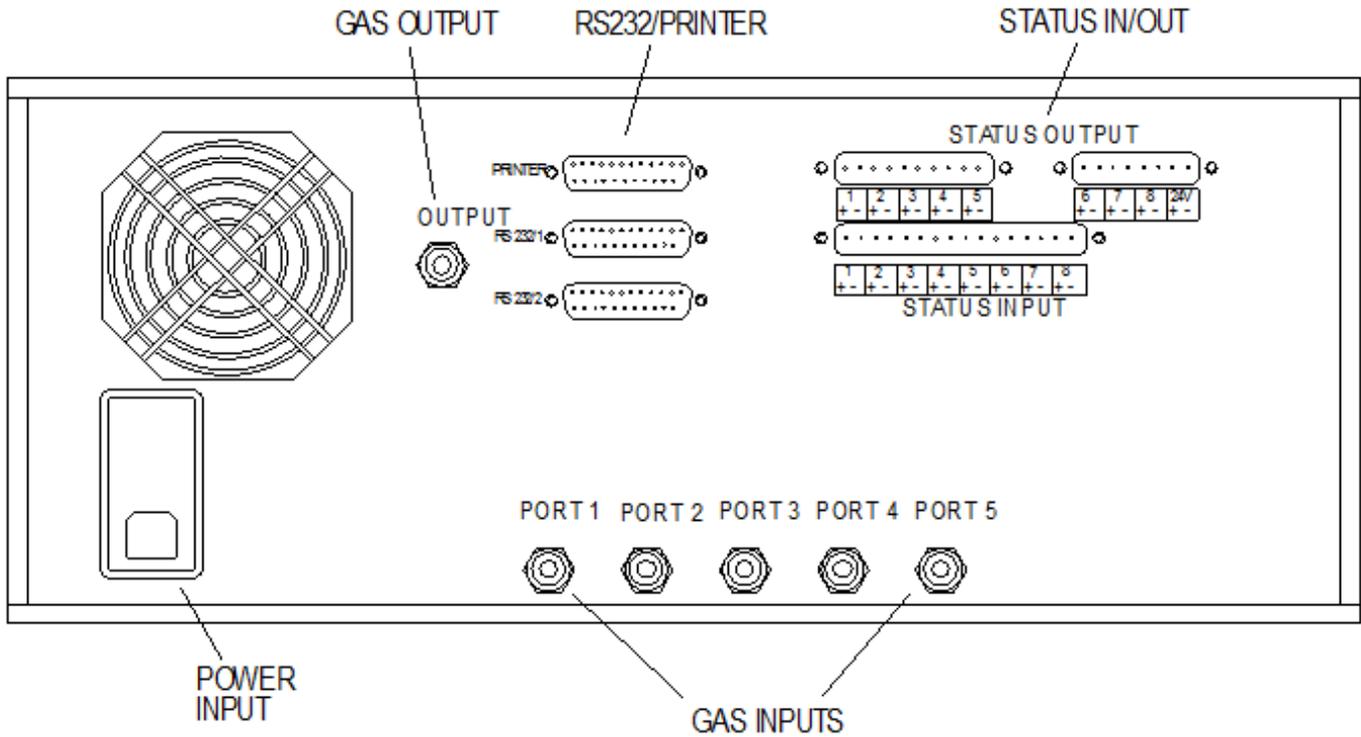
4 SYSTEM LAYOUT

4.1 FRONT PANEL



- POWER SWITCH** To turn the system on, push the power switch upwards. The switch and display will illuminate and the start-up message will appear.
- CONTRAST ADJUST** The contrast knob is used to adjust the display for optimum viewing. Due to the nature of LCD displays, this adjustment must be made if you change vertical orientation of the instrument.
- DISPLAY** The display is a 25 line by 80 column LCD, protected by a polycarbonate lens. Lines 24 and 25 are used as "soft key" labels, while line 23 is used primarily for status messages.
- KEYBOARD** The S-9100 has a durable membrane keyboard, which provides a tactile feedback when keys are pressed.
- NUMERIC KEYPAD** The numeric keypad is used for numeric data entry. The +/- key is used to change a number between positive and negative or as a toggle for data. This key will only operate when required.
- CURSOR KEYS** The cursor keys are used to move between the different fields and cells located on the different entry screens. When you move the cursor from any cell, the data in that cell will be accepted.
- SOFT KEYS** The eight "soft keys", located under the display, change function depending on the current operating mode. As you operate the system, the current function of each soft key will be displayed in the bottom 2 lines of the display.
- HELP KEY** The help key allows you to obtain context sensitive help at any time, without interfering with data currently being entered.

4.2 REAR PANEL



POWER INPUT

Supplies AC power to the instrument.

GAS INPUTS

Connections for input span and dilution gases.

GAS OUTPUT

Connection for output gas stream.

RS232/PRINTER

2 RS232 serial ports are supplied for connecting to a serial terminal or for remote communications. The printer port allows you to print screen data to a standard PC printer.

STATUS INPUT/OUTPUT

The optional status board allows the 9100 to signal external devices when certain operating event occur, and allows external devices to initiate system actions.

5 SYSTEM OPERATION

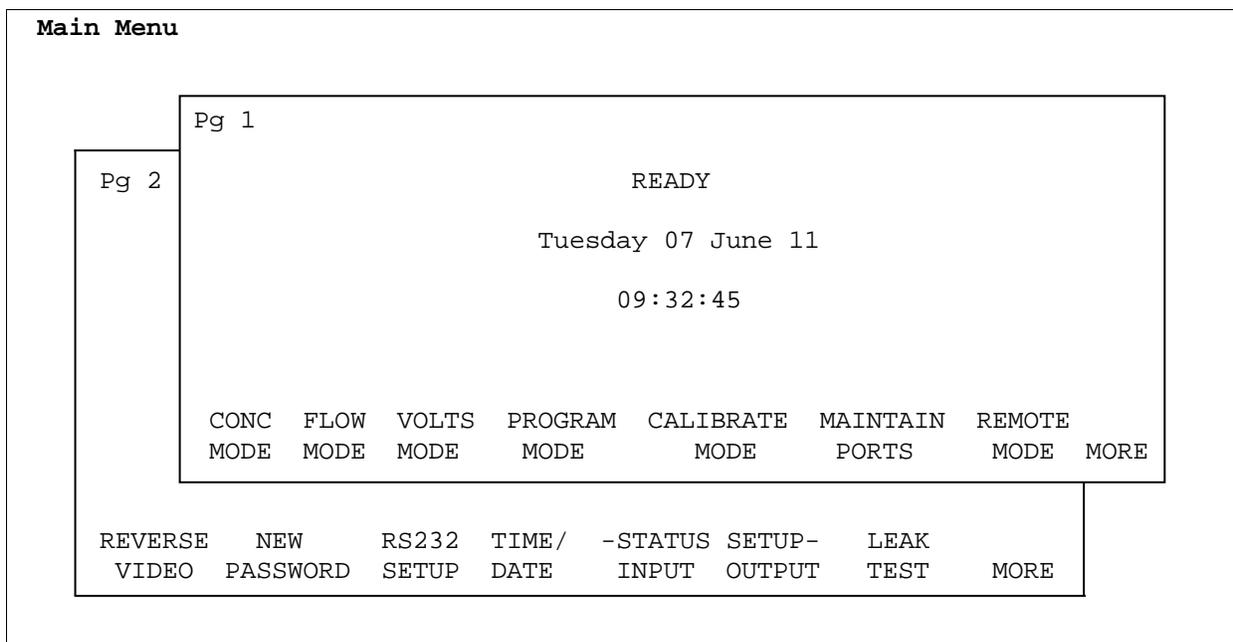
WARNING

SOME GASES CAN BE EXPLOSIVE OR OTHERWISE REACTIVE WHEN BLENDED. USERS MUST CHECK GAS COMPATIBILITY BEFORE BLENDING. PLEASE CONSULT A GAS HANDBOOK, A SPECIALTY GAS MANUFACTURER OR OTHER COMPETENT SOURCE FOR INFORMATION ABOUT GAS COMPATIBILITY. FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN DAMAGE TO THE INSTRUMENT, SERIOUS INJURY OR DEATH.

PRESSURIZED CYLINDERS ARE EXTREMELY DANGEROUS IF IMPROPERLY HANDLED. PROPER REGULATORS, USE OF SAFETY CAPS AND PROPER RESTRAINTS ARE MANDATORY. AVOID CROSS CONTAMINATION WHEN ATTACHING REGULATORS OR MAKING MANIFOLD CONNECTIONS. ALWAYS CONSULT YOUR GAS SUPPLIER FOR PROPER SAFETY PROCEDURES. FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN SERIOUS INJURY OR DEATH.

5.1 MAIN SCREEN (READY)

The S-9100 was designed with emphasis on simplicity and ease of use. The instrument's menu driven software guides you through all operating routines and provides on-screen mode specific help with the simple press of the HELP key. The main menu offers 14 primary functions, described briefly below:



CONCENTRATION (CONC) MODE

Allow you to create a gas mixture by specifying the desired gas concentrations and the total flow rate of the output gas stream. The software performs all necessary flow computations to achieve the desired mixture.

FLOW MODE

Allows you to create a gas mixture by specifying the flow rate of each gas, and the desired concentration of ozone.

VOLTS MODE

Allows you to operate the MFCs and the ozone module directly, by specifying a command voltage for each device.

PROGRAM MODE

Permits unattended, automatic operation of the instrument on a programmable seven-day schedule.

CALIBRATE MODE

Used to view or edit the calibration data for the MFCs, ozone module, analog to digital converters (ADC), and digital to analog converters (DAC).

MAINTAIN PORTS

Used to specify what gases are connected to the system. This information is used internally for error checking and all concentration and flow calculations.

REMOTE MODE

Allows the system to be operated remotely by computer, using the remote command protocol.

REVERSE VIDEO

Allows the display to be changed from blue text on a white background to white text on a blue background.

CHANGE PASSWORD

Allows you to assign password restrictions to various system functions.

RS-232 SETUP

Allows setting the RS232 serial communications parameters, such as baud rate and terminal type.

TIME/DATE

Used to set the current time and date.

STATUS INPUT

Used to assign different system operations to each of the eight status inputs. When an external device activates one of these inputs, the assigned operation will run.

STATUS OUTPUT

Used to setup the operation of the eight status outputs. When the specified conditions are met, the corresponding outputs become active, allowing external devices to be controlled.

LEAK TEST

Performs an automatic leak test of the system plumbing. This is a fully automated test requiring no user intervention.

5.2 CONCENTRATION (CONC) MODE

Operation: MANUAL Mode: CONC						
MFC	Port	Target Flow	Actual Flow	Target Gas	Actual Gas	
1	1	9.949	SLPM	N2	6747.7	PPM
2	2	68.149	SCCM	CO	37.183	PPM
				^ CH4	15.0	PPM
				NO	0.7435	PPM
Total Flow		10.02	SLPM	SO2	0.3693	PPM
				PRO	1.7074	PPM
<hr/>						
Ozone		1.05	PPM	NO2	0.7435	PPM
Ozone block temperature			50.0			
Ozone lamp drive voltage			12.56			
Ozone generator pressure			24.68			
Ozone generator flow			500.0			
START	SAVE	RECALL		DIAG	PRT SCRN	EXIT

Concentration Mode

One of the most powerful features of the S-9100 is the manual concentration mode. Here you will enter the concentration for one of the component gases in the tank connected to MFC 2 along with the total output flow desired. The system will then compute the proper flow settings for each MFC to produce the precise blend. The concentrations of the rest of the component gases in the tank will also be computed and displayed.

PORT FIELD

The "Port" field tells the system which port should be used for each MFC. In the S-9100, only port 1 can be connected to MFC 1, but MFC 2 can choose between port 2 and other optional ports. **NOTE: The ports should be completely setup in "MAINTAIN PORTS" before the concentration mode is operated.**

TARGET AND ACTUAL FLOW FIELDS

The "Target" and "Actual" flow fields are for display only and cannot be accessed with the cursor. When a change is made to the target gas or total flow fields the target flows for each MFC will be updated. Once a concentration is started with the START soft key, the actual flows will be displayed and updated about every two seconds.

TARGET GAS FIELD

The "Target Gas" field is where most of the data entry takes place. To change the concentration of the mix, move the cursor to the desired "Target Gas" cell and enter the desired concentration. Once the concentration has been entered, a carrot ("^") will appear next to the component name, marking this component as the one of interest. The largest amount which can be entered for any one particular gas component is determined from MAINTAIN PORTS. If an error is made the system will display the maximum amount available in an error message. The "Actual Gas" field is for display only and will be active when the START soft key is pressed and updated about every two seconds.

TOTAL FLOW AND OZONE FIELDS

The last two entry fields are "Total Flow" and "Ozone". In these fields, you will enter the desired amount for each in the mix. If a new value is entered a carrot ("^") is displayed next to the value showing this item has been changed. This carrot will be removed once the START or UPDATE soft key is pressed. If a data entry error is made, the system will display an error message when the START or SAVE soft key is pressed.

The last group of display-only fields is on the bottom left of the display. This is status information about the ozone module and will be constantly updated about every two seconds. Now that the different fields have been explained, we will proceed with the actual operations of the concentration mode.

OPERATION

As data is entered in different fields, or the START soft key is pressed, different notes may appear to the right of the target flow values. These notes describe the range status of the MFCs. The different status notes are ">MAX" for out of range, ">90%" which means the MFC will operate in the 90% to 100% of its range, "<10%" will appear if the MFC will operate under 10% of its range. If no status appears, the MFC is in its optimum range. **NOTE: Operating the MFC below 10% of its rated full-scale flow may result in flow inaccuracies.**

Once all the desired values have been entered for a particular mix, press the START soft key and the system will proceed to create the gas mixture specified. If the system has discovered any values it cannot reproduce, an error message will be displayed and the mix will not begin. Once the errors have been corrected, the START soft key can be pressed. While the system is running a mix, different concentrations, total flow, and ozone can be entered to produce a different mix without stopping the current operation. Once the new values have been entered, press the UPDATE soft key to update the currently running mix with the new values.

Also available in the concentration mode is the ability to save and recall up to 100 different mixes. Once a desired mix is entered, press the SAVE soft key and enter the desired register location in which to save the data. Now this mix can be recalled at any time by pressing the RECALL soft key and entering the same register number. It is suggested that a print out of the saved mix be saved with its register number written on it for future reference. This can be accomplished by connecting a parallel printer to the back of the S-9100 and pressing the PRT SCRN (print screen) soft key, causing the system to send a copy of the screen to the printer.

DIAGNOSTIC (DIAG) SOFT KEY

The DIAGnostic soft key provides additional information about the operation of the system and is not required for normal use. Pressing the DIAG soft key will display the latest ADC and DAC calibrations and the values of +15 and -15 volts. The values for the ADCs and DACs are in counts. The value for one count is approximately 1.2 mV. The system will first calibrate the ADC for 0 and 5 volts. There is a small offset built in to facilitate greater precision, so 0 volts does not equate to 0 counts. After the ADC is calibrated, each of the DACs will be calibrated with the ADC. These counts should only be used to confirm the ADC and DACs are operating properly. The expected counts for the ADC are around 20 for the low and around 4090 for the high. The DACs are slightly different with a low around 88 and a high around 4029. These values should stay about the same and not drift more than a few counts in normal operation. Please note that after the system has been turned off, there will be no valid diagnostic data until an operation is started. The DIAG soft key is a toggle and will remove this data from the screen.

5.3 FLOW MODE

		Operation: MANUAL		Mode: FLOW	
MFC	Port	Target Flow	Actual Flow	Target Gas	Actual Gas
1	1	10.0 SLPM		^ N2 2475.3 PPM	
2	2	25.0 SCCM		CO 13.64 PPM	
				CH4 5.5025 PPM	
				NO 0.2727 PPM	
Total Flow		10.02 SLPM		SO2 0.1355 PPM	
				PRO 0.6263 PPM	
<hr/>					
Ozone		1.05 PPM		NO2 0.2727 PPM	
Ozone block temperature			50.0		
Ozone lamp drive voltage			12.56		
Ozone generator pressure			24.68		
Ozone generator flow			500.0		
START	SAVE	RECALL		DIAG	PRT SCRN EXIT

Manual Flow Mode

The MANUAL FLOW MODE is similar to the MANUAL CONCENTRATION MODE in many ways. The major difference between the two modes is you decide what flows to set the MFCs to, thereby determining the concentrations in the mix, instead of having the system computing the flows.

In this mode, "Target Gas" is now a display only field and "Target Flow" becomes the field for entry. When target flow values are entered, the target gas field will be updated to reflect the new concentrations for each component in the tank.

To operate this mode, enter the desired flows for each MFC and the desired ozone concentration. Once all the values have been entered, press the START soft key to begin the mix.

The rest of the fields and operations are identical to the concentration mode. There are 100 registers available to save different flow mixes, which are separate from the 100 registers used by the concentration mode.

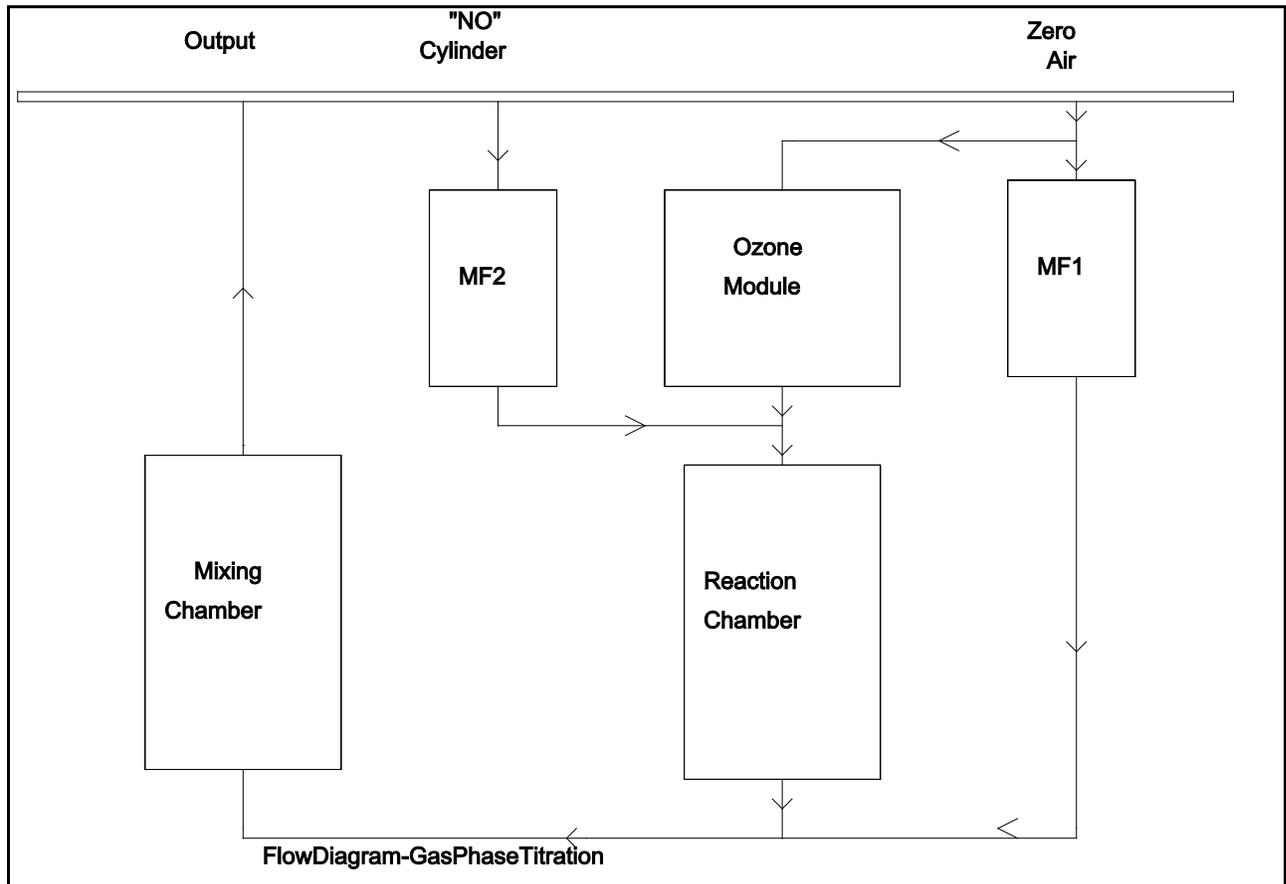
5.4 GAS PHASE TITRATION

Gas phase titration¹ is the chemical reaction between specific gases resulting in the creation of one or more new gases. In the S-9100, rapid gas phase titration is used to create Nitrogen Dioxide (NO₂) from Ozone (O₃) and Nitric Oxide (NO) as described in the following equation:



The nature of the reaction is such that when the concentration of NO or O₃ is known, the concentration of NO₂ can be determined. The EnviroNics recommended method of Gas Phase Titration is the excess Nitric Oxide Transfer Standard Procedure (GPT-NO).

When O₃ and NO are mixed, one of the O₃ molecules will combine with a molecule of NO to create a molecule NO₂ with the leftover two O₃ molecules released as Oxygen (O₂). Using GPT-NO, there will be an excess of NO after the reaction. For example, if 0.58 PPM of NO is combined with 0.5 PPM of O₃ then 0.5 PPM of NO₂ and 0.5 PPM of O₂ will be produced. Since there is more NO than required, an excess of 0.08 PPM of NO will be leftover. Please note that the EPA states that NO₂ audit gas for chemiluminescence analyzers must contain an excess of at least 0.08 PPM of NO, but a substantially higher excess may lead to audit errors.²



¹Based on "TRANSFER STANDARDS FOR THE CALIBRATION OF AMBIENT AIR MONITORING ANALYZERS FOR OZONE - Technical Assistance Document. EPA-600/4-79-056, Sept. 1976. Appendix C. By Frank F. McElroy, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, Research Triangle Park, NC 27711: July 1979.

²Code of federal regulations (July 1, 1990) 40 CFR 58, App. B, 3.2: pp. 152-153.

To perform GPT-NO on the S-9100:

- 1 - Determine the flow required by all the analyzers connected to the output. To this value, add 10 to 20% for excess so that all of the analyzers are assured of drawing NO₂. Enter this new total flow in the Total Flow cell.
- 2 - Determine the amount of NO₂ required at the output and enter this value in the Target Ozone cell.
- 3 - Add at least 0.08 PPM to the value entered for Target Ozone and enter this value in the Target Gas cell aligned with the Gas Name NO.
- 4 - Press the START soft key to begin the mix. If any requested concentration values are out of range, the system will display an error message.

In the MAINTAIN PORTS setup screen, be sure to include the gas name NO for one of the gases. This will allow the system to automatically display the target and actual NO₂ when target O₃ is requested. Once the system is running a mix, the actual NO and O₃ will be adjusted accordingly depending on the reaction. If NO is not included in the super blend or 0.0 is entered as the target O₃, information about NO₂ will be removed from the screen.

5.5 VOLTS MODE

Operation: MANUAL Mode: VOLTS			
MFC	Port	Target Volts	Actual Volts
1	1	0.25	0.25
2	2	1.75	1.75
<hr/>			
Ozone		1.05	
Ozone block temperature			50.0
Ozone lamp drive voltage			12.56
Ozone generator pressure			24.68
Ozone generator flow			500.0
START		DIAG	PRT SCRN EXIT

Volts Mode

The VOLTS MODE is used to control the flow controllers and ozone directly by commanding the exact voltage that is to be sent to each device. All commanded voltage values go directly to the flow controllers and ozone DACs, bypassing the built-in calibration data.

To operate the volts mode, enter the desired voltage for each flow controller, the ozone, and the desired port for each flow controller. When the target volts and ports are correct, press the START soft key to begin the operation. The actual volts are displayed for each flow controller response but not for the ozone. The reason that ozone does not have an ACTUAL display is that no response signal is available for the ozone generator command voltage. Instead, the ozone lamp drive voltage is displayed on the screen.

5.6 PROGRAM MODE

There are two sections in the PROGRAM MODE: TIMER CONTROL and SEQUENCE. The TIMER CONTROL is used to program the system to run selected sequences at specific times and days of the week. The SEQUENCE screen allows you to program the system to run a sequence of concentration, flow, and volts mode operations for various lengths of time.

5.6.1 SEQUENCE

SEQUENCE CONTROL									
Item	Runtime	Mode	Port	Air	Gas	Total	Ozone	Gas ID	Conc
1	01	CONC	2	10.0	25.0	10.025	0.15	CO	2300.0
.									
20	01	CONC	2	10.0	50.0	10.05	0.05	CO	2600.0
START SAVE RECALL CLEAR INSERT DELETE PRT SCRN EXIT									

Program Mode - Sequence Control

The SEQUENCE CONTROL section allows you to create a list of up to 20 concentration, flow, and volts mode operations that run in sequence. The runtime for each step in the sequence can be specified individually. Once a sequence is stored, it can be run manually, triggered by the optional status board, or run at a specified time/day using the TIMER CONTROL mode.

CREATING A SEQUENCE

When first entering the SEQUENCE CONTROL editor, a blank sequence is displayed. A sequence may contain up to 20 steps, which are numbered along the left of the screen.

There are 9 data entry columns for each sequence step. Not all fields are available, depending on the MODE setting you specify in column 2. Below is a list of accessible fields depending on the MODE:

MODE	Runtime	Mode	Port	Air	Gas	Total	Ozone	Gas ID	Conc
CONC	x	x	x			x	x	x	x
FLOW	x	x	x	x	x		x		
VOLT	x	x	x	x	x		x		

To enter a sequence step, place the cursor in the RUNTIME column and enter the desired runtime for that step. The runtime may be from 1 to 60 minutes. A runtime of 0 will cause that step to be skipped and not displayed.

Move the cursor to the MODE column and select the desired run mode by pressing the CONC, FLOW, or VOLTS soft key. Move the cursor to the PORT column and select the desired span gas port to be used in this step.

CONC MODE

If the CONC mode was selected, move the cursor to the TOTAL field and enter the desired "Total Flow", in LPM. Move to the "Ozone" field and enter in the desired amount of ozone, in PPM. Move to the "Gas ID", and select the gas ID number (from 1 to 6) for the gas component of interest. The gas ID number refers to the gases entered in the MAINTAIN PORTS screen, with gas #1 being the

first gas listed. When you move the cursor out of the GAS ID column, the number will be replaced with a name of the gas specified in the MAINTAIN PORTS screen. Next, move to the "Conc" field and enter the desired gas concentration for the gas of interest, in PPM.

FLOW AND VOLTS MODE

If FLOW or VOLTS mode was selected, move the cursor to the "Air" column and enter the amount of flow desired from MFC 1. For FLOW mode, enter this value in LPM and for VOLTS mode, enter the value in volts (from 0 to 5). Move to the "Gas" column and enter the flow desired for MFC 2. For FLOW mode, enter the flow in ccm, or from 0 to 5 volts for VOLTS mode. Next, move to the "Ozone" column and enter the ozone concentration in parts per million (PPM) for FLOW mode or from 0 to 5 volts for VOLTS mode.

When the cursor is moved from one column to the next, each entry is checked for legal values. If any value is out of range, an error message will be displayed at the bottom of the screen.

EDITING KEYS

There are 3 soft keys available for editing sequence data. The CLEAR soft key will clear the data in the current step. The INSERT soft key will insert a blank step at the current cursor location, and move all steps below it down one line. The DELETE soft key will remove the current step, and move all steps below it up one line.

SAVING and RECALLING a SEQUENCE

Setup STORE to register			
Register	Name	Register	Name
01		11	
.		.	
10		20	

Save SETUP to register >01

START CANCEL

Sequence control - Store to register

A sequence can be saved to or recalled from any of the 20 storage registers.

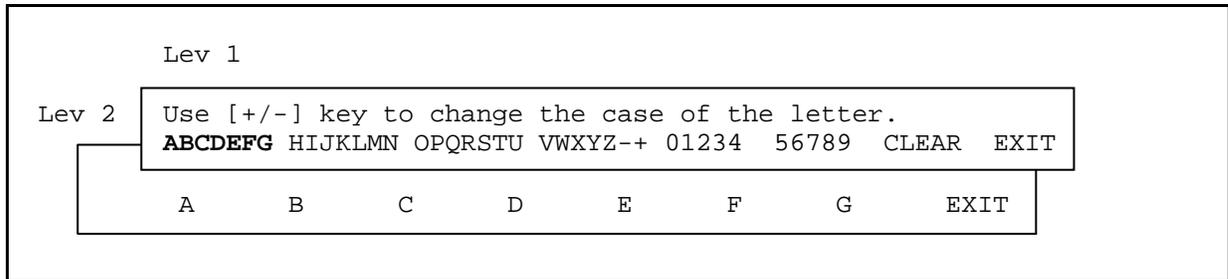
To save a completed sequence, press the SAVE soft key and enter the desired storage register locations. You can also associate a name with the register location if desired, using the system TEXT EDITOR (see below for how to use the text editor). Enter a name for the sequence, if desired, and press the EXIT soft key. This will save the sequence and return you to the sequence control screen. The storage register number and name will now be displayed at the bottom of the screen.

To recall a previously saved sequence, press the RECALL soft key and enter the desired register location. This will recall the sequence and return you to the sequence control screen. The storage register number and name will now be displayed at the bottom of the screen. Recalling a sequence will overwrite any existing sequence steps in the sequence control screen.

RUNNING A SEQUENCE

A sequence can be run manually or automatically through the TIMER CONTROL. To run a sequence manually, enter the desired sequence information, or recall a previously saved sequence with the RECALL soft key. To start running the sequence, press the START soft key. When a sequence is running, the current mode of operation (CONC, FLOW, VOLTS) is displayed, along with "Operation: Program," indicating the mode is running under program control. The name of the sequence, current sequence step, time, date, and time remaining will also be displayed at the bottom of the screen. Pressing the ADVANCE soft key will cause the current step to stop, and the next step in the sequence will begin to run.

SYSTEM TEXT EDITOR



Text Editor

The system text editor is used to enter alphanumeric information into the system, such as program, sequence or gas names. The system text editor appears automatically for any fields requiring alphanumeric data. To enter text, select the letter or number group from the soft keys. This will display each letter in the group above each soft key. Then, select the desired letter or number with the appropriate soft key. The left and right arrow keys can be used to move the cursor within the text entry field. Pressing the +/- key while the cursor is over a letter will toggle it between upper and lower case. Pressing the CLEAR key will clear any text entered. When you are finished with the text entry, press the "EXIT" soft key to accept the text.

5.6.2 TIMER CONTROL (TIMER CTL)

The TIMER CONTROL section of the PROGRAM MODE is used to program the system to run selected sequences at specific times and days of the week. Once a TIMER CONTROL program is started, the system will run each specified sequence at its appropriate day and time. After all sequences in the week are complete, the system will loop back to Sunday and start the week again. To use this mode, sequences must first be created and saved (See the SEQUENCE section above).

CREATING A TIMER

Under the desired day of the week, enter the number of the sequence that is to be run. Once the number has been entered, the first 5 characters of the name will be displayed next to the number. Next, enter the time of day for this sequence to start. The time is based on a 24-hour clock, where 12:00 is noon, and 24:00 is midnight. A time of 00:00 will cause the system to skip this sequence, and make it disappear from the display, unless the cursor is positioned in that location. Once the start time is entered, the system will display the duration of the selected sequence and compute the time it will finish.

You can enter up to three sequences for each day of the week. Be careful of sequence overlapping when setting up a TIMER CONTROL program. If any the start time of one sequence overlaps the end time of another, the system will mark that sequence with an asterisk when the START or SAVE soft key is pressed. All overlaps must be corrected for the START or SAVE soft keys to operate.

TIMER CONTROL							
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Sequence	01						
Start	12:00						
Duration	01:00						
Stop	13:00						
.							
.							
START	SAVE	RECALL	CLEAR	NEW TIMER		PRT SCRN	EXIT

Program Mode - Timer Control

A CLEAR soft key is provided to erase all data in the current program.

The NEW TIMER soft key allows a new TIMER CONTROL program to be loaded at a specific time and day of the week. This can be used to extend the timer beyond the limit of 3 sequences per day or to extend it beyond a 7 day repeating schedule. When a NEW TIMER action is added to a TIMER CONTROL program, it automatically loads another previously stored TIMER, and begins running it. This lets you chain one timer control program to another. To use the NEW TIMER function, you must have already saved one or more timer control programs. Place the cursor in the desired location, and press the NEW TIMER soft key. In the SEQUENCE row, enter the desired timer control register number to be loaded and enter the desired start time.

SAVING and RECALLING a TIMER

The save and recall operations work the same as in the SEQUENCE screen. To save a timer control program, press the SAVE soft key, enter the desired storage register number, and a name if desired. To recall a timer control program, press the RECALL soft key and enter the storage register number of the program to recall.

RUNNING A TIMER

To start a TIMER CONTROL, enter the desired timer information, or press the RECALL soft key to recall a previously saved program, and press the START soft key. The system will display the current time in the upper right corner of the screen, and the current date in the lower left. The day and time of the next sequence to run will be displayed in the lower right. When the specified time and date arrives, the sequence is started. When the sequence is running, the current mode of operation (CONC, FLOW, VOLTS) is displayed, along with "Operation: Program", indicating the mode is running under program control. The name of the sequence, current sequence step, time, date, and time remaining will also be displayed at the bottom of the screen. Pressing the ADVANCE soft key will cause the current step to stop, and the next step in the sequence will be run. If ADVANCE is pressed while on the last item in the sequence, the system will stop and wait for the scheduled time to run the next sequence. Pressing the STOP soft key at any time will abort the current sequence and return to the TIMER CONTROL editor.

5.7 CALIBRATE MODE

IMPORTANT

NOTE: It is important that a hard copy of the calibration data be kept in a safe place. This data will be required to restore the system in case of data loss.

Calibrate mode is used to enter calibration information for various system devices. Calibration data compares measured versus desired performance of the various devices, so that corrections can be made to improve their operation.

In addition, the calibrate mode also displays several messages related to the system operation:

- 1) The selected flow calculation method used by the calibration tables: "single slope and intercept" or "multi-point linear interpolation."
- 2) Whether or not the optional ozone pressure transducer is being used to correct ozone generation
- 3) Whether or not all flow will be shut off if the actual flow through the system drops below 50% of the target flow.

Refer to the [System Configuration Settings](#) section (pg. 37) for details on how to change these settings.

```
                                CALIBRATION

The system is using a multi-point linear interpolation for computing flows.
Ozone adjust - pressure gauge - is on.
Stop flows when low flow detected - is on.

MFC                                DEVICE
FLOW                                OZONE    ADC    DAC
```

Calibrate Mode - Main Menu

5.7.1 MFC FLOW

The MFC flow soft key allows you to calibrate the Mass Flow Controllers, using a flow calibration standard. It also allows you to enter calibration data for a pre-calibrated flow controller. When you press the MFC FLOW soft key, you will be prompted to enter the MFC to be calibrated, as well as which gas port you are using for your calibration gas.

SCREEN LAYOUT

The MFC FLOW calibration screen shows 11 calibration points, each with 5 field columns. The first column shows the percent of command in relation to the size of the MFC being calibrated and will be updated by the system whenever a command value is changed. The next two columns are for entering the command value, which can be entered in either flow or volts. The flow values range from 0 to the size of the MFC and the voltage values range from 0 to 5 volts (0 volts for 0 flow and 5 volts for max flow). When data is entered in one of those fields, the other will be computed by the system. The next column is where the true flow, as

measured by a calibrated flow standard, is entered. The right 2 columns are for display only, and will show the response of the MFC in both flow and volts when the MFC is energized.

The bottom of the screen contains the slope and intercept fields for the current data, as well as a display of the MFC/Port being calibrated and the date/time that the calibration data was last saved.

MFC FLOW CALIBRATION - All flows in lpm						
Percent	Command Flow	Volts	True Flow	Feedback Flow	Volts	
5	1.0	0.25	1.0			
.						
100	20.0	0.0	20.0			
Slope		>1.0				
Intercept		>0.0				
				Correlation Coefficient >0.0		
Port		>1				
MFC desired		>1				
Last cal was on Tuesday 08 February 11 at 14:23:49						
INIT		INIT		SAVE		
ENERGIZE	COMMAND	TRUE	CAL DATA	CALC	PRT CAL	PRT SCRN EXIT

Calibrate Mode - MFC Flow

CALIBRATING WITH A FLOW STANDARD

When calibrating MFC flow with a flow standard, a calibrated flow measurement device is used to measure the flow rate of the MFC. To ensure accuracy, the flow measurement standard must be more accurate than the specified flow accuracy of the mass flow controller. Connect a source of calibration gas to the desired gas input port, and connect your flow measurement device to the output of the system.

INITIALIZING CALIBRATION DATA

The INIT COMMAND soft key can be used to reset the calibration points (command flow) to the factory default values. These are normally 5% and 10% to 100% (in 10% intervals) of the MFC full-scale flow.

The INIT COMMAND soft key can be used to initialize the TRUE FLOW values to the COMMAND FLOW values, which effectively resets the calibration table to an "uncalibrated" state.

Both of these steps are optional, and are not required for calibration.

STARTING CALIBRATION

To start the calibration process, place the cursor on the row for the desired calibration point, and press the ENERGIZE soft key to start flowing calibration gas. Allow the gas flow to stabilize for about 5 minutes, then take a reading from your flow measurement device and enter the measured flow value in the TRUE FLOW column. Move the cursor to the next calibration point and press the UPDATE soft key. Repeat this process for each calibration point.

SLOPE AND INTERCEPT CALCULATION

The CALC soft key will calculate the slope and intercept for a line that best fits all 11 calibration points. This slope/intercept information is used only if the FLOW CALCULATION METHOD is set to "single slope and intercept." To calculate the slope/intercept, press the CALC soft key and then the YES soft key. While this step is not required, it should be performed so that the slope/intercept values agree with the calibration data.

The CALC key will also allow the calibration TRUE FLOW points to be calculated based on a manually entered slope and intercept value. To perform this operation, enter the desired Slope and Intercept values in the calibration screen, then press the CALC key. When prompted to "Calculate a new slope and intercept?" press NO. When prompted to "Calculate TRUE FLOW from slope and intercept?" press YES. **Performing this step will overwrite any existing calibration data and should be used with caution.**

SAVE CALIBRATION DATA

Once all calculations have been made, the SAVE CAL DATA soft key should be pressed to record the data in the system. If SAVE CAL DATA is not pressed, none of the data entered will be saved. When pressing the EXIT soft key, the system will ask for confirmation to EXIT without saving the data.

Each time the SAVE CAL DATA soft key is pressed, the calibration time/date stamp will be updated.

PRINTING THE CALIBRATION SHEET

To get a hard copy of the calibration data, press the PRT SCRN soft key for a copy of the display as it is displayed, or press the PRT CAL soft key for a formatted calibration report.

FLOW CALIBRATION FORMULAS

$$\text{intercept} = \bar{Y} - m * \bar{X} \quad \text{slope} = \frac{\bar{X} * \bar{Y} - \bar{Y} * \bar{x}}{\bar{X}^2 - \bar{X}^2}$$

Slope and Intercept

$$r = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\left[\sum_{i=1}^n (X_i - \bar{X})^2 \sum_{i=1}^n (Y_i - \bar{Y})^2 \right]^{1/2}}$$

Correlation Coefficient

5.7.2 OZONE CALIBRATION

IMPORTANT

After Ozone calibration is complete, keep a hard copy of the ozone and DAC device 011 calibration data in a safe place. This data is required recover the system in the event of memory loss

The ozone calibration screen is used only to enter ozone, flow and pressure data gathered in a previous flow operation. Unlike calibrating a flow controller, the system cannot be run from this screen. When the system is first received, it will have been calibrated with the Environics measurement standard at regular ozone and flow intervals.

When target values are entered, the system uses the previous calibration data to determine what the system really commanded and associates it with the true data. In this way, the system can gain greater accuracy with every calibration.

LIVE DATA OZONE CALIBRATION - All flows in LPM						
Target				True		
Percent	Ozone	Volts	Total Flow	Ozone	Total Flow	
5	0.05	0.25	13.0	0.05	13.0	
10	0.1	0.5	13.0	0.1	13.0	
.						
.						
100	1.0	5.0	13.0	1.0	13.0	
Calibration Pressure > 15.16						
Last ozone calibration was on Tuesday 08 February 11 at 14:23:49						
SAVE DATA		INIT ALL		PRT SCRN		EXIT

Calibrate Mode - Ozone

FIELD DESCRIPTIONS

TARGET - PERCENT

This is a display only field in which the system will compute the percent of ozone the calibration point represents in relation to the maximum amount of ozone that can be produced.

A calibration point is really made up of two parts, target ozone and total flow. With these two parts, the system can relate them back to the ozone module flow, which is typically 500 sccm, and the maximum ozone, which is typically 26 PPM at 500 sccm. For example, an ozone setting of 1 PPM @ 13.0 slpm is equivalent to 26 PPM @ 500.0 sccm. The formula for computing the command to the ozone module is as follows:

$$\text{Ozone Module O3} = \frac{\text{Target O3} * \text{Total Flow}}{\text{Ozone Module Flow}}$$

TARGET - OZONE

The entry for this field is the target ozone value entered in the flow mode. When an entry is made in this field the system will use the previous ozone calibration data to compute the "Target Volts."

TARGET - VOLTS

This is a display only field that shows the voltage applied to the ozone module. This value is computed from the "Target Ozone", "Target Flow", and the previous ozone calibration data.

TARGET - TOTAL FLOW

This field is for entry of the target total flow value, used in the flow mode for running ozone. When an entry is made in this field the system will use the previous ozone calibration data to compute the "Target Volts."

TRUE - OZONE

This field is for entry of the actual ozone, as measured by your ozone standard while in FLOW MODE.

TRUE - TOTAL FLOW

This field should duplicate the flow rate entered into the TARGET TOTAL FLOW column for the respective ozone point.

PRESSURE

This field is for entry of the average ozone chamber pressure, as indicated by the front panel pressure field during calibration in the FLOW mode.

SOFT KEY DESCRIPTIONS

INIT ALL

The INIT ALL soft key will initialize the screen to produce a calibration curve with a slope of 1 and an intercept of zero. In addition, the Pressure field will be initialized to standard sea level pressure plus 10 PSIG.

SAVE DATA

This soft key is used to record data in the system and update DAC (Digital to Analog Converter) device 011. DAC 011 is the device used to directly command voltage levels to the ozone generator. Once this device has been updated, the ozone data in the calibration table is no longer used. Once all data is entered and saved, you should exit out of ozone calibration to allow the system to use the new data. After saving the data, all TRUE ozone data will revert to the TARGET ozone data, getting the system ready for a second set of TRUE data (if necessary). In this way, the ozone calibration data can be compounded, allowing it to be fine-tuned for greater accuracy.

OPERATION

When ozone calibration is required, you should use the FLOW MODE to run all the calibration points of interest. Refer to the OZONE CALIBRATION procedure in the APPENDIX for details.

5.7.3 DEVICE - ADC (Analog to Digital Converter)

This area is used to enter the calibration data for the different ADC devices in the system. The following devices may be available for calibration depending on the options installed:

- 012 - Ozone pressure sensor
- 013 - Ozone block temperature sensor
- 014 - Ozone lamp drive voltage
- 015 - Ozone flow meter
- 021 - Plus 15 volts
- 022 - Minus 15 volts

```

                                DEVICE CALIBRATION
                                All ADC data is in PISA
                                Percent      Command      True
                                5             1.5          1.5
                                10            3.0          3.0
                                .
                                .
                                100          30.0         30.0
                                Live Reading  1.8
Device to calibrate >012
                                INIT        INIT        SAVE
                                COMMAND      TRUE        CAL DATA
                                PRT SCRN    EXIT
```

Calibrate Mode - ADC Device

When the device number is entered, its calibration table is displayed along with a live reading, which is updated every 2 seconds. This live reading can be used as the true if a calibrated source is used to supply the command.

5.7.4 DEVICE - DAC (Digital to Analog Converter)

This area is used to enter the calibration data for the different DAC devices in the system. This is an entry screen only. Currently there is only one DAC device (ozone - device # 011) available for calibration. This device calibration data is updated by the system and should be accessed only to get a hard copy of the data or to re-enter lost ozone data.

5.7.5 RECOVERY OF LOST CALIBRATION DATA

Calibration data can be lost by accidentally initializing the data, incorrectly changing the data, or loss of battery power to the internal memory chips (RAM). The recovery of the calibration data is an easy process if all the calibration data has been recorded and saved in a safe place. The following two sections will describe the process of re-entering all the calibration data.

IMPORTANT

If battery power is lost, the system will have to be PROPERLY CONFIGURED before any calibration data is entered. Contact your dealer or Environics for instructions on how to configure your system.

MFC and ADC/DAC DEVICES

MFC, ADC, and DAC calibration data is the easiest to recover. First, obtain copies of all the latest calibration data. Now, go into each of the respective calibration screens and enter the calibration data from your copy. Be sure to enter all 11 points of calibration data, entering zero for the points not used.

Note: Do not enter calibration for DAC device 011 here. This will be done in the OZONE section.

OZONE

The recovery of the ozone calibration data is a two-step process. First, using the most recent ozone calibration data, go into the ozone calibration screen and enter all ozone data, as well as the calibration pressure. Be sure to enter all calibration points, entering zero in the table for the points not used. When the entry is complete, press the SAVE DATA soft key to record the data in the system.

Next you will need the calibration data for DAC device 011, which coincides with the latest ozone calibration data. Go into the DAC device calibration screen for device 011 and enter all data shown on the DAC 011 calibration sheet. When the entry is complete, press the SAVE DATA soft key to record the data in the system. The ozone calibration data recovery is now complete.

When you are finished editing the port information, press the "EXIT" soft key to select a different port or exit back to the main menu.

5.9 REVERSE VIDEO

To change the display between blue text on a white background and white text on a blue background, press the "REVERSE VIDEO" soft key. If you want white text on a blue background press the "YES" soft key, otherwise press the "NO" soft key.

5.10 NEW PASSWORD

```
                                PASSWORD EDITOR

    Entering CONCENTRATION MODE  =NONE
    Entering FLOW MODE           =NONE
    Entering VOLTS MODE          =NONE
    Entering PROGRAM MODE        =NONE
    Entering CALIBRATION MODE    =NONE
    Entering PORT MAINTENANCE    =NONE
    Entering STATUS INPUT        =NONE
    Entering STATUS OUTPUT       =NONE
    Remote access from RS-232    =NONE
    Entering PASSWORD EDITOR     =NONE

    NONE   CHANGE   SAVE                               PRT  SCRN  EXIT
```

Password Editor

Access to most of the system operation in the S-9100 can be restricted with passwords. To enter the password editor you must enter the password for the editor. The default password, for the editor, supplied with the system is "1234". Once in the editor you can change any of the passwords by pressing the CHANGE soft key and entering in any 4-digit code. If you wish to remove any password, press the NONE soft key.

Before exiting from the password editor, press the SAVE soft key to save the changes you have made. **Make sure you record the password allowing access to the password editor and store it in a safe place. This is the only place passwords can be changed.**

IMPORTANT

PLEASE RECORD THE PASSWORD USED TO ENTER THE PASSWORD EDITOR AND STORE IT IN A SAFE PLACE. THIS IS THE ONLY PLACE THE PASSWORDS CAN BE CHANGED.

5.11 RS232 SETUP

SERIAL COMMUNICATIONS SETTINGS		
On / Off	ON	ON
Baud Rate	9600	9600
Terminal Type	CPU	VT100
Modem Connected	OFF	OFF
Supply DTR/RTS	NO	NO
Use CTR/DSR	NO	NO
TOGGLE		PRT SCRN EXIT

RS-232 Settings Editor

The system includes two RS232 serial communications ports, for connecting remote communications equipment, such as a modem or terminal. The RS232 setup screen is used to configure the operation of the two RS232 ports. There are 4 settings that need to be properly configured to assure correct operation.

5.11.1 PORT CONFIGURATION

ON / OFF Each RS232 port must be turned on before it can be used. If a port is not in use it should be turned off. It should be noted that if a slow baud rate is used, under 4800 baud, and one of the ports is on, the rate at which the display updates will be slow. This is because the system must update the terminal connected to the RS232 at its proper baud rate.

BAUD RATE The baud rates available are 300, 1200, 2400, 4800, 9600, 19.2K, 38.4K, and 56K. For short distances under 5 meters, a high baud rate can be used without any problems. In a noisy environment, a slower rate is strongly recommended. If you are using a modem, make sure the baud rate is set to the same rate as the modem transmitting speed. If you have a 1200 baud modem, set the system baud rate to 1200.

TERMINAL TYPE There are 3 Terminal Type settings available. To operate the system interactively from a remote terminal, select either TV950 (Televideo) or VT100 (DEC), depending on the communication protocol supported by your terminal software. To operate the system in Remote Mode, set the terminal type to CPU. NOTE: Do not set more than one RS232 port to CPU, or the system will not respond to Remote Mode commands. If a terminal type shows "DEAD" and cannot be changed, the system is indicating a problem with that RS232 port and should be reported to Environics.

MODEM CONNECTED If a modem is used with the system, the system must be told which port it's connected to for proper operation. Toggle to modem option "ON" on the port that has the modem.

SUPPLY DTR/RTS and USE CTS/DSR At this time, both of these selections cannot be accessed and are not used by the system.

5.11.2 CONNECTING COMMUNICATIONS EQUIPMENT

When using the RS232 ports, set the connected equipment to 8 data bits, 1 stop bit, no parity, the same baud rate as the system, and data flow control ie. DTR/CTS, ACK/NAK, or XON/XOFF.

MAKING THE CONNECTION

The RS232 ports on the system are configured as data terminal equipment (DTE) which is equivalent to an IBM PC compatible RS232 port. This means that whenever you connect another DTE type to the system, they will both try to transmit and receive on the same pins. To correct this problem, you will need to use a "NULL Modem cable" which will swap certain pins allowing the two ports to communicate.

USING A MODEM

If you plan to connect a modem, which is data communication equipment (DCE), to the system you will need to use a regular "straight through" cable. Many of the modems today have error correction and elaborate data compression schemes which must be disabled. The following is a list of items which must be addressed:

LOCAL DATA FLOW CONTROL

Many modems use local flow control like XON/XOFF or RTS/CTS. The system does not use local data flow control so these options should be turned off in the modem (NOTE: Some modems will have the command "AT&K0" to disable all local data flow control).

CARRIER TRACKING

In order for the system to know whether the modem is on-line or not the modem must track the actual state of the remote modems carrier (DCD signal). This can be performed in most modems by sending the command "AT&C1".

DATA COMPRESSION AND ERROR CORRECTION

If data compression is to be used, the user must be sure the modem to be communicated with can accept the compressed data being sent to it. This can be done by verifying that both of the modems use the same CCITT

SAVING THE SETUP

Once a modem is properly configured, the configuration should be saved in the modem's nonvolatile memory in case of power loss.

5.11.3 USING TERMINAL REMOTE

When using terminal remote, whatever is displayed on the system display is transmitted to the RS232 ports which have a terminal type assigned to them. The terminal type ports are also checked for key input. The keys on the system are the same on the terminal except for the soft keys. To use the soft keys from the terminal, press the letter 'f' or 'F' followed by the number of the soft key (1 - 8). Additional keys which perform other functions are listed below:

"F" followed by "1"-"8"	Soft key F1 through F8
"H"	HELP key
ENTER/RETURN	Repaints the screen
SPACE	Display the soft key "F" numbers for 4 seconds.

5.12 TIME and DATE

TIME/DATE EDITOR	
09:43:57	
Tuesday	17 May 11
UPDATE	EXIT

Time and Date Editor

The system has a battery backed up clock/calendar chip. This chip will handle leap years and different length months. The software will compute the day of the week from the date entered.

There are two fields in this screen, time and date, which are described below. If you modify any data in either field and wish the data to be used by the system, you must press the UPDATE soft key. If you make changes and press the EXIT soft key, the system will ask you if you really want to exit.

TIME

The time is in the 24 hour format, meaning that 00:00:00 is equivalent to midnight and 12:00:00 is noon. The three cells for entry are hours, minutes, and seconds. You can use the cursor to move to the cell that needs to be changed or just enter as much of the time that is required. If you enter a value in a cell that is invalid, like 75 minutes, the previous number will return.

DATE

The date is in DD-MMM-YY format, with the day of the month first followed by the month and year. The cursor is used to move to the cell that needs to be changed. When you are in the day cell, you can enter values from 1 to 31. When you enter the month cell, the month name will be replaced by the month number. When you leave the month cell the name of the month entered will replace the number. Enter only the last 2 digits for the year.

Each time you change any of the date cells, the system will compute the proper day of the week.

5.13 STATUS SETUP

The optional status board, located on the rear panel, has 8 programmable input and output lines available. The inputs provide the ability to trigger various system actions. To program the status inputs, press the STATUS SETUP - INPUT soft key on the main menu. The outputs allow the system to signal external devices when certain operating conditions occur. To program the operation of the status outputs, press the STATUS SETUP - OUTPUT soft key on the main menu.

5.13.1 SETTING UP STATUS INPUTS

```
STATUS INPUT ASSIGNMENT EDITOR

                                Type   Setup#

Status in #1 = STOP
.
.
Status in #8 =SEQUENCE    01
Idle timer   =TIMER CTL  01

Time for idle timer = 00 (0 to 24 hours, 0 = OFF)

STOP  IGNORE  TIMER CTL  SEQUENCE  REMOTE  SEQ GROUP  PRT SCRN  EXIT
```

Status Input Editor

The 8 status input lines have the ability to control the operation of the system. When the system detects that the 2 input terminals for a status input line are connected, the assigned operation will start. There is also an idle timer function, which can cause a programmed operation to start after the specified time period elapses with no keys being pressed.

PROGRAMMING THE STATUS INPUT ACTIONS

Move the cursor to the desired input number and press the soft key for the desired operation. The following actions are available:

STOP	Stop current operations and return to the READY mode.
IGNORE	Do nothing. Ignore this input line.
TIMER CTL	Program Mode - Timer Control. Begins running the specified Timer Control setup.
SEQUENCE	Program Mode - Sequence. Begins running the specified Sequence setup.
REMOTE	Places instrument in REMOTE MODE to process remote communication commands.
SEQ GROUP	Program Mode - Sequence (Group Mode). Selects a Sequence mode to run, based on the on/off state of a group of status inputs. For more details, refer to the STATUS INPUT - SEQUENCE GROUP section (pg. 51) in the Appendix.

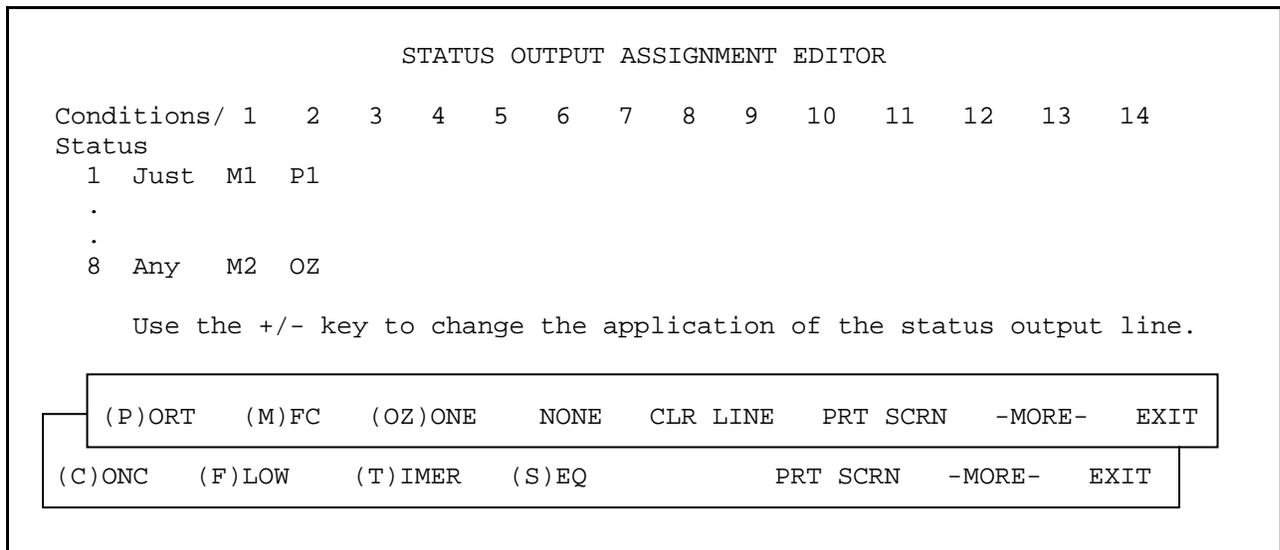
NOTE: The system must be in the READY mode for any operation (except STOP) to occur.

PROGRAMMING THE IDLE TIMER

The Idle Timer allows the system to take a specific action when there has been no keyboard activity for the specified period of time. To setup the IDLE TIMER, move the cursor to the "Idle Timer" field and select the desired action. Then move the cursor to the "Time for Idle Timer" field and set the desired idle time period. When the IDLE TIMER is active, a running count down will be displayed in the upper left corner of the screen indicating how much time before the idle timer action will take place. Every time a key is pressed, the idle timer countdown will be reset. When the IDLE TIMER counts down to 0, the system will automatically return to the READY mode and then start the selected operation.

5.13.2 SETTING UP STATUS OUTPUTS

The eight programmable status output lines can be used to indicate the operating status of the 9100 to external devices. Each output line is configurable to provide either a contact closure or a 24 volt output. To switch between contact closure and 24 volt output, you must remove the cover of the instrument and set the appropriate switches on the status board. To configure an output for 24 volts, set the corresponding switch to position A. To configure an output for contact closure, set its corresponding switch to position B. Be sure the power is off while changing the position of these switches.



Status Output Editor

In order for a status line to become active, the specified conditions for that status line must be TRUE. Up to 14 conditions may be specified for each status line. The following conditions may be specified:

- Px TRUE when Port # x is activated
- Mx TRUE when Mass Flow Controller x is operating
- OZ TRUE when Ozone is being generated
- Cxx TRUE when stored Concentration Setup xx is active
- Fxx TRUE when stored Flow Setup xx is active
- Txx TRUE when stored Timer Control program is active
- Sxx TRUE when stored Sequence Control program is active

To add a condition to a list, place the cursor in the desired location, and press the appropriate soft key. All conditions except ozone require one or more numbers to be entered. For example, to specify a Port condition, press the (P)ORT soft key followed by the desired port number.

EDITING KEYS

Two soft keys are provided for editing a status list. The NONE soft key will remove any single condition in the list, and the CLR LINE soft key will remove all conditions for the current status output

SETTING THE EVALUATION MODE (APPLICATION)

The evaluation mode determines how the individual conditions are evaluated in determining whether a status output line should be activated. Three different evaluations modes, or applications, are available.

OR	Active if one or more conditions are TRUE (1 or 2 or 3 etc.)
ANY	Active any time all the specified conditions are TRUE. Other conditions may be true as well.
JUST	Active when <i>just</i> the specified conditions are true. NO OTHER CONDITIONS CAN BE TRUE.

To change the evaluation mode, place the cursor in the row for the desired status line and press the "+/-" key.

Keep in mind that the system keeps track of ALL conditions, so although they may not be explicitly specified, these other conditions may be TRUE. When using the JUST application, if additional conditions are TRUE but are not specified, the output will not activate. For example, if port 2 is active, the condition P2 is TRUE, *even though it may not be a specified condition for a particular status output*. Suppose status output # 1 was setup as JUST M1 P1, and MFC 1, Port 1, and Port 2 were active. Since the P2 condition is also TRUE but is not specified, this output would NOT become active.

The only exception to this method of evaluating conditions is for the TIMER or SEQUENCE conditions. If the TIMER or SEQUENCE conditions are not specified, their TRUE/FALSE condition is ignored. Their TRUE/FALSE state is only considered when they are specified for that status output.

OPERATION

The status conditions are evaluated several times per second. When all specified conditions are met for a status line, it is activated. Whenever the conditions are no longer met, it is deactivated. Any time one or more status lines are active, a list of active status lines will be displayed in the lower right corner of the display.

5.14 LEAK TEST

LEAK TEST	
Pressure =	PSIA
Please have 5 to 10 PSI of pressure on port 1. \$\$\$ DO NOT CAP OFF THE OUTPUT \$\$\$	
START	EXIT

Automated Leak Test

The S-9100 leak test function is designed to operate without any user intervention. To access this function press the LEAK TEST soft key located on the second page of the main menu.

Before operating the leak test function the system should have a diluent source connected to port 1 at **a pressure of 10 psi**. Use the pressure displayed in the flow mode to confirm this pressure above atmospheric. **Be careful not to set the pressure over 13 psi, this will activate the pressure safety.** Press the START soft key to begin the test. For the first 90 seconds the system will measure the "no flow" atmospheric pressure. Next the system will pressurize with diluent for 45 seconds and then close the output solenoid. Now the system will analyze the static pressure for 45 seconds. For the last 60 seconds, the system will examine the pressure drop, determine if there is a leak of more than 1 sccm at 5-10 psi, and display the results. This test can be canceled at any time by pressing any key. The factory leak test specification is < 3 sccm.

6 SYSTEM CONFIGURATION SETTINGS

There are several system configuration settings, which are used to change the operation of the system. The various configuration settings are accessed by pressing a specific number key (indicated below), followed by the system password, consisting of the following keys:

[LEFT ARROW] [RIGHT ARROW] [0] [+/-]

FLOW CALCULATION METHOD

This setting controls how the S-9100 handles the calibration data for the mass flow controllers (MFCs). The available options are "Single slope and intercept" or "Multi-point linear interpolation". The single slope and intercept method derives a "best fit" linear equation from the MFC calibration data, and uses this single equation for calculating the correct MFC command voltage to achieve the desired flow rate. The multi-point linear interpolation method calculates a linear equation for each pair of calibration points (10 total) and selects the equation for the calibration data points that are closest to the desired flow rate. This provides an 11 point "curve-fitted" calibration, and significantly reduces any flow controller non-linearity. For this reason, Environics recommends using the multi-point linear interpolation method. To toggle between these two modes, go to the system READY screen, and press the 8 key, followed by the system password. The current flow calibration method is displayed in the CALIBRATE MODE screen.

OZONE PRESSURE ADJUSTMENTS

This setting will control how the S-9100 handles changes in the ozone generator pressure by controlling the intensity of the ozone lamp. When this feature is active, the system will automatically adjust the ozone, to compensate for changes in the current ozone oven pressure from the original pressure seen during calibration.

To toggle this option on or off, go to the system READY screen and press the 5 key, followed by system password. This will display the USER CONFIGURATION screen. Move the cursor to the "Ozone Adjust Pressure Gauge On" field and press either the YES or NO soft key. Environics recommends leaving this set to YES. The "Ozone Adjust Pressure Gauge" setting is also displayed in the CALIBRATE MODE screen.

LOW FLOW SHUTOFF

The S-9100 performs a continuous flow check to ensure that system is operating normally. If the actual flow through the system falls below 50% of the requested flow, a "LOW FLOW" warning message is displayed. This could be due to a cylinder running out of gas, or other failure. In the event that a LOW FLOW is detected, the system provides the option to STOP ALL FLOWS. If the "Stop Flows when Low Flow Detected" option is on, the system will shut down all solenoids and MFCs when a low flow condition is detected. The system will remain stopped until the START key is pressed to start a new flow operation.

To toggle this option on or off, go to the system READY screen and press the 5 key, followed by the system password. This will display the USER CONFIGURATION screen. Move the cursor to the "Stop Flows when Low Flow Detected" field and press either the YES or NO soft key. Environics recommends leaving this set to YES. The "Stop Flows when Low Flow Detected" option setting is also displayed in the CALIBRATE MODE screen.

OZONE LAMP PRECONDITIONING

Ozone lamp preconditioning gives the S-9100 the ability to stabilize the ozone concentration at the desired set point faster than with no preconditioning in most cases. This is achieved by commanding an "intermediate" ozone value to the ozone generator for a predetermined period of time. There are two entries required for this control. "Ozone precondition step - % of delta" determines what intermediate value

of ozone is used, according to the equation below. "Ozone precondition time" determines for how long to apply this intermediate ozone command. A precondition step value of 100% is the "normal" ozone operation. A precondition step value larger than 100% will allow the ozone concentration to stabilize faster. The factory default value for this is 130% for 90 seconds. Note that larger % or time values may cause the ozone concentration to "overshoot" the desired concentration.

To change this setting, go to the system READY screen and press the 5 key, followed by the system password. This will display the USER CONFIGURATION screen. Move the cursor to the Ozone Precondition Step or Ozone Precondition Time fields and enter the desired values.

The formula used for calculating the intermediate ozone setting and some examples are given below:

$$\begin{aligned} \text{OZONEDELTA} &= \text{NEW COMMAND} - \text{CURRENT COMMAND} \\ \text{INTERMEDIATE OZONE} &= \text{CURRENT COMMAND} + (\text{OZONEDELTA} * \text{STEP PERCENT}) \end{aligned}$$

Example 1 - increasing the ozone level:

$$\begin{aligned} \text{Current ozone command} &= 0.0 \text{ PPM} \\ \text{New ozone command} &= 0.300 \text{ PPM} \\ \text{Ozone precondition step} &= 130 \% \text{ of delta} \\ \\ \text{Ozone delta} &= 0.300 - 0.0 = 0.300 \\ \text{Intermediate step} &= 0.0 + (0.300 * 1.30) = 0.390 \end{aligned}$$

Example 2 - decreasing the ozone level:

$$\begin{aligned} \text{Current ozone command} &= 0.300 \text{ PPM} \\ \text{New ozone command} &= 0.200 \text{ PPM} \\ \text{Ozone precondition step} &= 130 \% \text{ of delta} \\ \\ \text{Ozone delta} &= 0.200 - 0.300 = -0.100 \\ \text{Intermediate step} &= 0.300 + (-0.100 * 1.30) = 0.170 \end{aligned}$$

OZONE LAMP PREBURN

The Ozone Lamp Preburn setting is another feature that allows the ozone concentration to stabilize more quickly at the desired level. This is done by turning on the ozone lamp prior to normal use. The Ozone Lamp Preburn feature is only available when operating the system through the PROGRAM MODE - TIMER CONTROL, where an operation is scheduled to occur at a predetermined time.

To change this setting, go to the system READY screen and press the 5 key, followed by the system password. This will display the USER CONFIGURATION screen. Move the cursor to the Ozone Lamp Preburn Time, and enter a value in minutes (3 digits required). This value determines how many minutes in advance of a scheduled TIMER operation to turn on the lamp. The default value is 060 minutes, while a value of 000 will disable the preburn feature. Next, move the cursor to the Ozone Lamp Preburn Voltage, and enter a lamp voltage value (between 0.0 and 5.0 volts). This value determines what command voltage is used to drive the ozone lamp during the preburn period. The default value is 5.0 volts

When a PROGRAM MODE - TIMER CONTROL is running, the system will turn on the ozone lamp for the specified number of minutes in advance of when the TIMER CONTROL is scheduled to run. If the time remaining before the next scheduled TIMER CONTROL sequence is less than the time period required for the lamp preburn, the preburn period will be cut short. The preburn period will not cause a TIMER CONTROL sequence to be rescheduled.

7 SYSTEM SAFETY FEATURES

The system has 3 safety checks built in to help prevent permanent damage to the system components. These checks are automatic and monitor the system at all times.

FLOW CONTROLLERS

If the actual flow through any MFC falls below 50% of its commanded value, the system will shut down all DACs and place a low flow warning message at the top of the display. To reset this error condition, you should check all port connections and then press the UPDATE soft key to return the system back to its previous settings.

OZONE MODULE

If at any time, while the system is producing ozone, the flow through the ozone module is less than 250 ccm, the system will shut down the ozone lamp and display an ozone flow error message on the status line. This prevents the back flow of ozone through the system. You should stop the operation and check all connections. If the error persists, you should check the flow path through the ozone module.

OVERPRESSURE

The system monitors for a maximum pressure of 28 psia. If at any time, a pressure of greater than 28 psia is detected, the output solenoid will be opened and all input solenoids will be closed. When the pressure is back to normal the system will automatically return to normal operation. This will protect the system from blocked output with open input, specifically in the leak test.

USER SAFETY - Operator's Responsibilities

The operator of the system must keep safety in mind when using the instrument. Danger to the operator or serious damage to the system can occur if the operator does not consider all the warnings listed in this manual or displayed by the system.

APPENDIX

A SYSTEM COMPONENTS

ELECTRONICS

The basic electronics consist of the Transputer board, the Memory board, the Comm/Driver board, the Analog board, the Motherboard, the LCD display and the power supplies. A brief description of each board is given below.

TRANSPUTER BOARD (PC201)

The Transputer board is the heart and brain of the system. This board runs the software program, manages the flow through the mass flow controllers, controls the display, reads the keypad input and all other functions.

ANALOG BOARD (PC202)

The Analog board interfaces with the Transputer board and controls and monitors the amount of flow that passes through each of the mass flow controllers. The ADC's and the DACs (which link the mass flow controllers to the Transputer board) are automatically calibrated upon the start of any gas flow.

ROM BOARD (PC203)

The software program resides on the ROM (Read Only Memory) board. Four Erasable Programmable Read Only Memory (EPROM) chips contain all of the necessary programs to run the entire instrument. This board may be easily changed in the event of a software revision or upgrade.

COMM/DRIVER BOARD (PC204)

The Comm/Driver board controls the function of all of the solenoids in the instrument. This board also provides you with one parallel printer port and two RS-232 serial ports.

MOTHERBOARD (PC208)

The Motherboard is the printed circuit board that ties all of the electronic boards together, connecting the proper address, data and system lines together and distributing power to other boards and components.

OZONE BOARD (PC210)

The Ozone board is located inside the ozone module. This board controls all the functions of the ozone module.

STATUS I/O BOARD (PC216)

The status I/O board is located on the back panel of the system. This is where all status input and output are connected and controlled.

OZONE MODULE

The ozone module contains all the hardware and electronics for the creation and control of ozone. The module is temperature controlled for stability.

DISPLAY

The display is a 640 x 200 pixel, cold cathode backlit liquid crystal display (LCD). The LCD is extremely rugged and will provide years of maintenance free service.

POWER SUPPLIES AND POWER ENTRY MODULE

Two open frame linear power supplies are used to supply power to the electronics and to the solenoids. These power supplies were chosen to operate on most AC power sources found worldwide, provided that the power entry module is set to the proper line voltage.

The power entry module acts as the power input "connector", the alternating current (AC) signal distribution, control, and surge protector. This module is mounted to the rear panel of the instrument. Each instrument is set at the factory for the customer's required voltage, and fused for the proper current. Available voltages are 115 VAC and 230 VAC.

PLUMBING

The plumbing consists of gas inlet connections, inlet solenoids, mass flow controllers, a serpentine pre-mix module, optional mixing chamber, ozone module, and associated plumbing. The solenoids provide a positive shutoff mechanism for the gas inlets, preventing unwanted gas flow. All gas fittings are stainless steel compression type unless otherwise specified.

MASS FLOW CONTROLLERS

The system is equipped with thermal mass flow controllers. Each mass flow controller is a closed loop system which accurately measures and controls the flow of gas by measuring the heat transferred to the gas as it passes through the mass flow controller's sensor tube. The system sends a 0-5 VDC signal to each mass flow controller, regardless of its size. For example, a 2.5 VDC signal corresponds to a commanded flow rate of 50% of the mass flow controller's full scale range (e.g. 50 sccm = 2.5 VDC command on an MFC with a 0-100 sccm full scale range).

The wetted surfaces in the mass flow controllers are 316 stainless steel, nickel, and Viton. Other materials may be ordered when gas compatibility requires it.

In a standard unit, all mass flow controllers will be calibrated with nitrogen, or zero air, depending on their applications, because they have nearly identical thermal and flow characteristics. Applications that require flow controllers to use very low-mass gases such as helium and hydrogen, require special calibration. Please consult Environics with questions concerning special gas applications.

B SPECIFICATIONS

FLOW

Size Ranges of MFCs:

0 - 100 sccm to 0 - 20 slpm

Performance (when operating between 10% and 100% of Full Scale Flow)

Accuracy

Concentration:	± 1.0 % reading
Flow:	± 1.0 % reading
Repeatability:	± 0.2 % reading

* Note: Mass Flow Controllers (MFCs) are calibrated to Standard Temperature (25°C) and Pressure (760 mm Hg) using a primary flow standard traceable to the National Institute of Standards and Technology (NIST).

MECHANICAL

Inlets:

Balance: One external 1/4" Swagelok™*
Analyte: One external 1/8" Swagelok™* per Port

Outlet:

One external 1/4" Swagelok™*
* (Or compatible fitting)

Wetted Surfaces:

Tubing: Electro-polished Stainless Steel and Teflon™
MFCs: Stainless Steel
Seals: Viton®

Blending Chamber: Glass
Mixing Chamber (optional): Glass

Ozone generator: Anodized aluminum

Operating temperature:

0° to 50° C.

Performance Temperature Range:

15° - 35°C

Weight:

Minimum 16 Kg (35 lbs.), Maximum 32 Kg (70 lbs.)

Dimensions:

Portable: 41.6 cm wide, 17.2 cm high, 58.8 cm deep
(17" wide, 7" high, 24" deep)

Rack: 46.6 cm wide, 17.2 cm high, 61.3 cm deep
(19" wide, 7" high, 25" deep)

ELECTRICAL

Standard Voltage: 115 VAC, 50/60 Hz
Optional Voltages: 100, 220-240 VAC, 50/60 Hz

Current Required: 2 Amperes maximum

PRESSURE

Minimum: 20 psig at port 1 and 10 psig at all other inlets.
Recommended: 25 psig
Maximum: 40 psig at all inlets.

IMPORTANT: Users must maintain an operating pressure differential, from the input of the system to the output of the system, of 20 to 40 PSID on port 1 and 10 to 30 PSID on all other ports. Never exceed 40 PSIG on any port.

NOTE: The inlet pressure on each port must be regulated such that it falls between the recommended pressures listed above. **The pressure at each port must be stable and should not oscillate for the proper operation of the mass flow controllers.** However, the inlet pressure may vary from port to port. (Example: The balance gas mass flow controller may be regulated from the cylinder such that the inlet pressure at the instrument is 25 psig. Another port may be regulated from the cylinder such that the inlet pressure at the instrument is 15 psig.)

C SERVICE AND MAINTENANCE

The following procedures/instructions are to be used when the system needs servicing or parts are being replaced.

WARNING

DISCONNECT POWER WHEN WORKING ON UNIT. DUE TO RISK OF INJURY OR ELECTRIC SHOCK, DISCONNECT POWER CORD FROM WALL WHENEVER SERVICING THE UNIT. EXTREME CAUTION SHOULD BE USED IF IT IS NECESSARY TO WORK INSIDE THE UNIT WITH THE POWER CONNECTED.

USE STATIC DISCHARGE EQUIPMENT. THE ELECTRONIC CIRCUIT BOARDS CONTAIN STATIC SENSITIVE COMPONENTS. ALWAYS USE STATIC DISCHARGE EQUIPMENT WHEN HANDLING CIRCUIT BOARDS.

Prior to putting the unit back in service after routine maintenance, please complete the following checklist:

- . Inspect power cord and internal wiring.
- . Check all fittings for tightness and leak check if possible.
- . Clean circuit boards (use vacuum or air gun to remove dust).
- . Check all tubing for splits, kinks or cuts.

C.1 TROUBLESHOOTING

TROUBLESHOOTING STEPS

The Environics 9100, with few moving parts and a durable electronics package, should provide a high level of reliability. In the event that there is a failure the following troubleshooting guide may be useful in isolating and solving the problem.

<u>Problem</u>	<u>Possible Solutions</u>
No display	Adjust Contrast knob Check power cable, line voltage, and fuse Check cable between display module and motherboard Be sure all boards are seated properly
Slow display	RS232 enabled with slow baud rate. Disable RS232 if not in use, or use a higher baud rate.
No display backlight	Check display backlight connectors.

Problem	Possible Solutions
No power	<p>Check power hookup and look for blown fuse</p> <p>Check line voltage</p> <p>Check for loose cables / boards</p>
No Keypad response	<p>Check keypad cable for proper connection</p> <p>Check for loose boards</p>
Erratic Fan	<p>Check for wiring problems with fan connection</p>
Solenoid failure	<p>Check solenoid connections on PC204</p> <p>Check +24 volts.</p> <p>Possible coil failure. Check and replace if necessary</p> <p>Possible seal problem. Check and replace if necessary</p> <p>Possible contamination (dirt). Check and clean.</p>
No Flow	<p>Check port connections.</p> <p>Check solenoids for proper operation.</p> <p>Check calibration tables.</p> <p>Try using Volts Mode to command flow controller. If Volts Mode operates, be sure FLOW/CONC MODE and MAINTAIN PORTS setup is correct.</p> <p>Check flow controller cable.</p> <p>Check +15 and -15 volts.</p> <p>Check response and command test points on the motherboard (PC208) and analog board (PC202).</p>

TEST POINTS

The S-9100 contains numerous test points to aid in diagnosing electrical problems. A spring tension test hook should be used to connect to the test point of interest. Care should be taken not to short circuit the test hook to any adjacent components.

PC201 PROCESSOR BOARD

T1 - Digital ground

PC202 ANALOG BOARD

TP0 - DAC channel 0

TP1 - DAC channel 1

TP2 - DAC channel 2

TP3 - DAC channel 3

TP4 - DAC channel 4

TP5 - DAC channel 5

TP6 - -5 Volt reference

TP7 - Analog ground

TP8 - Digital ground

TP9 - Multiplexer output

TP10 - +5 Volt reference

TP11 - +15 Volts

TP12 - -15 Volts

TP13 - Board enable

PC203 ROM BOARD

TP1 - Digital ground

TP2 - Board enable

PC204 SOLENOID/COMMUNICATIONS BOARD

TP1 - Board enable

TP2 - +5 Volts

TP3 - Digital ground

TP4 - +24 Volts

PC208 MOTHERBOARD

TP1 - Digital ground

TP2 - +5 Volts

TP3 - +15 Volts

TP4 - -15 Volts

TP5 - Analog ground

TP6 - +24 Volts

TP7 - Command volts A

TP8 - Response volts A

TP9 - Command volts B

TP10 - Response volts B

TP11 - Command volts C

TP12 - Response volts C

TP13 - Command volts D

TP14 - Response volts D

TP15 - Command volts E

TP16 - Response volts E

TP17 - Command volts F

TP18 - Response volts F
TP19 - Command volts G
TP20 - Response volts G
TP21 - Command volts H
TP22 - Response volts H
TP23 - Command volts I
TP24 - Response volts I

PC210 OZONE BOARD

TP1 - Lamp drive (5v @ 25v drive)
TP2 - Detector output
TP3 - Command/detector diff.
TP4 - Ozone command
TP5 - 1/2 lamp switcher
TP6 - Lamp wave form
TP7 - 1/2 lamp switcher
TP8 - Lamp wave form
TP9 - +5 Volt ref.
TP10 - +15 Volts
TP11 - -15 Volts
TP12 - Oven temp feedback
TP13 - +24 Volts
TP14 - Analog ground
TP15 - Ozone block temp (0v = 0°C, .5v = 50°C)
TP16 - Digital ground

PC216 STATUS BOARD (Optional)

TP1 - Contact 1 (logic level high = contact open)
TP2 - Contact 2 (logic level low = contact closed)
TP3 - Contact 3
TP4 - Contact 4
TP5 - Contact 5
TP6 - Contact 6
TP7 - Contact 7
TP8 - Contact 8
TP9 - +5 Volts
TP10 - Ground
TP11 - Board enable

C.2 OZONE LAMP REPLACEMENT

To replace the ozone lamp, carefully remove the ozone module cover and unplug the lamp from the circuit board. Remove the 3 screws on the collar holding the lamp to the oven and remove the lamp/collar assembly. Without touching the lamp glass with bare fingers, carefully insert the new lamp/collar assembly in the oven and align the three holes in the collar with the holes in the oven. Do not touch the setscrew in the collar. Replace the three screws, tighten them down, and plug in the lamp. With the ozone module cover off reconnect the power and proceed with the adjustment described below.

OFFSET ADJUSTMENT (POT R10)

Go into the VOLTS MODE (Sec. 0) and command 0 volts for ozone. Connect the negative lead of a voltmeter to TP14 and the positive to TP2. Adjust the offset pot, R10 located in the middle left portion of PC210, so the meter reads +0.10 volts +/- 0.02 volts. This may take several turns of the pot before the voltage moves from 0.

GAIN ADJUSTMENT (POT R1)

To adjust the gain pot, you must first enter the Calibrate Ozone Mode and initialize the ozone calibration data (Sec. 0). Once this is done enter the FLOW MODE, command ozone to 1.0 PPM, command MFC #1 to the highest expected ozone flow between 5000 ccm and 13000 ccm, and start the flow. After about 10 minutes of warm-up time, use an external ozone monitor and adjust the gain pot until the monitor reads between 1.0 PPM and 1.1 PPM.

The lamp has now been successfully installed. Replace the ozone module cover and the system cover.

C.3 OZONE CALIBRATION PROCEDURE

NOTES:

- System should be on for at least 45 minutes before proceeding.
- This procedure assumes factory-adjusted gain and zero.
- This procedure is for systems that contain the pressure control package.
- This process must be done following the MFC and ozone generator flow calibration processes, if necessary.

STEPS:

1. Verify factory ozone calibration, in FLOW mode, to your standard. If the system verifies to your certification specifications, stop.
2. Enter the CALIBRATION mode.
3. Press OZONE.
4. Press INIT ALL, YES.
5. Set the calibration pressure to 24.7 PSIG.
6. Press SAVE DATA, YES, EXIT, EXIT, EXIT.
7. Press the 5 key followed by the password - (left arrow, right arrow, 0, +/-). Make sure the ozone adjust pressure gauge is off, EXIT. If this does not work, the system has older software - instead, press the 7 key followed by the same password. This sequence by itself turns on or off the pressure correction function. Status of the pressure correction can be seen in the first screen of the calibration mode.
8. Enter the FLOW mode and set MF1 flow equal to the intended diluent flow for ozone calibration. Zero the flow for all other MFC'S.
9. Enter the MAX O3 concentration that you will be using.
10. Press the START/UPDATE key.
11. Allow for the overshoot and the stabilization time before accepting the reading from your ambient ozone monitor. This reading should be greater than the targeted concentration by no more than 10%. If not, the electronic gain adjustment will be required. Refer to the OZONE GAIN/ZERO ADJUSTMENT PROCEDURE.
12. Record the monitor's reading for that given command.
13. Repeat step 12 for up to 10 more points (concentrating more points around an area of interest will give better control in that area).
14. While the system is still running, record the pressure from the ozone generator pressure field for entry into the calibration table.
15. Press STOP, EXIT, CALIBRATE MODE, OZONE.
16. Enter all the target ozone points and total flow for each point.
17. Enter the true concentrations as seen on your analyzer and the same total flow rate as in the target total flow column.
18. Change the calibration pressure to the pressure recorded in step 14.
19. Press SAVE DATA, YES, EXIT, EXIT.
20. Perform the key sequence in step 7 and turn pressure correction ON.
21. Repeat steps 8 to 13 to verify calibration. If specific points are not within the allowable tolerance, repeat steps 15 to 19, only updating the true ozone column for the points that were out of tolerance.
22. Re-verify.

OZONE PRESSURE CORRECTION NOTES

When calibrating with pressure correction turned on, the system will compare the current pressure reading to the value specified in the calibration pressure field. The requested ozone level will then be adjusted up or down, depending on whether the current ozone pressure is higher or lower than the pressure value contained in the calibration pressure field. It is important that the calibration pressure field contains a

pressure value which is within 2% of the pressure reading displayed on the screen during calibration, in order to avoid radical corrections to the ozone lamp command voltage.

Pressure correction may be turned off during ozone calibration, but slight variations in the ozone concentration readings may be experienced if the ozone pressure varies. If you intended to activate the pressure correction feature later, without recalibrating ozone, then the calibration pressure field must contain a pressure value that is within 2% of the pressure reading displayed on the screen during calibration. If you do not intend to turn on pressure correction, a dummy pressure value of 24.7 may be used, which is 10 psi above atmospheric pressure.

PARTIAL OZONE RECALIBRATION

A partial calibration involving fewer than all previously calibrated points may be performed, but only when the current pressure is the same as the ozone pressure observed during the last full calibration. The calibration pressure field should be changed only when performing a full calibration.

C.4 OZONE GAIN/ZERO ADJUSTMENT PROCEDURE

If the actual concentration is below the target concentration during the ozone calibration procedure, remove the system cover and the ozone generator cover and perform the following steps:

1. While commanding the maximum ozone level from step 11 of the ozone calibration procedure, turn the gain pot clockwise one (1) turn at a time and wait for the new ozone level to stabilize on the ozone analyzer. Continue to adjust the gain pot until the correct ozone level is acquired.
2. Press the stop key and with a DVM (Digital Voltage Meter) hook the lead as follows:

RED – TP2 (usually a yellow test point)

BLACK – TP14 - Analog GND. (usually a brown test point)

This is the zero offset check for the ozone gain amplifier circuit. If this voltage is too low, the lamp could turn on even when not being commanded.

3. Adjust the zero pot for 0.1 VDC to 0.11 VDC and carefully reinstall the ozone generator cover and continue with the ozone calibration procedure.

NOTE: This procedure only needs to be performed at the maximum ozone concentration in the calibration table, generally .5 PPM.

D STATUS INPUT - SEQUENCE GROUP OPERATION

The SEQUENCE GROUP (SEQ GROUP) setting in the Status Input setup screen allows a group of status inputs to run a particular stored SEQUENCE, based on the pattern of status inputs that are active. For the SEQUENCE GROUP setting, only status inputs 1 through 5 may be used. The other available inputs may be assigned to any other status input setting.

To determine which sequence is to be activated, the system computes a "binary" value of which inputs are active, according to the following chart:

Active Status Input	Binary Value
1	1
2	2
3	4
4	8
5	16

For example, if inputs 1, 2 and 4 were active, the binary value computed would be $1+2+8 = 11$, so sequence #11 would be run. However, since only 20 SEQUENCES can be stored by the system, if the resulting sequence number is greater than 20, no action will take place.

SETTING UP SEQUENCE GROUP OPERATION

To select the SEQUENCE GROUP operation, move the cursor to Status Input #1 and press the SEQ GROUP soft key. This will also cause inputs 2-5 to change to type SEQ GROUP. Note that only status input #1 may be initially assigned as SEQ GROUP, and changing input #1 to any other type will cause all other SEQ GROUP settings to change to IGNORE.

If you do not need all 5 inputs for SEQ GROUP operation, you can individually change inputs 2-5 to another setting. Move the cursor to the LAST input designated as SEQ GROUP, and press another soft key to change its setting. Repeat this for each input line you wish to change.

OPERATION

When one or more status inputs designated as SEQ GROUP become active, the system will wait approximately 1/10 of a second before acting. This delay allows other inputs to become active as well, in case all inputs do not become active at exactly the same time.

After the delay, the binary value of the SEQ GROUP inputs is evaluated, as described above. This value will be used to recall and run a previously stored SEQUENCE. As with other status input settings, the system must be in the READY mode for any action to take place. Once the designated SEQUENCE starts running, changes to the status inputs are ignored until the system is returned to the READY mode. Therefore, it is not possible to change from one running SEQUENCE to another, without first returning to the ready mode.

When ALL of the SEQ GROUP inputs become inactive, the system will stop the current sequence and return to the READY mode.

E REMOTE MODE

The REMOTE MODE allows the instrument to be controlled remotely by a host computer. The instrument will respond to commands issued by the host computer, but will not issue any unsolicited messages to the host, except to acknowledge a command or to return an error code.

The host computer communicates with the instrument through one of the RS232 ports using the commands described in the "REMOTE MODE COMMAND LIST" section. If an error occurs, the instrument will return an error code, indicating the problem. These error codes are described in the "REMOTE MODE ERROR CODES" section.

In order to establish communication with a host computer, one (and only one) of the RS232 ports must be configured as terminal type "CPU", using the RS232 Setup screen. Configuring more than one port as type "CPU" may cause incorrect operation.

The instrument must be placed in "REMOTE MODE" for commands to be accepted. This can be done by pressing the REMOTE MODE soft key from the main menu, or by a status input line on the optional Status Board.

SPECIAL CODES

All remote mode communications make use of the following special single-byte ASCII codes:

<STX> - Start Transmission (ASCII Code 0x02)

This indicates the start of a new command being sent to the instrument.

<ACK> - Acknowledge Transmission (ASCII Code 0x06)

This is returned by the instrument indicating either that the command was accepted or the start of a list of requested data.

<NAK> - Not Acknowledge Transmission (ASCII Code 0x15)

This is returned by the instrument indicating the start of an error code transmission.

<ETX> - End of Transmission (ASCII Code 0x03)

This indicates the end of a command sent to the instrument, or the end of data received from the instrument.

COMMAND FORMAT

Commands sent to the instrument must be formatted as follows:

COMMAND FORMAT: <STX><command string><ETX>

All items in a command string must be separated by one or more spaces or commas. No space or comma is needed before or after "=", "?", <STX>, or <ETX>. Commands can be either upper or lower case.

Examples: <STX> FUNC 1 = 20 1 3 <ETX>
 <STX>FUNC,1=20,1,3<ETX>

<STX> flow 1 TARGET = 105.0 <ETX>

REPLY FORMAT

All replies from the instrument to the host computer will be formatted in one of three possible methods, depending on the type of response required.

COMMAND ACCEPTED If the command received requires no data to be returned, the instrument will acknowledge that it successfully received and performed the command. This will be indicated by:

RESPONSE: <ACK>

DATA RETURNED For commands that require data to be returned, the data will be formatted as shown below. If the data consists of a list of values, each value will be separated with a comma.

RESPONSE: <ACK><data><ETX>

EXAMPLES: <ACK> 2,5000.0,3,2000.0 <ETX>
 <ACK> 1,2,3,4,5,6 <ETX>
 <ACK> 2 <ETX>

ERROR RETURNED If the command received contains errors or cannot be performed by the instrument, an error code will be returned. The error code will consist of a 3 character numeric string, formatted as:

RESPONSE: <NAK><error code><ETX>

EXAMPLE: <NAK>035<ETX>

FORMAT OF NUMERIC DATA

All numeric data for physical parameters such as Flow, Concentration, Voltage, etc. must be specified as REAL numbers, with decimal point and fractional value required. Exponential notation is not permitted. All other numeric data must be specified as INTEGER values, with no decimal point.

All flow values are measured in SCCM and all concentrations are measured in PPM.

REMOTE MODE COMMAND LIST

FLOW MODE COMMANDS

FLOW X ACTUAL ?	Read the present actual flow of MFC X.
FLOW X TARGET ?	Read the present target flow of MFC X.
FLOW X TARGET = Y	Set MFC X target flow to a value of Y.
FLOW UPDATE	Start or update the FLOW mode.

FLOW SAVE XX	Save flow settings to location XX.
FLOW QUERY XX ?	Read all the stored flow settings location XX. The data will be returned in the format of "Port for MFC 1, OGC for MFC 1, Port for MFC 2, OGC for MFC 2, ...etc".
FLOW ALL TARGET ?	Read the target flow settings of the MFCs.
FLOW ALL ACTUAL ?	Read the actual flows of the MFCs.
FLOW PORT X MFC = Y	Set port X to be used by MFC Y
FLOW OZONE TARGET = X	Set the target ozone concentration to X.
FLOW OZONE TARGET ?	Read the target ozone concentration.
FLOW OZONE ACTUAL ?	Read the actual ozone concentration.
FLOW OZONE FLOW ?	Read the ozone flow rate.
FLOW OZONE BLOCKTEMP ?	Read the ozone block temperature.
FLOW OZONE LAMPVOLTS ?	Read the ozone lamp drive voltage.

CONCENTRATION MODE COMMANDS

CONC TOT ACTUAL ?	Read the present total actual flow of all MFCs.
CONC TOT TARGET ?	Read the present total target flow set for the CONC mode.
CONC TOT TARGET = Y	Set the total target flow to Y for the CONC mode.
CONC UPDATE	Start or update the CONC mode.
CONC SAVE XX	Save all OGC settings and total flow to location XX.
CONC QUERY XX ?	Read all the stored OGC settings and total flow from location XX. The data will be returned in the format of "Port for MFC 1, OGC for MFC 1, Port for MFC 2, OGC for MFC 2, ..., and finally the total flow setting".
CONC BALANCE = Y	Assign the work space balance MFC to Y.
CONC ALL ACTUAL ?	Read all the present actual OGCs.
CONC ALL TARGET ?	Read all the present target OGCs.
CONC PORT X MFC = Y	Set port X to be used by MFC Y

CONC X ACTUAL ?	Read the present actual OGC for Gas # X (of the current port)
CONC X TARGET ?	Read the present target OGC for Gas # X (of the current port)
CONC X TARGET = Y	Set the target OGC for Gas # X (of the current port) to a value of Y
CONC OZONE TARGET = X	Set the target ozone concentration to X.
CONC OZONE TARGET ?	Read the target ozone concentration.
CONC OZONE ACTUAL ?	Read the actual ozone concentration.
CONC OZONE FLOW ?	Read the ozone flow rate.
CONC OZONE BLOCKTEMP ?	Read the ozone block temperature.
CONC OZONE LAMPVOLTS ?	Read the ozone lamp drive voltage.

MISCELLANEOUS COMMANDS

HOME	This command will stop all operation of the instrument and return the instrument to the "HOME" mode from which PORT MAINTENANCE commands as well as other system maintenance commands may be issued.
STOP	This command will stop all operation of the system (except the communication) and return the system to an idle state with no flow and all ports shut off. The instrument will remain in whatever mode it was in prior to receiving the "Stop" command.
SIZE X ?	Read the present size of MFC X.
NUMBER MFC ?	Read the present number of MFCs installed in the system.
VALID PORT X ?	Read the present list of valid ports that can be assigned to MFC X. The data returned will be the port numbers that are legal.
TIME = HH MM SS	Set the present time to hours HH, minutes MM, and seconds SS. The hours will be from 00 to 23. The minutes and seconds will be from 00 to 59.
TIME ?	Read the present time in the system. The data returned will follow the TIME = command.
DATE = DD MM YY	Set the present date to day DD, month MM, and year YY. The day will be from 01 to 31. The month will be from 1 to 12. The year will be from 00 to 99 with 00 starting the year 2000.
DATE ?	Read the present date in the system. The data returned will follow the DATE = command.

WARNINGS ?

Read the present list of warnings from the last or present running CONC or FLOW. The data returned will be "MFC 1 code, MFC 2 code, ..." where the code will be: 0 for no warning, 1 for an MFC setting which is under 10 of max, 2 for an MFC setting over 90 percent of max, 3 for an MFC setting which is over the max, and 4 for an MFC setting which is under 0.

BATTERY ?

Test the current status of the Backup batteries. Returned status = "1" indicates that the batteries are OK. "0" indicates batteries are getting weak.

LOWFLOW ?

Test for a "Low Flow" error condition. Returned status = "1" indicates that a "Low Flow" error has been detected. "0" indicates flows are OK.

REMOTE MODE ERROR CODES**003 "DOUBLE STX RECEIVED"**

Two consecutive <STX> codes were received.

004 "COMMAND OVERFLOW"

The input buffer of the remote command processor has overflowed.

005 "SAVE OUT OF RANGE"

Save location out of range.

006 "RECALL OUT OF RANGE"

Recall or query location out of range.

007 "ZERO FLOW OUT OF RANGE"

The flow specified for divider ZERO is out of range.

008 "DIVIDER MODE SPAN OR DILUENT FLOW OUT OF RANGE"

The flow for span or diluent in a divider step is out of range.

009 "ILLEGAL SPAN PORT SELECTION"

The port designated as Span port in divider mode is illegal.

011 "ILLEGAL PORT SELECTION"

An illegal port selection has been detected.

012 "UNKNOWN COMMAND"

Unknown command.

018 "ILLEGAL COMMAND"

Requested operation conflicts with the current operating mode.

019 "UNDEFINED ERROR"

Unknown error.

020 "ATTEMPT TO INITIALIZE AN UNKNOWN STEP"

An attempt has been made to reference an undefined step.

- 022 "ILLEGAL PORT CHANGE"**
Illegal port assignment has been made, or a port change was attempted while not in the HOME state.
- 023 "OZONE ERROR"**
Error in the last Ozone command. Check for proper syntax and values in command string.
- 024 "ILLEGAL PORT SELECTED"**
The attempted MFC/Port assignment is invalid.
- 025 "FLOW OUT OF RANGE"**
An attempt has been made to perform a flow assignment that is out of range.
- 026 "PURGE OR FLOW OPERATING"**
A non PURGE or FLOW command was issued while a Purge or Flow mode is operating.
- 027 "PURGE OR CONCENTRATION MODE OPERATING"**
A non PURGE or CONC command was issued while Purge or Conc mode is operating.
- 028 "BAD FLOW ALL COMMAND"**
An error has been detected in the construction of a FLOW ALL command. Check command syntax.
- 029 "TOTAL FLOW OUT OF RANGE"**
The requested Total Flow is out of range.
- 030 "BAD TOTAL FLOW COMMAND"**
An error has been detected in the construction of a Total Flow command. Check command syntax.
- 031 "MFC SELECTION OUT OF RANGE"**
Either an attempt has been made to select an MFC that is out of range or the MFC number field contains an invalid character. Recheck MFC number and command syntax.
- 032 "BAD FLOW COMMAND"**
An error in a FLOW command has been detected. Check command syntax.
- 033 "BAD CONC ALL COMMAND"**
An error has been detected in the CONC ALL command. Check command syntax.
- 034 "CONCENTRATION OUT OF RANGE"**
The commanded concentration is out of range.
- 035 "BAD CONCENTRATION MODE COMMAND"**
Improperly formatted concentration mode command. Check command syntax.
- 036 "BAD OZONE COMMAND"**
An error has been detected in an OZONE command. Check command syntax.
- 037 "CONCENTRATION OR FLOW MODE ACTIVE"**
A non- CONC or FLOW command was received while conc or flow mode is operating.

- 038 "BAD PURGE COMMAND"**
An error has been detected in a PURGE command. Check command syntax.
- 039 "PORT SELECTION IS OUT OF RANGE"**
A port selection command has been received with a port selection that is out of range.
- 040 "MFC CANNOT BE ASSIGNED TO REQUESTED PORT"**
Specified MFC/port combination is not legal. Recheck legal Port/MFC combinations.
- 041 "INVALID PORT SELECT"**
An unknown or illegal port selection command has been received.
- 042 "K-FACTOR OUT OF RANGE"**
An out of range K-factor has been received. Recheck K-factor setting and command syntax.
- 043 "CONCENTRATION OUT OF RANGE"**
Concentration value out of range. Recheck concentration setting and command syntax.
- 044 "BAD PORT ALL COMMAND"**
An error has been detected in the construction of a PORT ALL command. Check command syntax.
- 045 "BAD PORT COMMAND"**
An error has been detected in the construction of a PORT command. Check command syntax.
- 046 "CALIBRATION POINT NUMBER OUT OF RANGE"**
A calibration point number has been received which is out of range. Recheck command syntax and point number being requested.
- 047 "BAD CALIBRATION COMMAND"**
Improperly formatted CALIBRATION command. Check command syntax.
- 048 "BAD VALID COMMAND"**
Improperly formatted VALID command. Check for proper command syntax.
- 049 "BAD TIME DATA"**
Time data is invalid or out of range.
- 050 "BAD TIME COMMAND"**
Improperly formatted TIME command. Check for proper command syntax.
- 051 "BAD DATE DATA"**
DATE data is invalid or out of range.
- 052 "BAD DATE COMMAND"**
Improperly formatted DATE command. Check for proper command syntax.
- 053 "ITEM NUMBER OUT OF RANGE"**
Requested ITEM Number is out of range.
- 054 "RUN TIME OUT OF RANGE"**
Run Time setting is out of range.

- 055 "MODE REQUEST OUT OF RANGE"**
Requested Mode is out of range.
- 056 "BAD FUNCTION COMMAND"**
An error has been detected in the construction of a FUNCTION command. Check command syntax.
- 057 "STARTING HOUR IS OUT OF RANGE"**
The requested starting hour is out of range.
- 058 "STARTING MINUTE OUT OF RANGE"**
The requested starting minute is out of range.
- 059 "STARTING DAY OUT OF RANGE"**
The requested starting day is out of range.
- 060 "FUNCTION NUMBER IS OUT OF RANGE"**
The requested function number is out of range.
- 061 "START TIME OVER 24 HOURS"**
The requested start time is over 24 hours.
- 062 "BAD PROCEDURE COMMAND"**
Improperly formatted PROCEDURE command. Check command syntax.
- 063 "BAD CALIBRATION TARGET COMMAND"**
Improperly formatted CALIBRATION command. Check command syntax.
- 064 "CALIBRATION SET OR TRUE OUT OF RANGE"**
A calibration command has been received with the set or true point out of range.
- 066 "PPM OUT OF RANGE"**
A requested concentration setting is out of range.
- 072 "COMPONENT SELECT OUT OF RANGE"**
The requested gas component is out of range. Legal range is from 1 to 6.
- 128 - 143 "DATA TRANSMISSION ERRORS"**
An error has been detected by the instrument's serial communication hardware. Check serial communications settings for proper baud rate, number of bits, and number of stop bits.
- 192 "ILLEGAL CHARACTER RECEIVED"**
An illegal character has been received within the command issued by the host. This error may be caused by invalid commands or data transmission errors.

NOTES