OWNER'S MANUAL

SERIES 2000 COMPUTERIZED MULTI-COMPONENT GAS MIXER

SERIES 2020 COMPUTERIZED GAS DILUTION SYSTEM

SERIES 2010 COMPUTERIZED AUTOMOTIVE GAS DIVIDER

SERIES 2014 COMPUTERIZED VOC (VOLATILE ORGANIC COMPOUNDS) GAS DILUTION SYSTEM

WARNING

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

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1 FORWARD

The Environics Series 2000 is designed to be the finest instrument available for producing highly precise blends of gases and optional Ozone. With the use of a powerful 32 bit microprocessor, user friendly software, mass flow controllers (MFC's) and our optional custom designed Ozone module we are able to give the user the power of precision without complex operation.

Even though the Series 2000 is very easy to operate, we strongly suggest you read through this manual completely. It will describe all the functions and operations of the system along with system specifications and useful trouble shooting information.

We are pleased to have supplied you with a quality instrument utilizing "state of the art" electronic technology. Your purchase is supported by a knowledgeable factory service team ready to assist you in the use of this instrument.

2 THEORY OF OPERATION

The Series 2000 family of instruments has been designed to precisely blend 2 or more gases with or without ozone. To produce such accurate results and meet the needs of different operating conditions, many innovative designs were implemented.

One of the most important parts of the Series 2000 is its measuring and controlling electronics. The system uses very accurate analog to digital converters (ADC) to read the analog signals from the different internal devices and digital to analog converters (DAC) to command other internal devices. To keep the ADC's and DAC's as accurate as possible, they are automatically calibrated through a unique process every time any operation is started.

Flow through the instrument is controlled by industry standard mass flow controllers (MFC's), 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 precise command voltage, from 0 to 5 volts, to the MFC's different amounts of gas are accurately allowed through.

When the instrument is operating with the optional ozone module, ozone flows into the reaction chamber along with the other gases. The volume and turbulence of the chamber gives the ozone time to react with the gas. The mix then flows to the mixing chamber where it is diluted with the gas from Port 1, which also has sufficient volume and turbulence for a proper mix at the output. This process is also used to produce NO_2 (See Gas Phase Titration, section 5.5, page 14).

The software allows the user to perform complex blends of gas and ozone with accuracy and ease. By using the user friendly soft keys, the user moves through menus which allow access to all system operations.

3 RECEIVING

The instrument is shipped completely assembled and ready to use. The user has only to properly unpack and inspect the instrument (see below) and connect appropriate gas cylinders or supplies to the gas inlet ports on the rear panel.

3.1 UNPACKING

The instrument 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 (2) small screws on each side of the top, remove any packing material and inspect the interior of the S-2000 for possible loose parts or visible damage. Also, check for any loose circuit boards, if there are any press each down to reseat them before proceeding to connect power. Report any instrument damage to your local Environics distributor or to Environics headquarters immediately. If there is no visible damage to the instrument, replace the cover and secure it with the screws removed earlier. Continue to the next section on power connection.

3.2 POWER CONNECTION

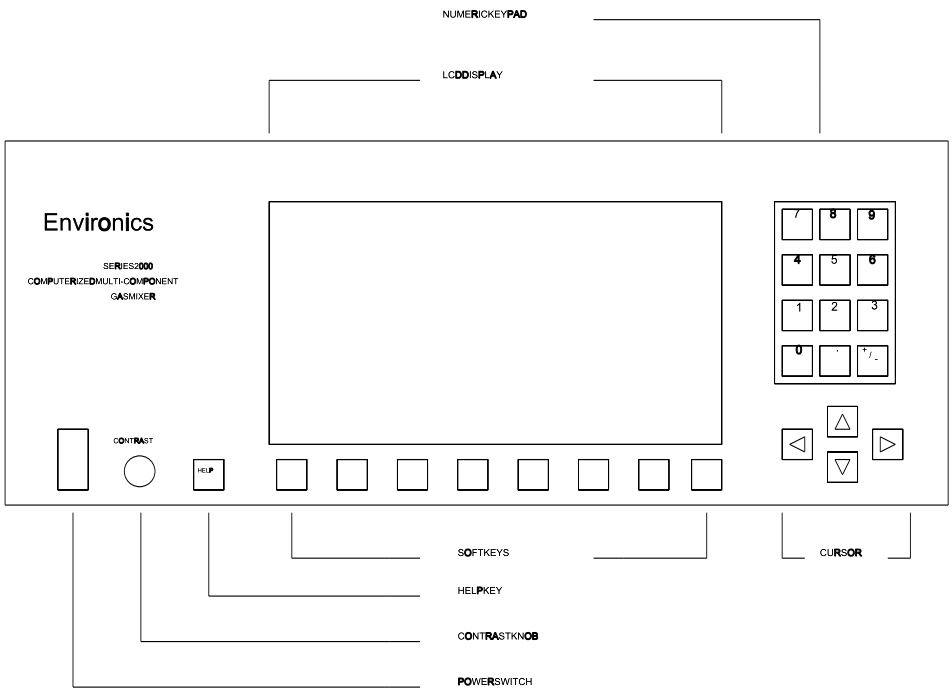
OPERATING THE S-2000 AT AN INCORRECT LINE VOLTAGE WILL DAMAGE THE INSTRUMENT AND VOID THE MANUFACTURER'S WARRANTY. CHECK THE LINE VOLTAGE BEFORE YOU PLUG THE INSTRUMENT INTO ANY POWER SOURCE. LINE VOLTAGES BETWEEN 100-120 VAC (OPTIONAL 220-240 VAC) ARE ACCEPTABLE.

WARNING

Insert the power cord into the socket on the rear panel of the instrument and then plug the grounded plug into an appropriate outlet. The standard unit allows for 100 - 120 VAC (50/60 Hz) **only**; nominal 230 VAC (50/60 Hz) input is optional. Once the instrument is plugged in the user should turn the front panel rocker switch to the "ON" position. The instrument will turn on and the display will run through a short self-testing procedure and then indicate "READY". If "READY" appears on the screen, the user 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.

Whenever connecting or disconnecting any cables, wiring harnesses or other sources of potential electrical impulse you must remove all power to the instrument. The RS-232 serial ports and the parallel printer port are especially susceptible to damage if the instrument is connected to power when any computer or printer equipment is connected or disconnected.

4 FRONT PANEL



4.1 POWER SWITCH

To turn the system on, push the power switch firmly up against the keyboard. The switch and display should illuminate and the start-up message should appear.

4.2 CONTRAST

The contrast knob, located on the lower left side of the front panel, 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.

4.3 DISPLAY

The large, 25 line by 80 column, LCD display is where the system and the user will perform most of their information exchange. The last two lines, 24 and 25, will be dedicated to "Soft keys". Line 23 will be used primarily for error and status messages.

4.4 KEYBOARD

The instrument has a durable membrane keyboard with a thick polycarbonet lens protecting the display. The keys operate with about 10 oz. of force, and you will feel a tactile feedback when contact is made.

4.4.1 NUMBER PAD

Located in the upper right portion of the keyboard, the number pad is where all requested numeric data entry will take place. 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.

4.4.2 CURSOR KEYS

The cursor keys, a group of arrows located in the lower right portion of the keyboard, 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.

4.4.3 SOFT KEYS

The soft keys, eight keys located under the display, are one of the most powerful features of the instrument. As you perform different functions, the operation of these soft keys will change and their meanings will be displayed above them on the last two lines of the display.

4.4.4 HELP KEY

The help key, located on the lower left portion of the keyboard, is an extremely useful feature of the instrument. At any time in the operation of the system, this key can be pressed to obtain context sensitive help without interfering with any data entry.

5 OPERATIONS

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.

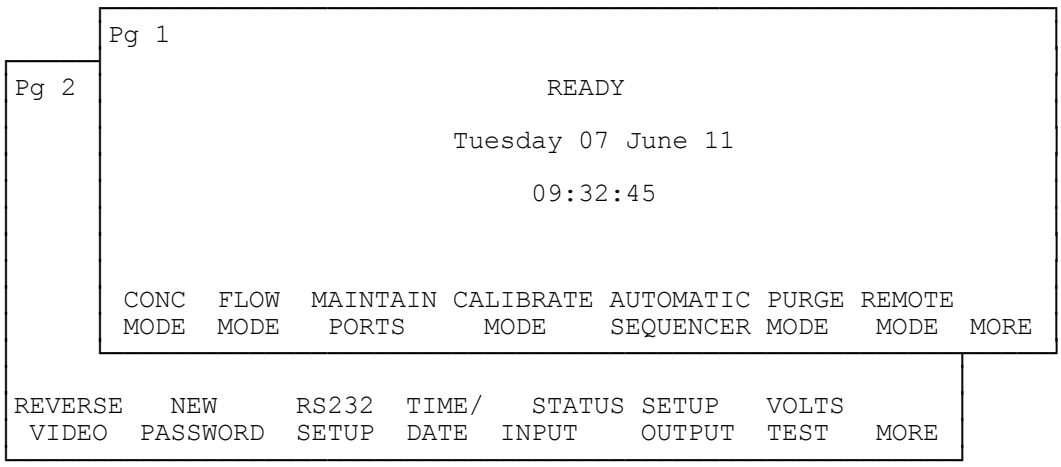
PRESSURIZED CYLINDERS ARE EXTREMELY DANGEROUS WHEN MISHANDLED. PROPER REGULATORS, USE OF SAFETY CAPS, AND PROPER RESTRAINTS ARE MANDATORY. AVOID CROSS CONTAMINATION WHEN ATTACHING REGULATORS OR MAKING MANIFOLD CONNECTIONS. ALWAYS CONSULT YOUR GAS SUPPLIER FOR PROPER SAFETY PROCEDURES. IF YOU ARE IN DOUBT ABOUT ANY SUCH PROCEDURES, DO NOT USE CYLINDERS OR PERMIT OTHERS TO DO SO. FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN SERIOUS INJURY OR DEATH.

ALWAYS DISCONNECT ELECTRICAL POWER BEFORE SERVICING UNIT. CONNECT UNIT TO A GROUNDED ELECTRICAL OUTLET.

WARNING

5.1 MAIN SCREEN (READY)

Main Menu



The instrument was designed with emphasis on simplicity and ease of use. The menu driven software guides users through all operating routines and provides on-screen mode specific help with the simple press of the "help" key. The main menu offers 13 primary options; each is described briefly below:

CONC (CONCENTRATION) MODE

Allow users to create a blend by entering the target gas concentrations, in PPM, for each port, the total flow, and ozone. The actual flows, concentrations, and ozone level will be displayed once the blend is started.

FLOW MODE

Allows users to enter the target flow for each MFC directly along with the required ozone. The actual flows, concentrations, and ozone level will be displayed once the flows are started.

MAINTAIN PORTS

Permits the user to describe, to the system, all gases connected just once. The information the system needs for each gas port is the gas name, concentration, and K-factor. This information will be used throughout the system in all other operations.

CALIBRATE MODE

Allows users to edit or view the calibration data for the MFC's, ozone module, analog to digital converter (ADC) devices, and digital to analog converter (DAC) devices.

AUTOMATIC SEQUENCER

Permits unattended, automatic operation of the instrument on a user-programmable schedule. There are 40 functions, each with the ability to operate up to 40 stored setups. These functions can then be entered in a procedure, each with its own start day of the week and time. A sequence of up to 40 functions can be entered in a procedure. The system can store 40 different procedures which can be recalled for operation at any time.

PURGE MODE

This mode will allow the system to be purged with a purge gas at specific purge flows.

REMOTE MODE

When the system is in the remote mode, all operations will be controlled by a computer connected to an RS-232 port.

REVERSE VIDEO

Allows users to change display format from white background with blue text to a blue background with white text.

CHANGE PASSWORD

Allows the user to assign passwords which can restrict access to almost all primary operations of the instrument.

RS-232 SETUP

Allows users to set appropriate Serial Communications parameters: "Baud Rate", "Terminal Type", "Communications Port", etc.

TIME/DATE

Allows the correct time and date to be entered for complete documentation and programming accuracy.

STATUS INPUT

Allows the user to assign different system operations to each of the eight status inputs. By signaling the system through one of the status inputs the assigned operation will run.

STATUS OUTPUT

Allows the user to setup the eight status output lines. These lines can be instructed to turn on when a selected MFC, port, ozone, or a saved setup is in operation.

VOLTS MODE

Allows users to enter the actual voltage supplied to each MFC and the ozone module. The actual voltages will be displayed once the flows are started.

5.2 COMMON SOFT KEYS

Throughout the system there are three common soft keys. The -MORE- and PRT SCRN labels will show up as soft key seven and EXIT will appear on soft key eight.

-MORE-

The -MORE- soft key indicates that there is another level of soft keys. This key acts as a toggle between the levels.

PRT SCRN

The PRT SCRN soft key, when pressed, will cause the system to send whatever is presently on the display to the parallel printer port. This can be useful in making copies of setups for your records or to obtain a copy of the way the system is performing during the operation of a setup.

EXIT

The EXIT soft key is used to exit the present operation and return the user to the previous screen. This key will always bring the user back one screen at a time.

5.3 CONCENTRATION (CONC) MODE

One of the most powerful features of the instrument is the concentration mode. Here the user can blend a multi-component gas mixture by specifying the gas concentrations (in % or ppm) for each component 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 each gas in the blend will also be computed and displayed.

```
                          CONCENTRATION MODE

Mfc   Port  Target Ogc       Actual Ogc         Gas Type
 1      1    BAL MFC         70.98   %     NITROGEN                    N2
 2      2   200.0   PPM      200.2  PPM    CARBON DIOXIDE              CO2
 3      3   20.0     %       20.0    %     ARGON                       Ar
Bal - Other                  9.0     %
Total Flow  10000.0 CCM      10000.2 CCM

_____________________________________________________________________________

Ozone       0.250   PPM       0.250  PPM

Ozone block flow              500.0  CCM
Ozone block temperature       50.0   DEG C
Ozone lamp drive voltage      12.56  VOLTS

 UPDATE   SAVE    RECALL   PPM OR %    OGC/FLOW            PRT SCRN   STOP
```

Concentration (CONC) Mode - Running w/optional Ozone

5.3.1 FIELD DESCRIPTIONS

MFC

This is a display only field which indicates the MFC being commanded. All information on this line will be related to the indicated MFC.

PORT

The "Port" field tells the system which port should be connected to which MFC. The instrument will display an error if the selected port is not available to the corresponding MFC. **NOTE: The ports should be completely setup in "MAINTAIN PORTS" before the concentration mode is operated.**

TARGET OGC

The "Target Ogc" field is where most of the data entry takes place. To change the concentration of the mix, move the cursor to the desired "Target Ogc" cell and enter the concentration in either PPM or percent which can be toggled by the PPM OR % soft key described below. Once the concentration has been entered, a carrot (^) will appear to the left of the entry indicating that the OGC has been changed. The largest amount which can be entered for any one particular gas is determined from MAINTAIN PORTS by the ports cylinder gas concentration (CGC). If an error is made, the system will display the maximum amount available in an error message.

ACTUAL OGC

The "Actual Ogc" field is for display only and will be active after the START soft key is pressed. The actual OGC of each gas will be shown, in either PPM or percent depending on the type selected for "Target Ogc", and updated about every two seconds. If the actual flow of each MFC is needed, press the OGC/FLOW soft key. This soft key acts as a toggle between the actual OGC and FLOW.

GAS TYPE

This is a display only field and will display the name assigned to the selected port. This port name is entered in MAINTAIN PORTS.

BALANCE (BAL) - OTHER

The balance - other field will only be displayed in the "Actual Ogc" area when a mix is running. In MAINTAIN PORTS, where CGC's are assigned to each port, if the CGC is not 100% then a percentage of the gas in the cylinder is some balance gas. When a mix is running, the actual OGC of the component gas is shown for each MFC and if these values were summed they may not add to 100% because of each MFC balance component gas. The "Bal - Other" value represents the cumulative balance gas of each MFC running.

The "Bal - Other" field can be toggled to display either PPM or percent by moving the cursor to the field and pressing the PPM OR % soft key.

TOTAL FLOW AND OZONE

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

The last group of display-only fields are on the bottom left of the display. This is status information about the ozone module and will be updated about every two seconds once a mix has started.

5.3.2 SOFT KEY DESCRIPTIONS

START

This soft key is used to begin the mix described on the display. If any errors are detected, the system will not allow the mix to start.

SAVE AND RECALL

The concentration mode has the ability to save and recall up to 100 different mixes. Once a desired mix is entered, press the SAVE soft key and the system will request a register number to save the present mix in. Now this mix can be recalled at any time by pressing the RECALL soft key and entering the same register number. Both the SAVE and RECALL soft keys can be used whether the system is idle or running a mix. 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 instrument and pressing the PRT SCRN (print screen) soft key, causing the system to send a copy of the screen to the printer (See Warning).

PPM OR %

This soft key will toggle any OGC field between PPM and percent. There can be any combination of PPM and percent on the display. It should be noted that when percent (%) is selected, the user will be entering the percent of gas desired in the mix. If, for example, port 1 has a CGC of 50,000 PPM then an entry of 10% is equivalent to 10,000 PPM and **NOT 10% of the cylinder.**

(BAL) MFC

To simplify the entry of a mix in the concentration mode, one MFC will be used to assure that the mix always adds to 100%. If the user wants a single gas at a concentration of 50%, the system will automatically calculate the "BAL MFC" to 50%. In the instrument, user can select the BAL MFC by moving the cursor to the desired MFC and pressing the BAL MFC soft key. This gives the user the ability to choose which MFC will add the diluent to the mix.

5.3.3 OPERATION

When 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 MFC's. 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: With optional Ozone, there will be an additional flow of 500 sccm added to the actual total flow when ozone is commanded.**

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 precise mix described on the display. 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 to the new values.

5.4 FLOW MODE

In the concentration mode, the user enters the desired concentration of each gas and the total flow. In the flow mode, the user is allowed to control the exact flow through each MFC.

```
                              FLOW MODE

Mfc   Port  Target Flow      Actual Flow       Gas Type
 1      1   5000.0  CCM      5001.2 CCM    NITROGEN                    N2
 2      2   2500.0  CCM      2500.5 CCM    CARBON DIOXIDE             CO2
 3      3   2500.0  CCM      2499.9 CCM    ARGON                       Ar

Total Flow  10000.0 CCM      10001.6 CCM




 START    SAVE    RECALL                                  PRT SCRN   STOP
```

Flow Mode - Running w/o optional ozone.

5.4.1 FIELD DESCRIPTIONS

MFC

This is a display only field which indicates the MFC being commanded. All information on this line will be related to the indicated MFC.

PORT

The "Port" field tells the system which port should be connected to which MFC. The instrument will display an error if the selected port is not available to the corresponding MFC. **NOTE: The ports should be completely setup in "MAINTAIN PORTS" before the flow mode is operated.**

TARGET FLOW

The "Target flow" field is where most of the data entry takes place. To change the flow of any MFC, move the cursor to the desired "Target Flow" cell and enter the desired flow in either CCM or LPM depending on how CALIBRATE - MFC SIZE was set up. Once the flow has been entered, a carrot (^) will appear to the left of the entry indicating the flow has been changed. The largest flow which can be entered for any MFC is the size of the MFC. As target flows are entered, different notes may appear to the right of the values. These notes describe the range status of the MFC's. The different status notes are ">90%" which means the MFC will operate in the 90% to 100% of its range and "<10%" if the MFC will operate under 10% of its range. If no status appears, the MFC is in its optimum range. If an error is made, the system will display the maximum amount available in an error message.

ACTUAL FLOW

The "Actual Flow" field is for display only and will be active after the START soft key is pressed. The actual flow through each MFC will be shown, in either CCM or LPM as in the "Target Flow" field, and updated about every two seconds.

GAS TYPE

This is a display only field and will display the name assigned to the selected port. This port name is assigned in MAINTAIN PORTS.

TOTAL FLOW

The total flow field is for display only and is a total of all the "Target flows".

OZONE (Optional)

The last entry field is "Ozone". In this field, the user enters the desired amount of ozone. 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 any error is made, the system will display what is wrong once the START or SAVE soft key is pressed.

The last group of display-only fields are on the bottom left of the display. This is status information about the ozone module and will be updated about every two seconds once the flows have started.

5.4.2 SOFT KEY DESCRIPTIONS

START

This soft key is used to begin the flows described on the display. If any errors are detected, the system will not allow the flows to start.

SAVE AND RECALL

The flow mode has the ability to save and recall up to 100 of its own setups (See CONC MODE - SAVE AND RECALL ,pg. 12, for information on save and recall).

5.4.3 OPERATION

Once all the desired values have been entered, press the START soft key and the system will proceed to command each MFC to the flows described on the display. 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 flows 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 what is currently running with the new values.

5.5 GAS PHASE TITRATION[1]

Gas phase titration is the chemical reaction between specific gases resulting in the creation of one or more new gases. In the instrument, rapid gas phase titration is used to create Nitrogen Dioxide (NO_2) from Ozone (O_3) and Nitric Oxide (NO) as described in the following equation:

$NO + O_3 \Rightarrow NO_2 + O_2$

The nature of the reaction is such that when the concentration of "NO" or "O_3" is known, the concentration of "NO_2" can be determined. The Environics recommended method of Gas Phase Titration is the excess Nitric Oxide Transfer Standard Procedure (GPT-NO).

When O_3 and NO are mixed, an O_3 molecule will combine with a molecule of NO to create a molecule NO_2 with the leftover O_2 released. Using GPT-NO, there will be an excess of NO after the reaction. As an example, if 0.58 ppm of NO is combined with 0.5 ppm of O_3, 0.5 ppm of NO_2 and 0.5 ppm of O_2 will be produced. Since there is more NO than required, an excess of 0.08 ppm of NO will be leftover. Please note the EPA states that NO_2 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.[1]

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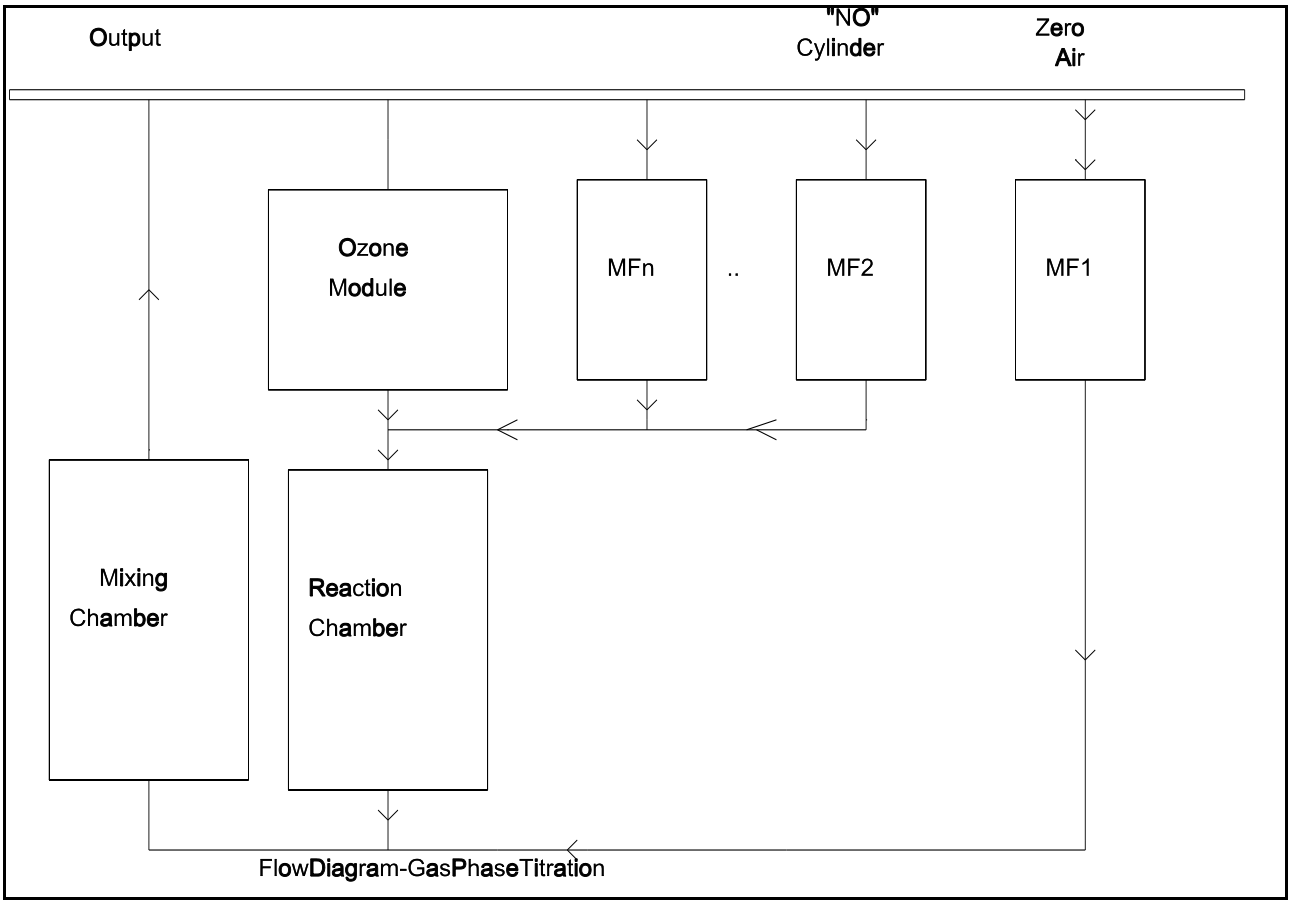
[1] Code of federal regulations (July 1, 1990) 40 CFR 58, App. B, 3.2: pp. 152-153.

[2] Based 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.



To perform GPT-NO on the instrument, follow the subsequent procedure:

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 NO_2. Enter this new total flow in the Total Flow cell.

2 - Determine the amount of NO_2 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 concentrations requested are out of range, the system will inform the user where the error lies.

When NO is included in the super blend, and named in MAINTAIN PORTS, the system will automatically display the target and actual NO_2 when target O_3 is requested. Once the system is running a mix, the actual NO and O_3 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 O_3, information about NO_2 will be removed from the screen.

5.6 MAINTAIN PORTS

Extreme care should be taken to assure the information entered in MAINTAIN PORTS is correct. All information entered here is carried throughout the system and can seriously affect the systems performance.

WARNING

Maintain ports is where the user describes to the system exactly what is connected to each port. There are three fields for entry plus a complete screen for computing K-factors, if needed.

```
Stored CONCENTRATION setups in ERROR

 00 22 71


Stored FLOW setups in ERROR

 37

The CHANGES made cause ERRORS in these stored setups.              Press any
key
```

Port Maintenance - Error Screen

Upon exit, if any changes are made in maintain ports, the system will check all stored concentration and flow mode setups. If any errors are caused by the changes, the system will display which setups contain errors. The major cause of errors is when the concentration of a port is reduced significantly, thus causing concentration mode setups which required the higher concentration to be in error.

```
                                PORT MAINTENANCE

Port#      Cylinder Gas Con.    K-factor                    Gas Type

  1            100.0    %        1.0       NITROGEN                          N2
  .
  .
  N            2500.0 PPM        1.415     ARGON                             Ar

┌──PPM OR %          ENTER GAS          SELECT GAS          PRT SCRN    EXIT
│ ┌COMPUTE K         ENTER GAS          SELECT GAS          PRT SCRN    EXIT
│ │
│ └─> Soft keys when the cursor is in the CGC field.
└──> Soft keys when the cursor is in the K-factor field.
```

Port Maintenance

5.6.1 FIELD DESCRIPTIONS

PORT #

This field shows the port number to which all the information on the line is associated.

CYLINDER GAS CONCENTRATION

The CGC field is where you enter the concentration of each cylinder. This can be done in either PPM or percent by using the "PPM OR %" soft key to select the mode of entry. If a cylinder contains pure gas, or a single gas component in a balance gas, the CGC is the concentration of the component (or 100% for pure gas). If a cylinder contains two or more components in a balance gas, the CGC would be the concentration of the gas component you are interested in.

K-FACTOR

The K-factor is the thermal absorption constant of the gas. The constant can be calculated by hand and then entered or the user can have the system perform the calculations by pressing the COMPUTE K soft key. With COMPUTE K, the user enters the concentration and type of each component in the cylinder and the system will compute the appropriate K-factor (See COMPUTE K, pg. 18).

If any cylinder does not contain 100% of a gas then COMPUTE K should be used to compute the correct K-factor.

GAS TYPE

The "Type" field is where a gas name can be entered. The user can either enter up to 35 alpha-numeric characters or select a name from the system or user gas libraries. Use the ENTER GAS soft key to enter or edit the gas type or press the SELECT GAS soft key to choose a name.

5.6.2 SOFT KEY DESCRIPTIONS

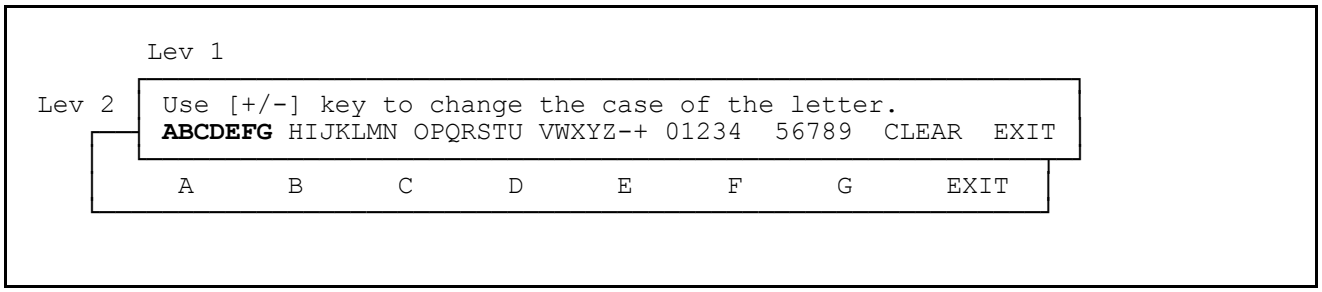
PPM OR %

Use this soft key to toggle the CGC entry between PPM and percent. If the CGC is 100%, the key will have no effect since the maximum PPM entry is 999999 PPM. If the CGC is under 10 PPM, pressing this key will display 0.0 % because the lowest percent entry is 0.001%. This soft key will only appear when the cursor is in the CGC field.

COMPUTE K

This soft key will allow the user to enter the COMPUTE K screen to compute the K-factor of any single or multiple component gas. The COMPUTE K screen is also where the user gas library can be edited. This soft key will only appear when the cursor is in the K-factor field.

ENTER GAS



Text Editor

When the ENTER GAS soft key is pressed, the system will bring up the text editor to allow the user to enter up to 35 characters to describe the gas connected to the port. Select the letter or number group from the soft keys and then select the desired letter or number soft key to enter your choice. In the text editor, you can use the cursor keys to move through the string. When you are finished with the text entry, press the "EXIT" soft key to accept the text. This name will be displayed when the system is running a flow or concentration.

SELECT GAS

```
SYSTEM   USER
```

Gas Library Selection Soft Keys

The SELECT GAS soft key will first display a sub-menu, giving the user the option of selecting a gas from the system or user libraries. The system library contains 134 of the most common gases. To select a gas from this library use the PAGE UP and PAGE DOWN soft keys to find the page that contains the desired gas and then place the cursor over the gas and press the SELECT soft key.

```
                ACETYLENE                    C2H2
                    .
                    .
                CARBON TETRAFLUORIDE         CF4

SELECT    PAGE UP    PAGE DOWN                                    EXIT
```

System Gas Library Screen

The user gas library has space for 30 custom gases of which the user enters their parameters from the COMPUTE K screen. (See USER GAS EDITING, pg. 20)

5.6.3 COMPUTE K SCREEN

Compute K is a K-factor calculator which gives the user the ability to compute the K-factor of a cylinder that contains a single diluted gas or one which contains many different gases such as a super blend. This process is very quick and easy.

```
                            COMPUTE K-FACTOR

Gas       Concentration      K-factor                    Type

 1          BALANCE          1.0       NITROGEN                      N2
 2         50.0    %         1.415     ARGON                         Ar
 3         2500.0 PPM        1.687     SULFUR DIOXIDE                SO2
 .
 .
10          0.0    PPM        1.0       NITROGEN                      N2

Cylinder Identification: CYL-1234.456

K-factor = 1.171 referenced to NITROGEN                    N2

PPM OR %    GAS TYPE    REF TYPE          ACCEPT    CYL ID    INIT    EXIT
```

Compute K Function

5.6.3.1 FIELD DESCRIPTIONS

GAS

This is a display only field to help associate a component gas with the information on the line.

CONCENTRATION

This is where the concentrations of different components are entered. The data can be entered in either PPM or percent with the use of the PPM OR % soft key. Any component containing a concentration of 0.0 will be removed from the final K-factor calculation.

K-FACTOR

This is a display only field and displays the K-factor of the selected components. This K-factor is for 100% of the component and is computed using the "CONVERSION FACTOR TABLE relative to nitrogen N_2" table in the rear of a Tylan© MFC manual. The component K-factor will always be shown relative to Nitrogen even if the final cylinder K-factor is relative to something else.

TYPE

This display-only field shows the name or identification of the selected component gas. When a gas is selected from one of the libraries, the type will be copied to this field.

CYLINDER IDENTIFICATION

A 12 character cylinder identification field is available for each port to identify the cylinder connected to it. To access the description, press the CYL ID soft key which will bring up the text editor.

K-FACTOR =

This display only field shows the K-factor for the complete cylinder which is computed from the concentrations and K-factors of the component gases. As component data is entered this field will automatically update.

REFERENCED TO

Most flow controllers are calibrated using Nitrogen. When a gas other than Nitrogen is used, the system uses the K-factor to adjust the command to the MFC which allows it to flow properly. Since the MFC was calibrated with Nitrogen, the K-factors used are referenced to Nitrogen, but what if the MFC was calibrated with Helium? This field lets the user select the same gas the MFC was calibrated with so the cylinder K-factor will be referenced to the calibration gas. This reference gas can be chosen by pressing the REF GAS soft key and selecting the appropriate gas from one of the libraries.

5.6.3.2 SOFT KEY DESCRIPTIONS

PPM OR %

Use this soft key to toggle the "Concentration" entry between PPM and percent. If the concentration is 100%, the key will have no effect since the maximum PPM entry is 999999 PPM. If the concentration is under 10 PPM, pressing this key will display 0.0 % because the lowest percent entry is 0.001%.

GAS TYPE

This key allows the user to select a component gas from one of the two libraries (See SELECT GAS on pg. 18, for instructions on how to use the libraries).

REF TYPE

This key allows the user to select the reference gas from one of the two libraries (See SELECT GAS on pg. 18, for instructions on how to use the libraries).

ACCEPT

Once all the data for each of the components has been entered, press this soft key to return the computed cylinder K-factor to the maintain ports screen.

CYL ID

Use this soft key to enter a cylinder identification using the system text editor (See ENTER GAS pg. 17 for instructions on the text editor).

INIT

This key will initialize the COMPUTE K screen to concentrations of 0.0 and Nitrogen for the types. The cylinder identification and reference gas entries will be left unchanged.

5.6.3.3 USER GAS LIBRARY EDITING

```
          Gas Name                    Cp            d             K
   NITROGEN                  N2     0.2485        1.25          1.0
      .
      .
   NITROGEN                  N2     0.2485        1.25          1.0


 SELECT    PAGE UP   PAGE DOWN                                EDIT    EXIT
```

User Gas Library

The USER gas library can be edited from the COMPUTE K screen by selecting the library, placing the cursor on the desired gas and pressing the EDIT soft key. When editing, the user will enter the gas name, specific heat in calories per gram degrees C (cal/g °C), the density in grams per liter (g/l @ 0°C), the molecular structure of the gas from the soft keys. Once a gas is entered in the user gas library, it can be selected like the gases in the system library. The system will use the data entered for the gas to correctly compute the K-factor.

5.7 CALIBRATE MODE

IMPORTANT
NOTE: It is very important that a hard copy of the SYSTEMS CALIBRATION SCREEN be kept in a safe place EACH TIME CALIBRATION DATA IS ENTERED. These hard copies are required to recover the system in case of data loss.

```
                              CALIBRATION

 Flow checking - is on.

                                 DEFAULT     DEVICE
   OZONE   MFC SIZE  MFC FLOW     FLOW     ADC        DAC              EXIT
```

Calibrate Mode - Main Menu

When the calibration mode is selected, there are six soft keys available to enter the different calibration displays. A message is also displayed which indicates whether or not all flow will be shut off if the flow through any MFC drops below 50% of what it was commanded.

The purpose of the calibrate mode is to allow the operator to enter information into the instrument that describes the measured performance of a device. Once entered, corrections can be made to the command voltage to a device and to the feedback when reading a device. Though a perfect device would have a slope of one and an intercept of zero (e.g. five volts equals full scale, two and one half volts equals half scale, etc.), most devices can be more accurately commanded at slopes and intercepts slightly different than one and zero respectively. The multi-point slope will generate a new slope between each set point listed in the calibration table (effectively straightening out non-linear performance curves of the device).

In the lower portion of any calibration screen is a time/date stamp that shows the last time the calibration data was saved.

5.7.1 MFC SIZE

```
                          FLOW CONTROLLER SIZE

                       Mfc#       Max Flow of MFC
                        1           20.0   LPM
                        .
                        .
                        n           5000.0 CCM

 CCM/LPM                                                PRT SCRN    EXIT
```

Calibrate Mode - MFC SIZE

The MFC SIZE screen is used to enter the size of each MFC and in which units, CCM or LPM, the system will display all the MFC's data. Each MFC can be individually configured for either CCM or LPM by placing the cursor on the desired MFC # and pressing the CCM/LPM soft key. **NOTE: Do not change any of the MFC sizes unless directed to do so by Environics.**

5.7.2 MFC FLOW

The way to calibrate the flow controllers installed in the instrument is to activate each mass flow controller one at a time while in the MFC FLOW calibration mode by pressing the ENERGIZE soft key. Once activated with calibration gas flowing, the true flow rate data for specific commanded set points can be determined from an in-line flow measurement standard monitoring the output of the instrument.

CALIBRATION WITH A FLOW STANDARD

It is suggested that the user first enter all the command values desired before continuing. To calibrate at a specific command value, move the cursor to that value and press the ENERGIZE soft key. The system will send the command directly to the MFC without applying any slope or intercept to it. Allow the system about 5 minutes to stabilize once energized. The user should now read the true flow on a flow standard and enter this value in the true flow cell associated with the command now running. To change to a different command without stopping the MFC, move the cursor to the next point and press the UPDATE soft key. The system must be stopped to change any "Set Point" data.

ENTERING PRE-CALIBRATED MFC DATA

To enter pre-calibrated MFC data, fill in the calibration screen with the pre-calibration data and press the SAVE CAL soft key to save the data.

```
                          FLOW CALIBRATION

                  Set Flow       True Flow      Feedback Flow

          5  %   1000.0 CCM      1002.1 CCM
          .
          .
          100%   20000. CCM      20015. CCM

          Port        >1 ; K-factor   > 1.0
          MFC desired >1 ; Description: NITROGEN 10/2/10

 Calibration data was last saved on   Friday   17  December  10

 ENERGIZE  SAVE CAL  SWAP CAL  DESCRIPT  INIT CAL  PRT CAL  PRT SCRN  EXIT
```

Calibrate Mode - MFC FLOW

5.7.2.1 FIELD DESCRIPTIONS

PERCENT

This field 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.

SET FLOW

This field is used to enter calibration set points. These are the values the MFC was, or is to be, commanded to.

TRUE FLOW

The true flow field is where the actual flow of the associated set point, determined by a flow standard, is entered.

FEEDBACK FLOW

This is a display-only field which will show the response of the MFC when energized.

5.7.2.2 SOFT KEY DESCRIPTIONS

ENERGIZE

Pressing ENERGIZE will start flow through the MFC at the "Set Flow" rate. The MFC is commanded with the set flow directly without going through any flow calibration table.

SAVE CAL

Once all the data has been entered, the SAVE CAL soft key should be pressed to record the data in the system. If the save is not performed, all the data entered will be lost so the system will request confirmation before exiting. If the save was performed, the system will use the calibration data in all future flow operations.

Each time the SAVE CAL soft key is pressed the time date stamp will be updated and displayed.

SWAP CAL

Press the SWAP CAL soft key to bring up the swap register list then select the register to exchange flow calibration data with. **NOTE: If a swap is performed the SAVE CAL soft key should be pressed to save the calibration data which is on the screen or the data will be lost upon exit.**

DESCRIPT

A 15 character description is available to describe how the MFC was calibrated. To access this description press the DESCRIPT soft key which will bring up the text editor (See pg. 17 for instructions on the text editor). **NOTE: This description will be used as the description in the swap registers.**

INIT CAL

The INIT CAL soft key will initialize both the set and true data in even steps from 10% to 100% of the size of the MFC with the first step at 5%. The system will proceed with the init after the user answers yes to a safety question.

PRT CAL

To get a hard copy of the calibration data the user can either press the PRT SCRN soft key for a copy of the display or press the PRT CAL soft key for a formatted copy of the data.

5.7.2.3 FLOW CALIBRATION DATA SWAP REGISTERS

12 "Swap Registers" are provided to allow saving additional sets of MFC flow calibration data (data). The method of saving and recalling data with these registers is through the "SWAP CAL" soft key. The user may choose not to use the swap registers unless more than one set of data is needed for an MFC.

To use a swap register, enter the data normally and then press the "SWAP CAL" soft key. The system will then display a list of the registers at which time the user will cursor to the desired register and press the "SELECT soft key. The system will then exchange or "swap" the present data with the data in the register.

```
                          SWAP REGISTERS

               Register     Description     Mfc
                  1       He 10-2-10        2
                  2       H2 10-6-10        2
                  .
                  .
                 12

        Port         >1 ; K-factor   > 1.0
        MFC desired >1 ; Description: NITROGEN 10/2/10

Calibration data was last saved on   Friday   17  December  10

  SELECT                        DELETE                     PRT SCRN    EXIT
```

Swap register list screen

Once the user has swapped data to a register, it can be recalled by pressing the "SWAP CAL" soft key and selecting that same register. The system will then "swap" the present data with the data in the register. Before any data is swapped, the swap register will be checked to make sure that the data in the register is for the present MFC. If the user is trying to swap with data from another MFC, the system will display the message, "Register calibration data is for another MFC. Press any key."

The user has the choice of using the "DELETE" soft key to erase the data in any of the registers. Once a register is empty, it can be used to hold data from any MFC.

Just as if new data was entered in normal flow calibration, the user will press the "SAVE CAL" soft key to save the displayed data. If EXIT is pressed before SAVE CAL is pressed, the system will first display the question, "All CHANGES will be LOST. EXIT without saving?" If the YES soft key is pressed, the system will then display, "A swap has been performed. Cal data will be LOST. EXIT without saving?" At this point if the user presses the YES soft key, the data on the screen will be lost.

Once data has been exchanged with a swap register, it is safe. The data in the swap registers is saved automatically and is not lost upon exiting.

```
                  FLOW CONTROLLER DEFAULT FLOW SETTING

                     Mfc#     Default Flow of MFC
                      1           1.0    LPM
                      .
                      .
                      n          50.0    CCM

  INIT ALL                                              PRT SCRN    EXIT
```

Calibrate Mode - DEFAULT FLOW

5.7.3 DEFAULT FLOW

The default flow screen is used to assign a flow setting to each MFC which is commanded any time the MFC is commanded to zero. The MFC, when commanded to zero, would be commanded to its default flow but its port solenoid is kept closed. The idea behind default flow is to keep the MFC flowing at all times, with its port gas when running and with purge gas when not running. This function is primarily used with systems that have the purge option.
To assign a default flow, move the cursor to the desired MFC and enter the desired flow. The INIT ALL soft key will assign 5% of each of the MFC's size as its default flow.

WARNING

NOTE: This function should not be used unless specifically requested by the user upon purchase. If any default flow is assigned it is possible to have unwanted gas added to the output.

5.7.4 OZONE

WARNING

NOTE: It is very important that a hard copy of the ozone and DAC device 011 (See pg. Error! Bookmark not defined.**; sec. 0) CALIBRATION SCREENS be kept in a safe place EACH TIME OZONE CALIBRATION DATA IS ENTERED. These hard copies are required to recover the system in case of data loss.**

The calibrate ozone 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	True Flow	Pressure	Ozone	True Flow
5	0.05	0.25	13.0	24.69	0.05	13.0
10	0.1	0.5	13.0	24.69	0.1	13.0
.						
.						
100	1.0	5.0	13.0	24.69	1.0	13.0

INIT ALL SAVE DATA PRT SCRN EXIT

Calibrate Mode - Ozone

5.7.4.1 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 which can be produced.

A calibration point is 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:

$$Ozone\,Module\,O3 = \frac{Target\,O3 * True\,Flow}{Ozone\,Module\,Flow}$$

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 and shows the volts applied to the ozone module. This value is computed from the "Target Ozone," "Target Flow," and the previous ozone calibration data.

TARGET - TRUE FLOW

The entry for this field is the target total flow 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".

PRESSURE

This field will appear only if the system is not compensating for pressure with the optional pressure sensor. Enter the ambient pressure, obtained from the FLOW MODE, for each point. If the Ozone generator pressure is recorded from the FLOW MODE screen for each point, it should be entered as displayed. **If the ambient pressure was recorded by an external monitor, 10 PSIA should be added to each reading before it is entered.** When all the data has been collected, enter the ozone calibration screen and fill in each line with the data gathered in the FLOW MODE.

TRUE - OZONE

This field is where the FLOW MODE's actual ozone, measured by your ozone standard, for each calibration point is entered.

TRUE - FLOW

This field is where the actual total flow for each calibration point, displayed on the FLOW MODE screen, is entered.

5.7.4.2 SOFT KEY DESCRIPTIONS

INIT ALL

The INIT ALL soft key will initialize the screen to a target and true flow of 13.0 slpm, a pressure of 24.69, and ozone values in 10 percent increments with the first point at 5 percent.

SAVE DATA

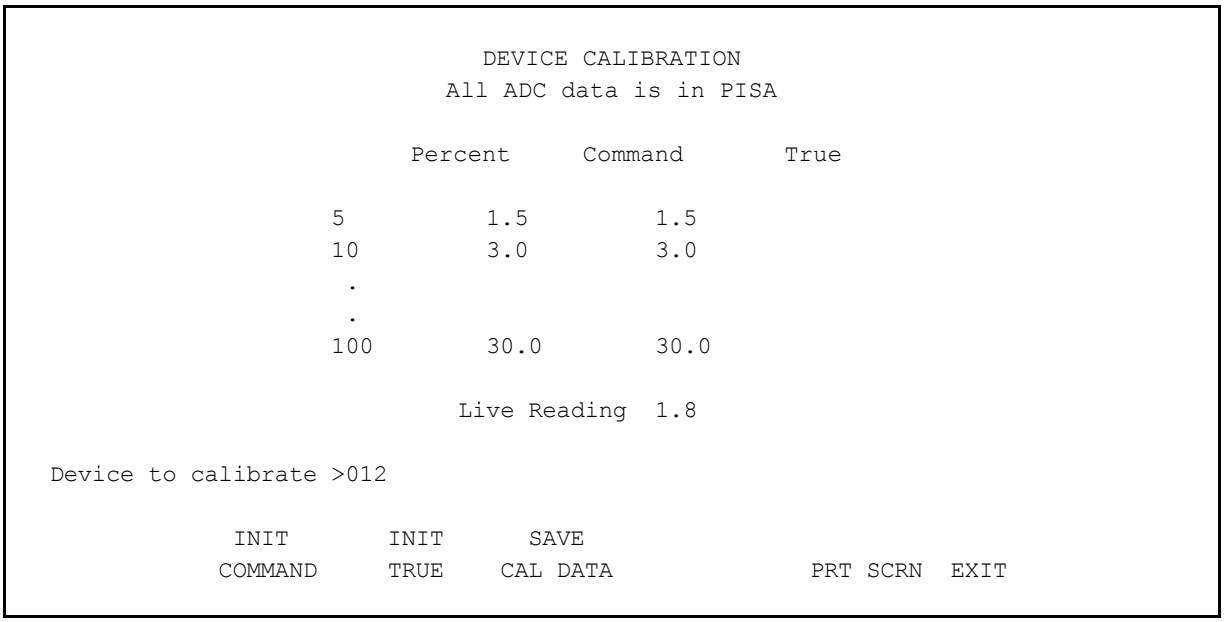
This soft key is used to record data in the system and update DAC device 011. Once all data is entered and saved, the user should exit out of ozone calibration to allow the system to use the new data.

5.7.4.3 OPERATION

When ozone calibration is required, the user should use the FLOW MODE to run all the calibration points of interest. When running, the user should record the target total flow, target ozone, true ozone (measured by a calibrated standard), true total flow which is displayed on the FLOW MODE screen, and the ambient pressure for each point from a calibrated gauge or from the FLOW MODE screen, if available.

Once all the data has been entered, the SAVE DATA soft key should be pressed to record the data in the system and update DAC device 011. The system will compute and save a new calibration curve. Upon exiting this screen, the system will use the new calibration data.

5.7.5 DEVICE - ADC (Analog to Digital Converter)



Calibrate Mode - ADC Device

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

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.

INIT CAL SOFT KEY

The INIT CAL soft key will initialize the command and true data in even steps from 10% to 100% of the size of the device with the first step at 5%. The INIT CAL soft key will only perform its function after the user presses the YES soft key to the safety question.

5.7.6 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. At the present time, there is only one device, ozone (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.

The INIT CAL soft key operates the same as DEVICE - ADC INIT CAL soft key.

5.7.7 RECOVERY OF LOST CALIBRATION DATA

Calibration date can be lost by accidently 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.

WARNING
NOTE: 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.

5.7.7.1 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. (For instructions on each calibration screen reference pg. **Error! Bookmark not defined.**; sec. 0 for MFC, pg. **Error! Bookmark not defined.**; sec. 0 for ADC and pg. **Error! Bookmark not defined.**; sec. 0 for DAC).

WARNING
NOTE: If your system has optional ozone, do not enter the calibration data for DAC device 011. This data will be entered in the next section.

5.7.7.2 OZONE

The recovery of the ozone calibration data is a two-step process. First, with the **LATEST** ozone calibration data, go into the ozone calibration screen and enter all the **"Target"** ozone and true flow (if applicable enter the pressure also). Remember to enter all 11 points, entering zero for the points not used. When the entry is complete, press the SAVE DATA soft key to record the data in the system.

For the second step you will need the calibration data for DAC device 011 which coincides with the latest ozone calibration data. Go into the DAC device screen for device 011 and enter all 11

calibration points (**NOTE: Do not skip any points, all 11 must be entered**). 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.

5.8 AUTOMATIC SEQUENCER MODE

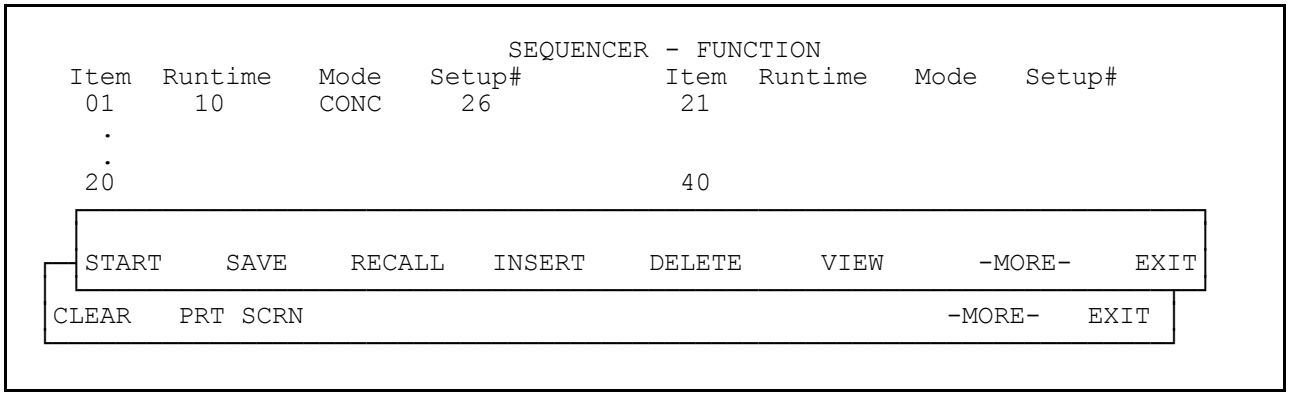
The instrument incorporates a powerful automatic sequencer mode, which gives the user the ability to program the instrument for independent and unattended operation. The function section of the manual makes reference to the CONC, FLOW, and PURGE modes and a thorough understanding of these modes is required before proceeding. If you have not read these sections please refer to pg. 10 for the CONC mode, pg. 13 for the FLOW mode, and pg. 33 for the PURGE mode.

5.8.1 FUNCTION

Throughout the manual, we stress the power and convenience of saving and recalling setups. The idea of designing a setup to perform a desired operation and then have the ability to save and later recall that same setup is very important and eliminates the need to re-enter that setup multiple times. This idea carries on right into the function mode of the automatic sequencer. A function is a list of previously saved setups which are to be recalled in sequence.

Within its 40 items a function can contain any combination of concentration, flow, and purge operations all running for different lengths of time. The order of these operations does not matter but the system will run items in sequence starting with item #1. Every time the system gets to an item with a run time greater than 00, the operation described in that item will be performed. If an item has a run time of 00 it will be skipped and the next item in sequence will be checked. Once the system has finished with item 40, the function is considered complete and the system will either return to a procedure or to the function screen depending on where it was started.

The system can save up to 40 functions, saving the user the time of re-entering the data over again. These saved functions are also used in a procedure which will be described in the next section.



Automatic Sequencer - Function

5.8.1.1 FIELD DESCRIPTIONS

ITEM

The item number is a display-only field and is used to indicate the item being worked on.

RUN TIME

This field is used to enter the amount of time the particular setup is to run. This time can be different in every item. The legal entries are 00 to 60 minutes with **00 meaning "skip this item**".

MODE

The MODE field is to indicate what type of mode is to run: CONC, FLOW, or PURGE. When the cursor is in this field the user can select the mode from one of the first three soft keys.

SETUP #

The setup number is the storage register which contains the setup to be recalled and run. The legal entries are from 00 to 99.

5.8.1.2 SOFT KEY DESCRIPTIONS

START

The START soft key will begin the function described on the screen. Once the function has begun, the display will show the setup which is running in its native screen.

SAVE / RECALL

The system has 40 storage registers, 00 to 39, for functions which are separate from the procedure registers. After a function is designed and entered, it should be saved for possible recall by a procedure. Any function stored in register 00 will be displayed whenever the function mode is entered.

INSERT

The INSERT soft key will insert an item above the cursor. All other items from the cursor on will be pushed down by one. **NOTE: If there is any data entered in item 40 and the INSERT soft key is pressed that data will be lost when it is over written by the data in item 39.**

DELETE

When the DELETE soft key is pressed the item the cursor is on will be removed and all items after the cursor will be move up one.

```
                        SEQUENCER - FLOW VIEW

Mfc   Port  Target Flow      Actual Flow       Gas Type
 1      1   5000.0  CCM      5001.2 CCM    NITROGEN                    N2
 2      2   2500.0  CCM      2500.5 CCM    CARBON DIOXIDE             CO2
 3      3   2500.0  CCM      2499.9 CCM    ARGON                       Ar

Total Flow  10000.0 CCM      10001.6 CCM

Viewing FLOW setup #26                                    Press any key
```

Automatic Sequencer - Function View - Flow Mode

VIEW

The VIEW soft key will display the setup indicated in the item the cursor is on. If the item has FLOW 26 as its mode and setup # then view will display FLOW setup #26 as shown above. The same is true for CONC and PURGE modes.

START - ADVANCE

The ADVANCE soft key will be displayed after a function has begun. This key, which when pressed, will stop the setup that is running and start the next item in the function. If there are no other items in the function with run times greater than 00, the system will exit back to the function screen and wait for a key press.

START - STOP

The STOP soft will stop the setup running and the system will exit back to the function screen.

5.8.1.3 OPERATION

```
                          SEQUENCER - FLOW VIEW

Mfc   Port  Target Flow      Actual Flow        Gas Type
 1      1   5000.0  CCM      5001.2 CCM    NITROGEN                    N2
 2      2   2500.0  CCM      2500.5 CCM    CARBON DIOXIDE             CO2
 3      3   2500.0  CCM      2499.9 CCM    ARGON                       Ar

Total Flow  10000.0 CCM      10001.6 CCM

Running FLOW setup #26

09:56:32    Wednesday  29 December 10    Run time remaining = 08:27
                          ADVANCE                                  STOP
```

Automatic Sequencer - Running Function - Flow Mode

Operating a function independent of a procedure is one of the powerful features of this system. Here a user can directly run a sequence of up to 40 different concentrations, flows, and purges without having to go through a procedure and entering the present time and day. Once the desired function is on the display, either by entering or recalling one previously stored, press the START soft key and the system will proceed with running each setup in sequence. A function can also be started by the idle timer or a status input (See STATUS - INPUT, IDLE TIMER pg. 49).

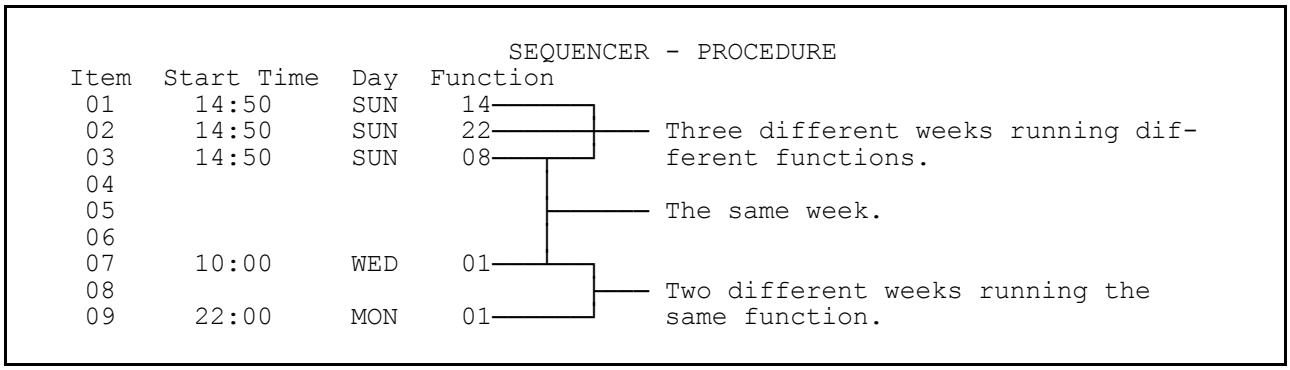
As shown above, if a function is running FLOW #26 then the flow mode screen is displayed but the title indicates that the operation is from the sequencer. When a function is running CONC and PURGE setups their respective screens will be displayed.

If there are any setups that are not valid, the function will not start. Instead, the system will display the message "One or more items are not valid". At this point, the display will have carrot marks (^) to the left of each item number that contains an error. These errors must be corrected in the mode that it was caused, ie. if an carroted item has CONC 26 then the user must go to the CONC mode and recall #26, make the necessary corrections, then save the setup back to register #26. Once all errors are corrected, the system will allow the function to run.

5.8.2 PROCEDURE

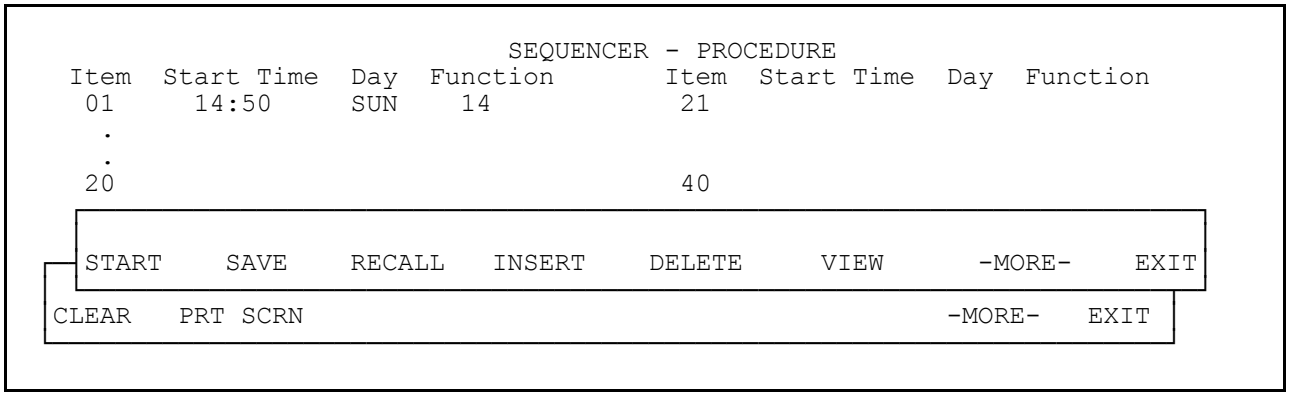
The procedure portion of the automatic sequencer uses the same idea of recalling a sequence of saved setups as discussed in the function section but this time the setups being recalled are saved functions and the sequence is day and time of the week. Since a procedure relies on functions, a thorough understanding of the previous section is required before this section is read.

When designing a procedure, the user will decide what day and time of the week each function is to begin. The system will work through a procedure in sequence starting with item #01. When running, the system will check the start time of an item to see if it is 00:00 which tells the system to "skip this item". If the start time is greater than 00:00, the system will compare that start time and day to the current time and day and wait. When the two times and days match the function described in the item, it will start. Once the function is complete, the system will continue checking items for the next one to run. When the system finishes item 40 in the procedure it will loop back and start checking with item one. This continuous loop can be stopped at any time by pressing the STOP soft key.



Automatic Sequencer - Procedure - Examples

The procedure portion of the automatic sequencer is very flexible. The one rule to remember is that any start day and time which is equal to or less than the one before it will be considered a new week. Using this rule you can see how a procedure can be designed to have a 40 week loop running a different function each week by having the same start day and time in all the items and entering different function numbers.



Automatic Sequencer - Procedure

5.8.2.1 FIELD DESCRIPTIONS

ITEM

The item number is a display only field and is used to indicate the item being worked on. This number will be referenced when the procedure is running.

START TIME

This field is where the desired starting time of the function is entered. This time is entered in a 24 hour format, ie. 12:00 is noon and 24:00 is midnight. A start time of 00:00 for any item will make the system skip over that item when running but not remove the day and function number information. When the cursor is on any item, the start time, day, and function name will be displayed no matter what the start time is. The DELETE, INSERT soft key combination can be used to init any item to a start time of 00:00, SUN as the day, and 00 as the function.

DAY

This field indicates what day of the week the function is to operate. When the cursor is in this field use the soft keys to enter the day of the week.

FUNCTION

The purpose of the procedure mode is to run previously entered and stored functions at specific days and times of the week. The function field is where the number of the function to be run is entered.

5.8.2.2 SOFT KEY DESCRIPTIONS

START

The START soft key will start the procedure described on the screen. After the key is pressed the system will ask which item to start with. Once the item number is entered the system will go to that item and wait for its start day and time. Once that item has finished the system will continue from that point, ie. if the start item is 12 than once 12 has finished the system will continue with 13 and so on.

SAVE / RECALL

The system has 40 storage registers, 00 to 39, for procedures. After a procedure is designed and entered, it should be saved for possible recall at a later time. Any procedure stored in register 00 will be displayed whenever the procedure mode is entered.

INSERT

The INSERT soft key will insert an item above the cursor. All other items from the cursor on will be pushed down by one. **NOTE: If there is any data entered in item 40 and the INSERT soft key is pressed that data will be lost when it is over written by the data in item 39.**

DELETE

When the DELETE soft key is pressed the item the cursor is on will be removed and all items after the cursor will be move up one.

VIEW

```
                              SEQUENCER - FUNCTION
  Item  Runtime   Mode   Setup#         Item  Runtime   Mode   Setup#
   01     10      CONC     26            21
    .
    .
   20                                    40
Viewing FUNCTION setup #26                                  Press any key

  START   SAVE   RECALL   INSERT   DELETE     VIEW     -MORE-     EXIT
```

Automatic Sequencer - Procedure - View Function

The VIEW soft key will display the function indicated in the item the cursor is on. If item #26 is chosen as the function to be viewed, the system will display FUNCTION setup #26 as shown above.

START - ADVANCE

The ADVANCE soft key will be displayed after the procedure has started a function. This key, which when pressed, will stop the present item, in the function that is running, and start the next item with a run time greater than 00. If there are no other items in the function the system will exit back to the procedure screen and wait for the next start day and time to arrive.

START - STOP

The STOP soft key will cause whatever is running to stop and the system will exit back to the procedure editing screen.

5.8.2.3 OPERATION

```
                              SEQUENCER - PROCEDURE
 Item  Start Time  Day  Function       Item  Start Time  Day  Function
  01     14:50     SUN    14            21
   .
   .
  20                                    40

14:37:41    Wednesday  29 December 10       Next item to run is  1
                                                                STOP
```

Automatic Sequencer - Procedure - Waiting to run a function

```
                          SEQUENCER - FLOW VIEW

Mfc   Port  Target Flow      Actual Flow        Gas Type
 1      1   5000.0  CCM      5001.2 CCM    NITROGEN                    N2
 2      2   2500.0  CCM      2500.5 CCM    CARBON DIOXIDE             CO2
 3      3   2500.0  CCM      2499.9 CCM    ARGON                       Ar

Total Flow  10000.0 CCM      10001.6 CCM

Running FLOW setup #26 from PROCEDURE item # 1

09:56:32    Wednesday  29 December 10    Run time remaining = 08:27
                          ADVANCE                              STOP
```

Automatic Sequencer - Running Procedure - Flow Mode

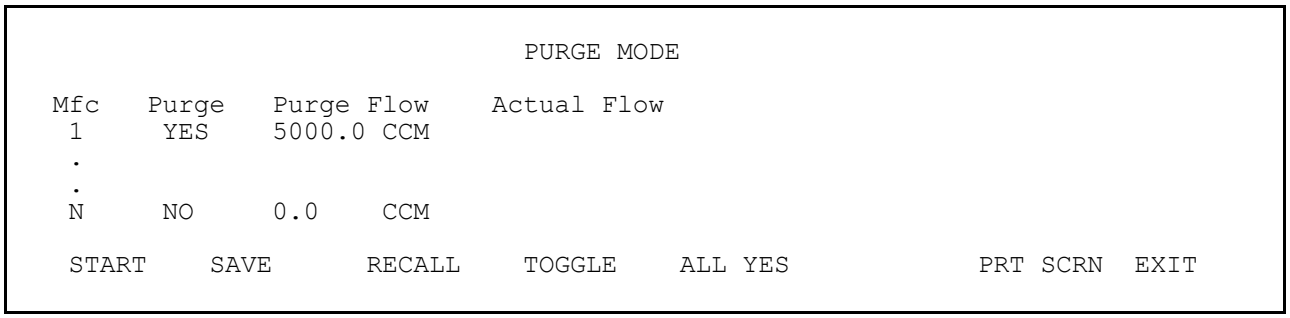
A procedure can be activated three ways: the ideal timer, status input, or by pressing the START soft key (See STATUS - INPUT, IDLE TIMER pg. 49; sec. 0, for information on the first two methods). If the START soft key is pressed, the system will request which item number it should start the loop with. This entry gives the user the option of beginning a procedure in the middle rather than at item one. If the procedure was activated by one of the first two methods, the system will always start with item one. In all cases, when a procedure has completed item 40, it will loop back to item one.

While a procedure is active but not running a function, the system will display the current date and time as well as what item is next in line to run. When a procedure runs a function, the screen will display the appropriate operation being performed. (See FUNCTION - OPERATION, pg 30)

There are two possible errors that can appear when the START soft key is pressed. The first error is when two items overlap each other, ie. a function starts on Monday at 10:00 and runs for 40 minutes then the next function must start after 10:40 on Monday. If an item will overlap another, that item will be marked with a pound sign (#) to the left of the item number. The second error is when an item has a function in which the function itself has an error. This error will be marked by a carrot (^) to the left of the item number. These errors can be corrected by going back into the function portion of the automatic sequencer and recalling the function with the error. Make the necessary corrections and re-save the function. (See FUNCTION - OPERATIONS, pg. 30, for more information on function errors)

5.9 PURGE MODE

The optional "PURGE MODE" allows the user to send a purge gas through the entire plumbing system, or only a small portion of it, to flush any gas residue out of the solenoids, tubing, mass flow controllers and blend chamber. Users should make use of the "PURGE MODE" frequently, as it will make the system cleaner, safer and will prolong instrument life. The "PURGE MODE" should be used to flush the system between the blending of gases which may be reactive, flush dust and other particles out of a system which has not been used for a period of time, or clean the system after the use of gases which will present possible risks if left in the system because of toxicity or corrositivity.



Purge Mode

5.9.1 FIELD DESCRIPTIONS

MFC

This is a display only field which indicates the MFC being commanded. All information on this line will be related to the indicated MFC.

PURGE

This field indicates whether an MFC is included in the purge. Use the TOGGLE soft key to change this field indicator.

PURGE FLOW

The purge flow field is where the amount of purge gas desired for each MFC is entered. **NOTE: Even if there is a flow greater than 0.0 entered there must be a YES in the purge field before the MFC is commanded**.

ACTUAL FLOW

This is a display only field which shows the feedback from the MFC's when a purge is in operation.

5.9.2 SOFT KEY DESCRIPTIONS

START

This soft key will start the purge described on the screen. Any MFC which has a YES for operation will begin flowing purge gas at the entered purge flow.

SAVE AND RECALL

The PURGE MODE has the ability to save and recall up to 100 different setups (See CONC MODE - SAVE AND RECALL pg. 12).

TOGGLE

The toggle soft key will toggle the "Purge Flow" setting for the selected MFC from 0 to the maximum flow attainable by the MFC.

5.9.3 OPERATION

A dry, inert gas, such as Nitrogen (N2), should be connected to the inlet compression fitting on the rear panel of the instrument labeled "PURGE PORT". Any regulated cylinder or other gas source will suffice. If air or nitrogen is being used as a balance gas, the user may elect to use it also as a purge gas. The most convenient way to provide air or nitrogen to the "PURGE PORT" is to put a "T-fitting" in the balance gas line so that the balance gas cylinder can be simultaneously used as the source of purge gas. Only one port, either the balance gas port or the purge gas port, can be energized at any one time so there is no possibility for pressure instability on one of the channels.

The user can begin a PURGE by placing the cursor on the line of the MFC that is to be purged and pressing the "YES" soft key. "YES" should appear next to any and all mass flow controller numbers that are to be purged. The user has the

option to select "ALL YES" which will instruct the instrument to purge the entire system. After selecting YES for the MFC's to be purged, the purge flow should be entered for each MFC with a YES. Once the screen is as desired, the user should press the "START" soft key and the instrument will begin to purge the system as instructed.

5.10 COMPUTER REMOTE

The computer remote function of the system gives the user the ability to write a computer program to control all operations. The user will communicate with the system through one of the RS232 ports and the STX/ETX, ACK/NAK protocol. If the system has any problems with the commands being sent to it, an error code will be returned describing exactly what it did not understand, right down to the exact location in the command string.

Before any attempt is made to communicate with the system using the computer remote function, one of the systems RS232 ports must be configure to indicate control by a computer (See RS232 SETUP pg. 46).

Once one of the RS232 ports is configured for computer control, the system can be placed in remote mode in one of two ways, pressing the REMOTE MODE soft key, or by a status input line (See STATUS SETUP - INPUT pg. 49).

5.10.1 Protocol Codes

All communications to and from the system, in remote mode, will use the following protocol:

STX - Start Transmission (ASCII Code Decimal 02 - Ctrl B)

This indicates the start of a new instruction being sent to the system.

ACK - Acknowledge Transmission (ASCII Code Decimal 06)

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

NAK - Not Acknowledge Transmission (ASCII Code Decimal 21)

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

ETX - End of Transmission (ASCII Code Decimal 03 - Ctrl C)

This indicates the end of either an end of a command being sent to the system or the end of a communications from the system.

5.10.2 Unit Of Measure

All flows used in the system are measured in sccm and all concentrations are measured in ppm.

5.10.3 Communications To The System

5.10.3.1 Format Of The instruction

All communications to the system will be in 8 bit ASCII format with one stop bit and no parity. All instructions sent to the system will begin with an STX and end with an ETX. All items in an instruction must be separated by one or more spaces or commas. No space or comma is needed before or after "=", "?", STX, or ETX. All text can be in either upper or lower case. An example would be:

STX FUNC 1 = 20 1 3 ETX
STX FUNC,1=20,1,3 ETX
STX FLOW 1 TARGET? ETX
STX flow,save,23 ETX

5.10.3.2 Format Of Numeric Data

If the command requires an integer, no preceding zero is required, even if the command could take more than one number. So "01" is the same as "1." If the command requires a floating point number to be sent, E notation is not required. If the data is less than one, the required format is to have a leading zero before the decimal point. An example would be "0.123" and NOT ".123."

5.10.4 Communications From The System

5.10.4.1 Format Of Returned Data

All data returned from the system will start with an ACK followed by a list of data separated by commas and ending with an ETX. If a single number is returned there will be no trailing comma. Integers **will not** contain preceding zeros and real numbers **will not** be in E notation. Some examples would be:

ACK 2,5000.0,3,2000.0 EXT
ACK 1,2,3,4,5,6 ETX
ACK 1,23,2,3000.0 EXT
ACK 2 ETX

5.10.4.2 No Data Expected

If a command is sent in which no data is expected, an **ACK** will be returned from the system to indicate that the command was accepted.

5.10.4.3 Returned Error

If the command received contains or causes an error, an error code will be returned from the system. This code will begin with an **NAK**, followed by a 3 digit code, and end with an **ETX**. Some examples would be:

NAK 000 ETX
NAK 035 ET

5.10.5 The Work Space Buffer

In the command list which follows, you will notice "work space" and "present" mentioned. When a command is received by the system which involves a change to some value, the value which is changed is the one in the work space and not the one in the system. When you instruct the system to perform an update or a save, the work space data is then transferred to the system. This is done to allow you to change many values and then update them all at the same time. The commands which use "present" are referring to what is actually stored in the system and NOT the work space. Any command which queries or looks at present data will not involve or change the work space.

5.10.6 Computer Remote Command List

5.10.6.1 FLOW MODE

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 the work space target flow of MFC X to a value of Y.

FLOW UPDATE

Transfer all work space flow settings, port assignments to MFC's and ozone. Start or update FLOW mode. If a flow is in progress, only the flow settings will be transferred and not the port assignments.

FLOW SAVE XX

Save all the work space 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, ...".

FLOW ALL TARGET ?

Read all the present target settings of the MFC's.

FLOW ALL ACTUAL ?

Read all the present actual flows of the MFC's.

5.10.6.2 CONC MODE

FLOW TOT ACTUAL ?

Read the present total actual flow of all MFC's.

FLOW TOT TARGET ?

Read the present total target flow set for the CONC mode.

FLOW TOT TARGET = Y

Set the work space total target flow to Y for the CONC mode.

CONC X ACTUAL ?

Read the present actual OGC for MFC X.

CONC X TARGET ?

Read the present target OGC for MFC X.

CONC X TARGET = Y

Set the work space target OGC for MFC X to a value of Y

CONC UPDATE

Transfer all work space OGC settings, port assignments, total flow to the MFC's and ozone. Start or update the CONC mode. NOTE: If a concentration is already in progress only the work space OGC settings and total flow will be transferred and not the port assignments.

CONC SAVE XX

Save all work space 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,...," 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 OGC's.

CONC A LL TARGET ?

Read all the present target OGC's.

5.10.6.3 MAINTAIN PORTS

PORT X TYPE ?

Read the present gas name assigned to port X.

PORT X K = Y

Assign the K factor Y to port X.

PORT X K ?

Read the present K factor assigned to port X.

PORT ALL K ?

Read all the present K factors assigned to the ports.

PORT X MFC = Y

Assign the work space port X to MFC Y.

PORT X MFC ?

Read the present port assigned to MFC X.

PORT X CONC = Y

Assign the cylinder gas concentration Y to port X.

PORT X CONC ?

Read the present cylinder gas concentration for port X.

PORT ALL CONC ?

Read all the present cylinder gas concentrations.

PORT ALL MFC ?

Read all the present port assignments for the MFC's.

5.10.6.4 OZONE

OZONE ACTUAL ?

Read the present actual ozone.

OZONE TARGET = Y

Assign the work space ozone command to Y.

OZONE TARGET ?

Read the present ozone command.

5.10.6.5 FLOW CALIBRATE MODE

CAL X SET Y ?

Read the present set calibration point Y for MFC X.

CAL X TRUE Y ?

Read the present true calibration point Y for MFC X.

CAL X ALL ?

Read all the present set and true calibration points for MFC X. The data will be returned as "set 0, true 0, set 1, true 1, ..., set 10, true 11".

5.10.6.6 PURGE MODE

PURGE X ON

Set the work space purge list for MFC X to on.

PURGE X OFF

Set the work space purge list for MFC X to off.

PURGE X TARGET = Y

Set the work space target purge flow of MFC X to a value of Y.

PURGE X ?

Read the present setting for MFC X in the purge list.

PURGE X TARGET ?

Read the current target purge flow for MFC X.

PURGE UPDATE

Transfer the work space purge list to the MFC's. Start or update the PURGE mode.

PURGE SAVE XX

Save the work space purge list to location XX.

PURGE QUERY XX

Read the purge list stored in location XX. The data will be returned as "MFC 1 on/off, MFC 2 on/off, ...". On will be a 1 and off will be a 0.

5.10.6.7 AUTOMATIC SEQUENCER MODE

FUNC X = TT M SS

Fill work space function item number X with the run time TT, mode M, and setup number SS. The run time will be 0 to 60 minutes. The mode will be 0 for CONC, 1 for FLOW, and 2 for PURGE. The setup number SS, 00 to 99, is the location of the CONC, FLOW, or PURGE setup which was previously stored.

FUNC CLEAR

Clear the all 40 items of the work space function to a run time of 00, mode of 0 (CONC), and a setup number of 00.

FUNC QUERY XX YY

Read the present stored function XX item YY. The data returned will follow the FUNC = X TT M SS command.

FUNC SAVE XX

Save the work space function to location XX.

PROC X = HH MM D FF

Fill work space procedure item number X with the start time hour HH, start time minutes MM, start time day, and function number FF. The start time hour will be 0 to 24. The start time minutes will be 0 to 59. The start time day will be 0 for Sunday, 1 for Monday, etc. The function number FF, 00 to 99, is the location of the function which was previously stored.

PROC CLEAR

Clear the all 40 items of the work space procedure to a start time hour of 00, start time minutes of 00, start time day of 0 (Sunday), and a function number of 00.

PROC QUERY XX YY

Read the present stored procedure XX item YY. The data returned will follow the PROC = X HH MM D FF command.

PROC SAVE XX

Save the work space procedure to location XX.

5.10.6.8 MISCELLANEOUS

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 port shut off.

SIZE X ?

Read the present size of MFC X.

NUMBER MFC ?

Read the present number of MFC's installed in the system.

VALID PORT X

Read the present list of valid ports which can be assigned to MFC X. The data returned will be the port numbers which 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.

5.10.7 Computer Remote Error

If there is a problem with a received command, the system will respond with an error in the form of "**NAK** 3 byte error code **ETX.**" If you get an error, record the 3 byte error code and look it up in the list of error codes. The error code list contains the error code, the place in the command which failed which is marked by "**", and an explanation of the error. When you see "...," this means that more text can follow the point where the error starts. If there is no error location marked in the command, this means that the command was received properly but the command itself caused an error.

5.10.7.1 Computer Remote Error Codes

000 **"*"**

Unknown command.

001 **"STX ... STX**

Received second STX without receiving the ETX.

002 **"...**

Buffer over run. More than 79 bytes were received without the ETX.

003 **"FLOW UPDATE"**

Trying to update a flow with a concentration or purge already in progress.

004 **"FLOW UPDATE"**

Duplicate ports while trying to update the flow mode. Two flow controllers can not have the same port assignment.

005 **"FLOW SAVE **"**

Flow save location out of range.

006 **"FLOW QUERY **"**

Flow query location out of range.

007 **"FLOW ALL **"**

Unknown flow all command.

008 **"FLOW TOT TARGET = **"**

Flow total target out of range.

009 **"FLOW TOT **"**

Unknown flow total command.

010 **"FLOW ** ..."**

Flow command flow controller number out of range.

011 **"FLOW X TARGET = **"**

Flow target value out of range.

012 **"FLOW **"**

Unknown flow command.

013 **"CONC UPDATE"**

Trying to update a concentration mode with a flow or purge already in progress.

014 **"CONC UPDATE"**

Trying to update a concentration mode with a flow error (out of range).

015 **"CONC UPDATE"**

Trying to update a concentration mode with a duplicate port. Two flow controllers can not have the same port assignment.

016 **"CONC SAVE"**

Trying to save a concentration setup with a flow error (out of range).

017 **"CONC SAVE"**

Trying to save a concentration setup with a duplicate port error. Two flow controllers can not have the same port assignment.

018 **"CONC BALANCE = **"**

Concentration balance flow controller number out of range.

019 **"CONC ALL **"**

Unknown concentration all command.

020 **"CONC ** ..."**

Concentration command flow controller number out of range.

021 **"CONC X TARGET = **"**

Concentration target value out of range.

022 **"CONC **"**

Unknown concentration command.

023 **"PURGE UPDATE"**

Trying to update a purge mode with a concentration or flow already in progress.

024 **"PURGE SAVE **"**

Purge save location out of range.

025 **"PURGE QUERY **"**

Purge query location out of range.

026 **"PURGE ** ..."**

Purge command flow controller number out of range.

027 **"PURGE **"**

Unknown purge command.

028 **"PORT ** ..."**

Port number out of range.

029 **"PORT X MFC = **"**

Port assignment flow controller number out of range.

030 **"PORT ** MFC = Y"**

Port assignment port number is not a valid port.

031 **"PORT **"**

Unknown port command.

032 **"CAL ** ..."**

Calibration flow controller number out of range.

033 **"CAL X ... **"**

Calibration point number out of range.

034 **"CAL X **"**

Unknown calibration command.

035 **"VALID PORT **"**

Valid port flow controller number out of range.

036 **"VALID **"**

Unknown valid command.

037 **"SIZE **"**

Size command flow controller number out of range.

038 **"TIME = **"**

Time received was incorrect.

039 **"TIME **"**

Unknown time command.

040 **"DATE = **"**

Date received was incorrect.

041 **"DATE **"**

Unknown date command.

042 **"FUNC ** = TT M SS"**

Function item number out of range (Assignment).

043 **"FUNC XX = ** M SS"**

Function run time out of range (Assignment).

044 **"FUNC XX = TT ** SS"**

Function mode out of range (Assignment).

045 **"FUNC XX = TT M **"**

Function setup number out of range (Assignment).

046 **"FUNC SAVE **"**

Function save location out of range.

047 **"FUNC QUERY ** YY"**

Function location number out of range (Query).

048 **"FUNC QUERY XX **"**

Function item number out of range (Query).

049 **"PROC SAVE **"**

Procedure save location number out of range.

050 **"PROC QUERY ** YY"**

Procedure location number out of range (Query).

051 **"PROC QUERY XX **"**

Procedure item number out of range (Query).

052 **"PROC ** = HH MM D FF"**

Procedure item number out of range (Assignment).

053 **"PROC XX = ** MM D FF"**

Procedure start time hour out of range (Assignment).

054 **"PROC XX = HH ** D FF"**

Procedure start time minute out of range (Assignment).

055 **"PROC XX = HH MM ** FF"**

Procedure start time day out of range (Assignment).

056 **"PROC XX = HH MM D **"**

Procedure function number out of range.

057 **"FUNC **"**

Unknown function command.

058 **"PROC **"**

Unknown procedure command.

059 **"PROC XX = ** ** D FF"**

Procedure start time is greater than 24:00 hours.

060 **"PURGE ALL **"**

Unknown purge all command.

061 **"CONC SAVE **"**

Concentration save location is out of range.

062 **"CONC QUERY **"**

Concentration query location is out of range.

063 - 067

Reserved

068 **"OZONE **"**

Ozone command is unknown

069 **"FLOW UPDATE"**

Ozone command is over the maximum with the total flow commanded.

070 **"CONC UPDATE"**

Ozone command is over the maximum with the total flow commanded.

071 **"PURGE XX TARGET = **"**

Purge flow is over the maximum.

072 **"PORT X CONC = **"**

Cylinder gas concentration is out of range.

073 **"PORT X K = **"**

K-factor is out of range.

5.11 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, select the "YES" soft key, else select the "NO" soft key.

5.12 NEW PASSWORD

```
                          PASSWORD EDITOR

                Entering CONCENTRATION MODE =NONE
                Entering FLOW MODE          =NONE
                Entering PORT MAINTENANCE   =NONE
                Entering CALIBRATION MODE   =NONE
                Entering SEQUENCER MODE     =NONE
                Entering PURGE MODE         =NONE
                Entering REMOTE MODE        =NONE
                Leaving  REMOTE MODE        =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 instrument 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.

WARNING

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.

5.13 RS232 SETUP

```
            SERIAL COMMUNICATIONS SETTINGS
                                -COM1-  -COM2-
              On / Off           OFF     OFF
              Baud Rate          300     1200
              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

RS232 setup is where you configure the two RS232 ports in the system to match your application. There are 4 items which need to be selected in order to assure proper operation of these ports.

5.13.1 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 by the user and are not used by the system.

5.13.2 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

rating (ie. V.22, bell 212A, V.32).

If the modem connected to the system has error correction capabilities (Usually this capability is available in modems with a CCITT rating above V.32) they might have to be disabled if the error codes are sent to the system (NOTE: Some modems will have the command "AT&Q0" to disable error correction).

SAVING THE SETUP

Once a modem is configured with the baud rate and other options the configuration should be saved in case of power loss. Most of today's modems have memory in which to save their configurations. Please check the modem manual to find out how to perform a save. If the modem has dip switches, set the switches to the options described above.

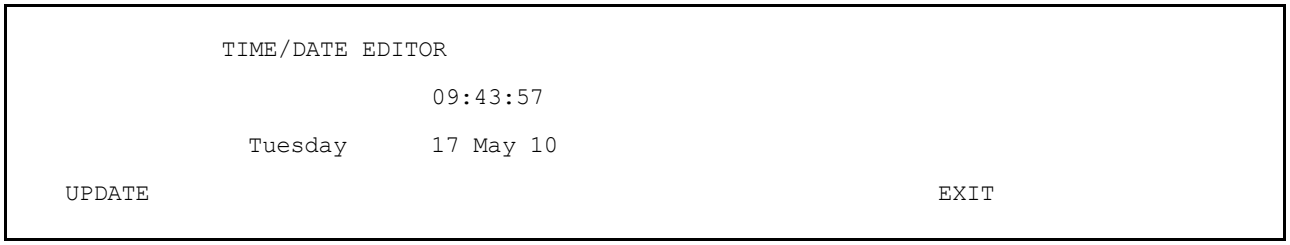
Once the modem connected to the system is properly configured, communications can take place. Approximately 5 seconds after the two modems have connected, the user should press the carriage return to repaint the screen.

5.13.3 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:

'H' - Is equal to the help key and will bring up the help screen.
Carriage Return - Will repaint the screen.
Space bar - Will display the soft key F numbers for 4 seconds.

5.14 TIME / DATE



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.

5.14.1 TIME

The time is in the 24 hour format, meaning that 24:00:00 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 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.

5.14.2 DATE

The date is in the European format, with the day of the month first followed by the month and year (DDMMYY). 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 of 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. The values for the year cell are the year only (ie. 2010 is entered as 10). Each time you change any of the date cells, the system will compute the proper day of the week.

5.15 STATUS SETUP

5.15.1 INPUT

```
                    STATUS INPUT ASSIGNMENT EDITOR

                                    Type     Setup#

                     Status in #1 =  STOP
                        .
                        .
                     Status in #8 =FUNCTION    01
                     Idle timer   =PROCEDURE   01

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

STOP   IGNORE   PROCEDURE   FUNCTION   REMOTE          PRT SCRN   EXIT
```

Status Input Editor

The instrument has 8 status input lines available on the rear panel. These inputs have the ability to control the operation of the system depending on how the user programs them. The system also has an idle timer feature which can cause a programmed operation to start after a programmed time expires with no keys being pressed. To program these functions, press the STATUS SETUP - INPUT soft key found on the second page of the main menu.

5.15.1.1 INPUT LINES

To program the 8 status inputs move to the desired input number and press the soft key for the desired operation. The system will request the 2 digit register number of where the operation is stored. When the system detects a status input line being closed, the assigned operation will start. **NOTE: The system MUST be in the READY mode before an operation can start. Also, the operation must have been previously stored before the operation can be performed.** Going to the READY mode can easily be done by assigning one of the status lines to STOP and signal this status input first before signaling the desired operation status input.

5.15.1.2 IDLE TIMER

The "Idle Timer" operation is entered the same as the input lines. An additional number is needed which is the amount of time the system can remain idle without a key being pressed. This entry is in hours, 01 - 24, and an entry of "00" will turn off the idle timer function. If the idle timer is running, a countdown will be displayed in the top left corner along with the operation that will be performed when the idle time reaches 00. Every time a key is pressed, while the timer is running, the idle timer will be reset to the entered time.

When the idle timer reaches its set time the system will automatically go to the READY mode and then start the selected operation.

5.15.2 OUTPUT

```
                    STATUS OUTPUT ASSIGNMENT EDITOR

Conditions/ 1   2   3   4   5   6   7   8   9   10   11   12   13   14
Status
  1  Just  M1  P1
  .
  .
  8  Any   M2  OZ

     Use the +/- key to change the application of the status output line.

 (P)ORT   (M)FC   (OZ)ONE    NONE   CLR LINE   PRT SCRN   -MORE-   EXIT
(C)ONC   (F)LOW   P(U)RGE                      PRT SCRN   -MORE-   EXIT
```

Status Output Editor

The instrument has eight assignable status output lines available for contact closure or switching of 24 volts on the rear panel. To switch between contact closure and 24 volts control, the user must remove the cover to the system and move the position of the switches, between A and B, at the top of the status board on the back panel.

To control the operation of the status outputs, press the STATUS SETUP - OUTPUT soft key found on the second page of the main menu. This will bring up the STATUS OUTPUT ASSIGNMENT EDITOR, which is where condition lists and applications are assigned to the status output lines.
Any time a status line is active, a list will be displayed in the lower left portion of the display.

CONDITIONS

Each of the status lines has a list of up to 14 conditions, along with an application, that must be met before the status line is activated. To add a condition to a list, press the appropriate soft key. The different conditions are ports "(P)ORT", flow controllers "(M)FC", and ozone "(OZ)ONE", which are on the first level of soft keys, along with a stored concentration setup "(C)ONC", flow setup "(F)LOW", and purge setup "P(U)RGE" located on the second level of soft keys. All conditions, except ozone, require the user to enter a number. If the condition is a flow controller the "(M)FC" soft key would be pressed followed by the flow controller number.

APPLICATIONS

There are three types of applications available to a status line, "Just", "Any", and "Or." To toggle between application types, press the "+/-" key. A description of each of these conditions follows.

JUST

The "Just" application should be assigned if a status line is to be active only when exactly the conditions in a condition list are met, no more, no less.

For example, if the condition list for status line 1 had "M1" and "P1" and the application was "Just", then status line 1 would be active only when MFC 1 and port 1 were running. If ozone or MFC 2 were also on, then the "Just" application would not be met and the status line would not be active.

Care must be taken to list the exact combination of conditions when using the "Just" application. If MFC 1 is desired as a condition then port 1 must also be added to the list since port 1 will always go on when MFC 1 goes on. Knowing this, one could differentiate between MFC 2 with port 2 and MFC 2 with port 3.

ANY

If the status line is to be active when **all** the conditions in a list have been met, the "Any" application should be applied. This application differs from the "Just" by considering conditions found in the condition list. Other conditions may be active as well but are ignored.

If a status line is set to "Any", with a condition list containing "M1" **and** "P1", then the status line would be active when MFC 1 and port 1 were running, along with any other conditions. If ozone or MFC 2 were on as well, the "Any" application would still be met and the status line would be active.

The MFC/port combinations are not as critical with the "Any" application. If it is desired that a status line be active any time MFC 1 **and** MFC 2 are running then a list of "M1" and "M2" with an application of "Any" would be all that is required.

OR

If the status line is to be active when **any one or more** of the conditions in a list have been met, the "Or" application should be applied. Other conditions may be active as well but are ignored.

If a status line is set to "Or", with a condition list containing "M1" and "M2", then the status line would be active when MFC 1 **or** MFC 2 were running, along with any other conditions. The "Or" application requires that one or more conditions are met. The status line will become active when at least one of the conditions has been met.

EDITING KEYS

There are two soft keys for editing a status list, "NONE" and "CLR LINE". The "CLR LINE" soft key will remove all conditions for a list which will in turn de-activate a status line. The "NONE" soft key will remove any single condition in a list. Move the cursor over the condition to be removed and press the "NONE" soft key.

5.16 VOLTS MODE

```
                              VOLTS MODE

Mfc   Port  Target Volts   Actual Volts
 1      1      0.25           0.25
 2      2      1.75           1.75

_____________________________________________________________________________

Ozone          1.05

Ozone block flow              500.0
Ozone block temperature       50.0
Ozone lamp drive voltage      12.56

 START                                                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 volts go directly to the flow controllers and ozone DAC's and doesn't use the calibration data entered by the user.

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 the ozone does not have an ACTUAL display is that there is no response for the actual ozone. The ozone lamp drive voltage is available on the screen to determine what the ozone lamp was commanded to.

5.17 IDLE TIMER

The "Idle Timer" operation is entered the same as the input lines. An additional number is needed which is the amount of time the system can remain idle without a key being pressed. This entry is in hours, 01 - 24, and an entry of "00" will turn off the idle timer function. If the idle timer is running a countdown will be displayed in the top left corner along with the operation that will be performed when the idle time reaches 00. Every time a key is pressed, while the timer is running, the idle timer will be reset to the entered time.

When the idle timer reaches its set time, the system will automatically go to the READY mode and start the selected operation.

6 SYSTEM SAFETY FEATURES

The system has a safety check built in to prevent permanent damage to the system components. This check is automatic and is monitored by the system at all times.

6.1 FLOW

If at any time, while a flow is in operation, the actual flow for either MFC is less than 50% of its commanded value the system will shut down all DAC's and place a low flow warning message at the top of the display. To reset this error condition, the user should check all port connections and press the UPDATE soft key to return the system back to its previous settings.

APPENDIX

A 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.

B DESCRIPTION OF PRINTED CIRCUIT BOARDS

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 follows.

B.1 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.

B.2 ANALOG BOARD (PC202)

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

B.3 ROM BOARD (PC203)

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

B.4 COMM/DRIVER BOARD (PC204)

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

B.5 MOTHERBOARD (PC208)

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

B.6 OZONE BOARD (PC210)

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

B.7 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.

B.8 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.

C DESCRIPTION OF THE DISPLAY

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

D 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 the power entry module is set to the proper line voltage (Appendix D, pg 54).

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 120 VAC and 240 VAC.

E PLUMBING

The plumbing consists of gas inlet connections, inlet solenoids, mass flow controllers, a serpentine pre-mix module, 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.

F 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 (eg. 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.

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 which 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.

G SYSTEM GAS LIBRARY

ACETYLENE	C2H2
AIR	
ALLENE	C3H4
AMMONIA	NH3
ARGON	Ar
ARSINE	AsH3
BORON TRIBROMIDE	BBr3
BORON TRICHLORIDE	BCL3
BORON TRIFLUORIDE	BF3
BROMINE	Br2
BROMINE PENTAFLUORIDE	BrF5
BROMINE TRIFLUORIDE	BrF3
BROMOTRIFLUOROMETHANE	CBrF3
BUTADIENE	C4H6
BUTANE	C4H10
1 - BUTENE	C4H8
CARBON DIOXIDE	CO2
CARBON MONOXIDE	CO
CARBON TETRACHLORIDE	CCl4
CARBON TETRAFLUORIDE	CF4
CARBONYL SULFIDE	COS
CHLORINE	Cl2
CHLORINE TRIFLUORIDE	ClF3
CHLORODIFLUOROMETHANE	CHClF2
CHLOROFORM	CHCl3
CHLOROPENTAFLUOROETHANE	C2ClF5
CHLOROTRIFLUOROMETHANE	CClF3
CYANOGEN	C2N2

CYANOGEN CHLORIDE	ClCN
CYCLOPROPANE	C3H5
DEUTERIUM	D2
DIBORANE	B2H6
DIBROMODIFLOUROMETHANE	CBr2F2
DIBROMETHANE	CH2Br2
DICHLORODIFLOUROMETHANE	CCl2F2
DICHLOROFLOUROMETHANE	CHCl2F
DICHLOROMETHYLSILANE	(CH3)2SiCl2
DICHLOROSILANE	SiH2Cl2
DICHLOROTETRAFLOUROETHANE	C2Cl2F4
DIFLUOROETHYLENE	C2H2F2
DIMETHYLAMINE	(CH3)2NH
DIMETHYL ETHER	(CH3)2O
DIMETHYLPROPANE	C3H12
DISILANE	Si2H6
ETHANE	C2H6
ETHANOL	C2H6O
ETHYL ACETYLENE	C4H6
ETHYL CHLORIDE	C2H5Cl
ETHYLENE	C2H4
ETHYLENE OXIDE	C2H4O
FLUORINE	F2
FLUORFORM	CHF3
FREON-11	CCl3F
FREON-12	CCl2F2
FREON-13	CClF3
FREON-13 B1	CBrF3
FREON-14	CF4
FREON-21	CHCl2F
FREON-22	CHClF2
FREON-113	CCl2FCClF2
FREON-114	C2Cl2F4
FREON-115	C2ClF5
FREON-C318	C4F6
GERMANE	GeH4
GERMANIUM TETRACHLORIDE	GeCl4
HELIUM	He
HEXAFLUOROETHANE	C2F6
HEXANE	C6H14
HYDROGEN	H2
HYDROGEN BROMIDE	HBr
HYDROGEN CHLORIDE	HCl
HYDROGEN CYANIDE	HCN
HYDROGEN FLUORIDE	HF
HYDROGEN IODINE	HI
HYDROGEN SELENIDE	H2Se
HYDROGEN SULFIDE	H2S
IODINE PENTAFLUORIDE	IF5
ISOBUTANE	CH(CH3)3
ISOBUTYLENE	C4H6
KRYPTON	Kr
METHANE	CH4
METHANOL	CH3OH
METHYL ACETYLENE	C3H4
METHYL BROMIDE	CH2Br
METHYL CHLORIDE	CH3Cl
METHYL FLUORIDE	CH3F
METHYL MERCAPTAN	CH3SH
METHYL TRICHLOROSILANE	(CH3)SiCl3
MOLYBDENUM HEXAFLUORIDE	MoF6
MONOETHYLAMINE	C2H5NH2
MONOMETNYLAMINE	CH3NH2

NEON	Ne
NITRIC OXIDE	NO
NITROGEN	N2
NITROGEN DIOXIDE	NO2
NITROGEN TRIFLUORIDE	NF3
NITROSYL CHLORIDE	NOCl
NITROUS OXIDE	N2O
OCTAFLUOROCYCLOBUTANE	C4Fe
OXYGEN	O2
OXYGEN DIFLUORIDE	OF2
PENTABORANE	B5H9
PENTANE	C5H12
PERCHLORYL FLUORIDE	CLO3F
PERFLUOROPROPANE	C3F8
PHOSGENE	COCL2
PHOSPHINE	PH3
PHOSPHOROUS OXYCHLORIDE	POCL3
PHOSPHOROUS PENTAFLUORIDE	PH5
PHOSPHOROUS TRICHLORIDE	PCl3
PROPANE	C3H8
PROPYLENE	C3H6
SILANE	SiH4
SILICON TETRACHLORIDE	SiCL4
SILICON TETRAFLUORIDE	SiF4
SULFUR DIOXIDE	SO2
SULFUR TETRAFLUORIDE	SF4
SULFUR HEXAFLUORIDE	SF6
SULFURYL FLUORIDE	SO2F2
TETRAFLUORAHYDRAZINE	N2F4
TRICHLOROFLUOROMETHANE	CCl3F
TRICHLOROSILANE	SiHCl3
TRICHLOROTRIFLUOROETHANE	CCl2FCClF2
TRISOBUTYL ALUMINUM	(C4H9)3AL
TITANIUM TETRACHLORIDE	TiCL4
TRICHLORO ETHYLENE	C2HCl3
TRICHLORETHANE	C2H3Cl3
TRIMETHYLAMINE	(CH3)3N
TUNGSTEN HEXAFLUORIDE	WF6
URANIUM HEXAFLUORIDE	UF6
WATER VAPOR	H20
VINYL BROMIDE	CH2CHBr
VINYL CHLORIDE	CH2CHCl
XENON	Xe

H SPECIFICATIONS

H.1 FLOW

Size Ranges of MFC:

0 - 10 sccm to 0 - 30 slpm; up to 1500 slpm (optional)

Performance

	Performance* as a Percent of Set point From 10 to 100 %	
	Full Scale Flow	of Full Scale Flow
Concentration:	± 0.5 %	± 0.75 %
Flow:	± 0.5 %	± 0.75 %
Repeatability:	± 0.2 %	± 0.5 %
Linearity:	± 0.2 %	± 0.5 %

* Note: Mass Flow Controllers (MFC's) are calibrated to Standard Temperature (0°C) and Pressure (760 mm Hg) using a primary flow standard traceable to the National Institute of Standards and Technology (NIST).

H.2 MECHANICAL

Inlets:

Balance: One external ¼" Swagelok™*
Analyte: One external ¼" Swagelok™* per Port

Outlet:

One external ¼" Swagelok™*
* (Or compatible fitting)

Operating Pressures:

Minimum: 30 psig at port 1 and 10 psig at all other inlets.
Recommended: 35 psig.
Maximum: 150 psig at all inlets.

Wetted Surfaces:

Tubing: 316SS Electro-polished Stainless Steel,(Optional -Teflon™)
MFC's: Stainless Steel, (Optional - Hastelloy, Monel).
Seals: Viton®; (Optional -Kalrez®, Buna-N®, Neoprene®).

Blending Chamber: Teflon™ coated Aluminum.

Mixing Chamber: Teflon™ coated Aluminum.

Operating temperatures:

0° to 50° C.

Weight:

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

Dimensions:

46.6 cm wide, 17.2 cm high, 61.3 cm deep;
(19" wide, 7" high, 25" deep).

H.3 ELECTRICAL

Standard Voltage: 120 VAC 50/60 Hz
Optional Voltage: 240 VAC 50/60 Hz

Current Required: 3 Amperes maximum

NOTE: Users may change the voltage of the instrument to 120 VAC or 240 VAC. To make the voltage change, remove the power cord and open the cover of the power entry module by inserting a small screwdriver in the notch located at the top and prying open the cover. Remove the "cam wheel" and rotate it such that the proper voltage shows through the opening. If you have any questions, please call Environics for assistance.

Improper line voltage can cause serious damage to the instrument. Users must make sure that line voltages are compatible with the operating voltage of the instrument. 120 VAC is standard, and 240 is optional. No other line voltages are acceptable.

H.4 OPERATING CONDITIONS

Performance Temperature Range: 15°- 35°C

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 35 psig. Another port may be regulated from the cylinder such that the inlet pressure at the instrument is 25 psig.)

H.5 PRESSURE

Users must maintain an operating pressure from the cylinders of no more than 100 psig. Pressures higher than 100 psig can cause the solenoids to leak gas into either the system or the air. **Operating the instrument at pressures greater than 100 psig voids the manufacturer's warranty.**

I SERVICE AND MAINTENANCE

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

MAINTENANCE 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 check list:

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

I.1 TROUBLESHOOTING

I.1.1 TEST POINTS

The test points are color coded loops of wire soldered to their board. A spring tension test hook should be used to connect to the test point of interest. Care should be taken so not to short the test hook to any adjacent components.

I.1.1.1 PC201 PROCESSOR BOARD

T1 - Digital ground > Top-middle of the board

I.1.1.2 PC202 ANALOG BOARD

TP0 - DAC channel 0 \
TP1 - DAC channel 1 \
TP2 - DAC channel 2 \ Bottom of board
TP3 - DAC channel 3 /
TP4 - DAC channel 4 /
TP5 - DAC channel 5 /
TP6 - -5 Volt reference > Left side of A/D chip (Top of board)
TP7 - Analog ground \
TP8 - Digital ground \
TP9 - Multiplexer output \
TP10 - +5 Volt reference > Along the top of the board
TP11 - +15 Volts /
TP12 - -15 Volts /
TP13 - Board enable /

I.1.1.3 PC203 ROM BOARD

TP1 - Digital ground \ Top of board
TP2 - Board enable /

I.1.1.4 PC204 SOLENOID/COMMUNICATIONS BOARD

TP1 - Board enable \
TP2 - +5 Volts \ Top of board
TP3 - Digital ground /
TP4 - +24 Volts /

I.1.1.5 PC208 MOTHER BOARD

TP1 - Digital ground \
TP2 - +5 Volts \
TP3 - +15 Volts \ Along right side
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 \ Top of board in front
TP16 - Response volts E / of modular connectors

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 /

I.1.1.6 PC210 OZONE BOARD (Optional)

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

I.1.1.7 PC216 STATUS BOARD (Optional)

TP1 - Contact 1 \
TP2 - Contact 2 \
TP3 - Contact 3 \
TP4 - Contact 4 \ Top of board
TP5 - Contact 5 / Contact open = logic level high
TP6 - Contact 6 / Contact closed = logic level low
TP7 - Contact 7 /
TP8 - Contact 8 /
TP9 - +5 Volts \
TP10 - Ground > Top right of board
TP11 - Board enable /

I.1.2 PROBLEMS AND SOLUTIONS

The Environics 2000 Series, 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.

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.

No display:	Adjust Contrast knob
	Check cable leads between display module and motherboard
	Check power hook up & line voltage
Slow display:	Check RS232 setup to see if there is a terminal defined for an RS232 port with a slow baud rate and that RS232 port is on.
Backlight failure:	Check pins & pin connectors on boards
	Check for loose boards
No power	Check power hookup and look for blown fuse
	Loose cables to motherboard
	Check line voltage
Loose boards	Check all wiring for loose connections
	Check all electronic boards
No Keypad Response	Check keypad cable for proper connection and misaligned pins
	Replace keypad if damaged
	Check for loose boards
	Check power hook up and voltage
Erratic Fan	Check for wiring problems with fan connection
Solenoid failure	Check solenoid connections on PC204
	Possible coil failure. Check and replace if necessary
Possible seal problem.	Check and replace if necessary
	Possible contamination (dirt). Check and clean.

	Check +24 volts.
No Flow	Check flow controller cable.
	Check response and command test points on the motherboard (PC208) and analog board (PC202).
	Check calibration tables.
	Use volts mode to command flow controller and then check command and response points test points.
	Check +15 and -15 volts.
	Check port connections.
	Check solenoids for proper operation.

I.2 OZONE LAMP REPLACEMENT (Optional Ozone Generator)

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 3 holes in the collar with the holes in the oven. Do not touch the set screw in the collar. Replace the 3 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 volt meter 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, the user 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 warmup, 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 also the cover of the system.

J PRINTED CIRCUIT BOARD SCHEMATICS

All Printed Circuit Board Schematics are included with new systems on a CD along with this manual. They are provided in PDF file format in a folder labeled "Gen2 schematics." The below chart will guide you as to which file/s corresponds to each circuit board. In some cases, multiple files are required to provide high resolution for each board. In these cases, the files are labeled sequentially.

CIRCUIT BOARD	File/s (PDF)
PC201 PROCESSOR BOARD	PC201-1, PC201-2, PC201-3
PC202 ANALOG BOARD	PC202-1, PC202-2, PC202-3
PC203 ROM BOARD	PC203
PC204 SOLENOID/COMMUNICATIONS BOARD	PC204-1, PC204-2, PC204-3
PC208 MOTHER BOARD	PC208
PC210 OZONE BOARD (Optional)	PC210
PC216 STATUS BOARD (Optional)	PC216

K PARTS LIST

	Description	Qty.	Part No.
1.	S-2000 Computerized Ambient Calibrator	1	S-2000
1.0	Flow Controllers (all 1/4" fittings)	2	---
	Mass flow controller	1	MA01-005-020000
	Mass flow controller	1	MA01-006-00100
	Screw, (8/32 x 3/8)	4	HA0101-0832C06
1.1	Front panel subassy	1	A004
	Membrane switch (S-2000)	1	
	LCD display, subassy	1	A013
	LCD display	1	DJ02-001
	Connector	1	HJ10-008
	Pins	2FS	AJ06-003
	Screws (#4-40 x .375)	4FS	HA0101-0440C06
	Power switch	1	SJ02-001-125
	Receptacle, female, .250	3FS	AJ02-002-D320
	Contrast Pot, subassembly	E010	
	Potentiometer	1	PK04-103
	Connector	1	HJ10-004
	Terminals	1	AJ06-003
	Wire		
	Knob	1	KJ01-001
	Tape	FS	DB002
1.2	Bottom chassis subassy	1	---
	Bottom panel subassy	1	---
	Bottom panel	1	M005
	Standoffs	7FS	HA0405-A0632B10
	Stud (8/32 x 3/8)	10FS	HA0401-A0832B12
	MFC Spacer plate, Tylan	1	M010
	Bracket Support 3/4	1	M016
	Bracket Support 2.0	2	M015
	Kep nut, 8/32	2FS	HA0713-C0832
	Screw (6/32 3/8)	4FS	HA0101-A0632B06
	Kep nut, 6/32	4FS	HA0713-C0632
	Power supply, 60 watt, subassy	1	A009
	Power supply, 5 volt, 60 watt	1	PJ01-001
	Harness, P/S, 5 volt, input	1	E004
	Kep nut, 8/32	4FS	HA0713-C0832
	Harness, P/S, 5 volt, output, 60W	1	E003
	Power supply, 24 volt, subassy	1	A007
	Power supply, 24 volt, 60 watt	1	PJ01-003
	Harness, P/S, 24 volt, input	1	E005
	Harness, P/S, 24 volt, output	0	E014
	Kep nut, 8/32	4FS	HA0713-C0832
1.3	Rear panel subassy	1	A014
	Rear panel, Tylan	1	M064
	Standoffs	6FS	HA0405-A0440B09
	Standoffs	5FS	BS05-632-8
	Standoffs	6FS	BS05-440-14
	Rear panel, Tylan	1	M064
	Standoffs	6FS	HA0405-A0440B09
	Power entry harness	1	E002

	Description	Qty.	Part No.
	Fuse, 2 amp	FS	FJ02-002-0022
	Fan subassy	1	A012
	Fan	1	BA01-003
	Connector	1	HJ10-008
	Pins	2FS	AJ06-003
	Fan guard	2	GA101
	Filter	FS	---
	Washer, flat (7/16 ID, 7/8 OD)	4FS	HA0601-E300258
	Screws (6/32 x 1.5")	4FS	HJ0101-0632B32
	Nuts (6/32)	4FS	HJ0713-C0632
1.4a	Input Solenoid Subassembly (no purge)	0	A006-1
	Solenoid, 2 way	4	SA01-003
	Fitting, male bulkhead 1/4"	1	FA104-01-SO402
	Fitting, male bulkhead 1/8"	2	FA104-01-S0202
	Fitting, male connector 1/4"	1	FA101-01-S0402
	Fitting, male connector 1/8"	1	FA102-01-S0202
	Fitting, male run tee 1/8"	1	FA116-01-S0202
	Connector	3	HJ10-018
	Pins	FS	AJ06-003
	Teflon tape	FS	
1.4b	Output Solenoid Subassy	1	A006-1
	Solenoid, 2-way	1	SA01-003
	Fitting, male bulkhead	1	FA104-01-S0402
	Fitting, male connector	1	FA101-01-S0402
	Connector	1	HJ10-018
	Pins	2FS	AJ06-003
	Teflon tape	FS	---
1.5	Mixing Chamber Subassy		
	Mixing chamber	2	100E65
	Mixing chamber plug	2	100E66
	Mixing chamber baffle	2	100E67
	#8 washer	8FS	#8
	8-32 screws	4FS	---
	O ring	2	---
	Mixing chamber bracket-top	1	M076
	Mixing chamber bracket-bottom	1	M073
	Fitting - Male elbow	2	FA102-01-S0402
	Fitting - Male run tee	2	FA116-01-S0402
	Hose clamp 2 3/4" (cut excess)	4	HA9100-001
	1/4 * 20* 1/4" socket screw	2FS	
	Pem 1/4 * 20	2FS	
	Top/lamp holder	1	M083
	Lamp(pull after)	1	LJ01-002
	Connector	1	HJ08-001-K03
	Pins	2FS	
	O ring, lamp	1FS	KA01-BA2110-01
	Bulkhead connector	1	FA112-01-S04
	Reducing fitting	1	FA119-01-M04
1.6	Ozone		
	Ozone Generator	1	A025
	Block	1	M081
	Top/Lamp holder	1	M083

Description	Qty.	Part No.
Base	1	M082
Detector holder/seal	1	M084
Detector cap	1	M085
Bulkhead connector	1	M086
Thermistor, subassy	1	A028
O ring, lamp	1	KA01-BA2110-01
Window	1	AA01-001
O ring, window	1	KA01-BA2014-01
5-hole disk	1	100-E58
Ozone cover	1	M060
Ozone support bracket	1	M058
PC Board	1	PC210-D
Pressure sensor	1	SA09-001
Detector sensor	1	SK05-001
O ring, detector	1	KA01-BA2112-01
Lamp - subassy	1	A029
Mass Flow Meter	1	MA10-001
Resistor, subassy	1	A027
Tubing	1	M088
Back Pressure Regulator, subassy		
Back Pressure Regulator	1	VA004
Bracket	1	M075
Fitting - Male elbow	2	FA102-03-S0402
Pressure Regulator, subassy		
Regulator	1	VA003
Bracket	1	M074
Fitting - Male elbow	2	FA102-01-S0402
Metering valve	1	FA119-01-S04
Metering valve - tube	1	M089
1.7 Plumbing		
All Teflon		
1.8 Enclosure, 7.5", subassy	1	
Enclosure	1	EA01-002
Bottom panel	1	EA99-001
Top vented panel	1	EA99-002
Side panel	2	EA99-003
Side L rail	4	EA99-004
Front Rack handle	2	EA99-005
Rear corner trim	2	EA99-006
Top horizontal trim	2	EA99-009
Slide mount spacer	4	EA99-011
Slides	2	EA10-B308-118
1.9 Electronics, subassy	1	
Motherboard, subassy	1	PC208-1D
Card guide subassy	10	A003
Card guide post	6	GK001
Snap-in card guide	6	GK002
Transputer board, subassy	1	PC201-1D
Batteries	2	BK05-002
Analog board, subassy	1	PC202-1D
ROM board, subassy	1	PC203-1D
Comm/Driver board, subassy	1	PC204-1D
Status I/O board	1	PC216-D

Description	Qty.	Part No.
Ozone Generator board, subassy	1	PC210-D
1.10 Harnesses	1	
Line cord (120 VAC)	1	VJ10-003-H5167
Harness, RS-232	2	E015
Harness, Printer	1	E015
Harness, data bus	1	E009
Harness, 24 volt, motherboard	1	E013
Harness, LCD data	1	E007
Flow Controller Cable - S2000	A/R	E008

L PC BOARD PARTS LIST

Subassy P/N: **PC201**
Description: **Transputer Board, GEN2**
Revision: **C**

Item	Ref.	Qty.	Part number	Description	Value
1	BAT1,BAT2	2	BK05-002	Battery,	3v, 1200 mAh
2	BH1, BH2	2	CJ001	Battery holder	
3	C1,31	2	CK20-105A	Cap, Ceramic,	1.0 uF
4	C2,3,6-9, 11-22,24-30, 32-43,45-51	44	CK20-104A	Cap, Ceramic,	0.1 uF
5	C4,5	2	CK20-150A	Cap, Ceramic,	15 pF
6	C10,23	2	CK11-101A	Cap, Tantalum,	100 uF
7	C44	0	CK20-103A	Cap, Ceramic,	.01 uF
8	D1-5	5	DK02-5817	Diode, Schottky,	1N5817
9	DL1	1	DK07-003	Red LED, PC mount	
10	OSC1	1	XK02-505	Oscillator,	5 MHz
11	OSC2	1	XK02-226	Oscillator,	22.1184 MHz
12	PC201	1	PC201	PC Board	
13	Q1	1	QK01-3905 2N3905		
14	Q2	1	QK02-2369		2N2369A
15	R1,3,16,17, 23,25,26, 27,28	9	RK2-0031GH103	Resistor,	10.0 K
16	R2	1	RK2-0031GF202	Resistor,	2.00 K
17	R4	1	RK2-4753	Resistor,	475 K
18	R5	1	RK3-226	Resistor,	22 Meg Ù
19	R7,13	2	RK2-1301	Resistor,	1.30 K
20	R8	1	RK2-0031GF102	Resistor,	1 K
21	R9,10	2	RK2-3920	Resistor,	392 Ù
22	R11,12,24	3	RK2-4751	Resistor,	4.75 K
23	R14,15	2	RK2-0560	Resistor,	56.0 Ù
24	R18,20,21,22	4	RK2-3320	Resistor,	332 Ù
25	RN1,RN2	0	RK8-472	Res. Network, 10 pin,	4.7 K
26	SOC1	3	HJ07-001-R14	Socket, 14 pin DIP, .300	U13,14,27
27	SOC2	1	HJ07-001-R16	Socket, 16 pin DIP, .300	U3
28	SOC3	18	HJ07-001-R20	Socket, 20 pin DIP, .300	
29	SOC4	7	HJ07-001-R24	Socket, 24 pin DIP, .300	
30	SOC5	2	HJ07-001-R28	Socket, 28 pin DIP, .300	U33-U34
31	SOC6	1	HJ07-001-T24	Socket, 24 pin DIP, .600	U2
32	SOC7	4	HJ07-001-T28	Socket, 28 pin DIP, .600	U5-U6,U11-U12

Item	Ref.	Qty.	Part number	Description	Value
33	SOC9	2	HJ07-Z84	Socket, 84 pin PLCC	U1,U35
34	SOC10	2	HJ07-A10	Socket, 10 pin SIP (for RN1 & RN2)	
35	T1	1	AJ99-001	Test point, black	
36	U1	1	UK17-002	Transputer	T425
37	U2	1	UK25-003	Real Time Clock	6818
38	U3	1	UK30-001	Battery Backup Supervisor	MAX691
39	U4	1	UK29-003-005	PLD	22V10
40	U5,6,11,12	4	UK19-004	32K x 8 SRAM (.600)	xx256
41	U7	1	UK29-003-004	PLD	22V10
42	U8	1	UK29-003-002	PLD	22V10
43	U9	1	UK29-003-003	PLD	22V10
44	U10	1	UK02-002	Octal 3-State Inverter	74LS240
45	U13	1	UK04-006	NAND gate, open collector	7403
46	U14	1	UK06-004	NOR gate	74LS02
47	U15,16,30 31,32	5	UK09-004	Octal 3-State Flip/Flop	74LS374
48	U17,19,20 21,22,23, 24,26	8	UK07-002	Octal 3-State Transceiver	74LS245
49	U18	1	UK29-003-001	PLD	22V10
50	U25,29	2	UK01-008	Octal 3-State Buffer	74LS244
51	U27	1	UK25-004	Dual Timer	556
52	U28	1	UK29-003-006	PLD	22V10
53	U33,34	2	UK19-006	8K x 8 SRAM,(.300), 55 nsec	
54	U35	1	UK27-002	LCD Controller	V6366
55	U36	1	UK18-007	2K x 8 PROM	27C291
56	U37,38	2	UK01-009	Octal 3-State Buffer	74HC244
57	Y1	1	XK01-323	Crystal,	32.768 KHz

Subassy P/N: **PC202**
Description: **Analog Control Board, GEN2**
Revision: **C**

Item	Ref.	Qty.	Part number	Description	Value
1	C1-12,14, 19-25,30-39, 50-53,65,66	36	CK20-104B	Cap., Ceramic,	0.1 uF
2	C13,15,40, 42,44,46,54, 56,58-63	14	CK20-103B	Cap., Ceramic,	0.01 uF
3	C16,41,43, 45,47,55,57	7	CK11-100A	Cap., Tant.,	10 uF
3B	C17,18	2	CK11-100B	Cap., Tant.,	10 uF
4	C26-29,48,49	6	CK20-330A	Cap., Ceramic	33 pF
5	C64	1	CK11-101A	Cap., Tant.,	100 uF
6	D1	1	DK01-914	Diode,	1N914
7	P2,3	0	Analog In		
8	PC202	1	PC202 Rev. A	PC Board	
9	R2,6	2	RK2-2743	Resistor, M.F.,	274 K
10	R3	1	RK2-2212	Resistor, M.F.,	22.1 K
11	R4,7	2	RK2-1783	Resistor, M.F.,	178 K
12	R5	1	RK2-6811	Resistor, M.F.,	6.81 K
13	R9,14-16, 19,20	6	RK2-3010	Resistor, M.F.,	301 Ù

Item	Ref.	Qty.	Part number	Description	Value
14	R10-13,17,18	6	RK2-5114	Resistor, M.F.,	5.11 Meg
15	R21,22	2	RK2-1501	Resistor, M.F.,	1.5 K
16	R23	1	RK1-010	Resistor, M.F.,	1 Ù
17	SOC1	8	HJ07-001-R08	Socket, 8 pin DIP, .300	
18	SOC2	4	HJ07-001-R14	Socket, 14 pin DIP, .300	
19	SOC3	4	HJ07-001-R16	Socket, 16 pin DIP, .300	
20	SOC4	14	HJ07-001-R20	Socket, 20 pin DIP, .300	
21	SOC5	1	HJ07-001-R24	Socket, 24 pin DIP, .300	
22	SOC6	1	HJ07-001-T28	Socket, 28 pin DIP, .600	
23	SOC7	2	HJ07-001-U32	Socket, 32 pin DIP, .900	Use for U8
24	TP0-5	6	AJ99-010	Test point, White	Analog out
25	TP6,13	2	AJ99-004	Test Point, Orange	-5Ref,Bd Enbl
26	TP7	1	AJ99-002	Test Point, Brown	AGND
27	TP8	1	AJ99-001	Test Point, Black	DGND
28	TP9	1	AJ99-006	Test Point, Green	MUX OUT
29	TP10	1	AJ99-003	Test Point, Red	+5 Ref
30	TP11	1	AJ99-005	Test Point, Yellow	+15 V
31	TP12	1	AJ99-007	Test Point, Blue	-15 V
32	U1	1	UK11-001	16-1 Analog Multiplexer	MUX-16
33	U4	1	UK31-001	Sample & Hold Amp	HA-5320-5
34	U5	1	UK09-005	Hex Flip-Flop	74HCT174
35	U6,7,9,10	4	UK09-004	Octal Flip-Flop	74LS374
36	U8	1	UK24-007	12 bit A-to-D converter or ADADC80-12	ADC80MAH-12
37	U11	1	UK12-002	1 of 8 demultiplexer	74LS138
38	U12	1	UK29-002-002	PLD	20L8
39	U13	1	UK02-002	Octal 3-state inverter	74LS240
40	U14,16	2	UK07-002	Octal bus transceiver	74LS245
41	U15	0	UK29-001-008	PLD	16L8
42	U17,18	2	UK21-003	+5 volt voltage reference	AD586KN or AD586LQ
43	U19-24	6	UK24-006	12 bit CMOS DAC	AD7545AKN
44	U25-27		UK20-005	Dual SPDT analog switch	DG303ACJ
45	U29-34	6	UK22-014	Op amp, voltage	OP77EP
46	U35,36	0	UK22-013	Inst Amp	INA110KP or AD524AD

Subassy P/N: **PC203**
Description: **ROM Board, GEN2**
Revision: **E**

Item	Ref.	Qty.	Part number	Description	Value
1	C1-13	13	CK20-104A	Cap., Ceramic,	0.1 uF
2	C14	1	CK10-00135C107	Cap., Al Elec,	100 uF
3	PC203	1	PC203	PC Board	
4	SOC1	4	HJ07-001-T28	Socket, 28 pin DIP, .600	U1-U4
5	SOC2	9	HJ07-001-R20	Socket, 20 pin DIP, .300	U5-U13
6	TP1	1	AJ99-001	Test point, Black	GND(TP1)
7	TP2	1	AJ99-004	Test point, Orange	Bd Enbl(TP2)
8	U1-4	4	UK18-008	EPROM, 64K x 8, .600 C	27C512
9	U5-7	3	UK09-004	Octal Tri-State Flip-Flop	74LS374
10	U8	1	UK29-001-009	PLD	16L8
11	U9	1	UK02-002	Octal Inverter	74LS240
12	U10-13	4	UK01-008	Octal Tri-State Buffer	74LS244

Subassy P/N: **PC204**
Description: **Comm/Driver Board**
Revision: **D**

Item	Ref.	Qty.	Part number	Description	Value
1	C1,3-23, C25-27	25	CK20-104B	Cap., Ceramic,	0.1 uf
2	C2	1	CK11-101A	Cap., Tant.,	100 uf
3	C28	1	CK10-00135C107	Cap., Al El,	100 uf
4	C24,29-36	9	CK20-182A	Cap., Ceramic,	.0018 uf
5	OSC1	1	XK02-185	1.8432 MHz Crystal Osc	
6	P1-14	14	HJ01-018	Conn, 2 pin, Molex	
7	P15	1	HJ01-022	Conn, double row, 25 x 2, .150" tail	
8	P16,17	2	HJ01-013	Conn, 6 pin power, Molex	
9	P18,19	2	HJ01-020	Conn, 2 pin power, Molex	
10	P20	1	HJ03-001	Conn, DB25, Female	
11	P21,22	2	HJ01-019	Conn, DB25, Male	
12	PC204	1	PC204	PC board	
13	R1-R14	14	RK5-221	Resistor,	220 ohms
14	R15	1	RK2-0270	Resistor,	27.4 ohms
15	RN1-RN3	0	RK8-002	Res. Network, 2 term, SIP, 330/390 ohm	
16	RN4,RN8	2	RK8-202D	Res. Network, DIP, 8 pack, 2K	
17	RN5,RN7	2	RK8-103D	Res. Network, DIP, 8 pack, 10K	
18	RN6	1	RK8-270D	Res. Network, DIP, 8 pack, 27 ohms	
19	SOC1	11	HJ07-001-R16	Socket, 16 pin DIP, .300	
20	SOC2	11	HJ07-001-R20	Socket, 20 pin DIP, .300	
21	SOC3	1	HJ07-001-R24	Socket, 24 pin DIP, .300	U2
22	SOC4	2	HJ07-001-T24	Socket, 24 pin DIP, .600	U13,14
23	SOC5	1	HJ07-Z68	Socket, 68 pin PLCC	U12
24	SOC6	3	HJ07-A10	Socket, 10 pin SIP	RN1-RN3
25	TP1	1	AJ99-004	Test point, Orange	BRD-EN
26	TP2	1	AJ99-003	Test point, Red	+5V
27	TP3	1	AJ99-001	Test point, Black	GND
28	TP4	1	AJ99-010	Test point, White	+24v
29	U1,3	2	UK09-004	Octal Flip-Flop	74LS374
30	U2	1	UK29-002-001	PLD	20L8
31	U4	1	UK07-002	Octal bus transceiver	74LS245
32	U5,9	2	UK01-008	Dual, Quad buffer	74LS244
33	U6	1	UK02-002	Dual, Quad inverter	74LS240
34	U7,10	2	UK12-002	1 of 8 demultiplexer	74LS138
35	U8	0	UK29-001-007	PLD	16L8
36	U11,17,18,21	4	UK13-004	7 Driver	ULN2013A
37	U12	1	UK27-003	Serial & Parallel Comm	LD1108
38	U13,14	2	UK13-003	5 Driver/Receiver, RS232	SP235
39	U15,16,19,20	4	UK09-006	Octal D-Flip Flop w/clear	74LS273

Subassy P/N: **PC208**
Description: **Motherboard, GEN2**
Revision: **E**

Item	Ref.	Qty.	Part number	Description	Value
1	AC2	1	IJ01-001	Inverter	(See SP1-SP5)
2	C1,4	2	CK20-103A	Cap., Ceramic, .01 uF, .250 C	
3	C2,3	2	CK10-00135C337	Cap., Al Elec., 330 uF, 35V, .200 C	
4	C5	1	CK20-105A	Cap., Ceramic, 1.0 uF, .250 C	

Item	Ref.	Qty.	Part number	Description	Value
5	CGD01-10	10	A003	Card Guide, subassy.	
6	DCC1	1	PJ03-001	DC-DC Converter, +5 to +22V	
7	J1-5	5	HJ12-002	Edge Card Conn, 100 pin	
8	P12	1	HJ01-022	Conn, double row, 25 x 2	To other bds
9	P1	1	HJ01-023	Conn, single row, 13 pins	To Keypad
10	P2	1	HJ01-021	Conn, double row, 20 x 2	To Display
11	P3	1	HJ01-014	Conn, 3 pin power, Molex	To Contrast
12	P4-11	8	HJ01-024	Conn, single row, 10 pins	
13	P13-21	9	HJ01-012	Conn, 8 pin, DuPont	To MFC's
14	PC208	1	PC208	Motherboard, GEN2, blank	
15	PW1,PW2	2	HJ01-013	Conn, 6 pin power, Molex	Power In/Out
16	PW3	1	HJ01-020	Conn, 2 pin power, Molex	To LCD bklite
17	R1	1	RK2-3652	Resistor,	36.5 K
18	R2	1	RK2-6811	Resistor,	6.81 K
19	R3	1	RK2-0031GF4752	Resistor,	47.5 K
20	R4,R5	2	RK2-2212	Resistor,	22.1 K
21	R6	1	RK2-2743	Resistor,	274 K
22	RTV	A/R			
23	RN1-5,7-10	0		Terminator Res. (Not Used)	
24	SOC1	9	HJ07-A10	Socket, SIP, .100 spacing, 10 pins	
25	SOC2	1	HJ07-001-R14	14 Pin, Skinny DIP Socket, U2	
26	SOC3	1	HJ07-001-R20	20 Pin, Skinny DIP Socket, U1	
27	SP1-5	5		Spacer (Used under Inverter, AC2)	
28	SCR1	10	Floor Stock	#6-32, w/washer, .375 long, for A003	
29	TP1	1	AJ99-001	Test point, Black	DGND
30	TP2	1	AJ99-003	Test point, Red	+5V
31	TP3	1	AJ99-005	Test point, Yellow	+15V
32	TP4	1	AJ99-007	Test point, Blue	-15V
33	TP5	1	AJ99-009	Test point, Grey	AGND
34	TP6	1	AJ99-010	Test point, White	+24V
35	U1	1	UK01-009	Buffer, octal	74HC244
36	U2	1	RJ03-002-510	Relay, SPDT	W171DIP25

Subassy P/N: **PC210**
Description: **Ozone, GEN2**
Revision: **A**

Item	Ref.	Qty.	Part number	Description	Value
1	C1,24	1	CK04-002A0B105	CAP	1uf
2	C2	1	CK20-002B0A330	CAP	33pf
3	C17	1	CK20-00250B102	CAP	.001uf
4	C10,C16	2	CK20-103B	CAP	.01uf
5	C5-9,12,13	12	CK20-104B	CAP	.1uf
6	C14,15,18,19, C23			CAP	.1uf
7	C20,C21,C22	3	CK10-00135C107	CAP POLARIZED	100uf
8	C4,C11	2	CK11-100A	CAP POLARIZED	10uf
9	C3	1	CK10-00135C337	CAP POLARIZED	330uf
10	P5	1	HJ08-009-001	CONNECTOR 2 PIN,M	
11	P4	1	HJ01-006-P20	CONNECTOR 20 PIN,M	
12	P6	1	HJ08-009-002	CONNECTOR 3 PIN,M	
13	P1,2	1	HJ08-009-003	CONNECTOR 4 PIN,M	
14	P7	1	HJ08-009-004	CONNECTOR 6 PIN,M	
15	D1,D2	2	DK02-00-4002	DIODE	1N4002

Item	Ref.	Qty.	Part number	Description	Value
16	D3-8	6	DK01-00-4148	DIODE	1N4148
17		1	FOAM TAPE		
18	HS2	2	HK02-003-T220	HEAT SINK, TO220	
19		1	HK01-004-T003	HEAT SINK, TO3	
20	U4	1	UK22-010	OP AMP, QUAD	LM324AJ
21	U2	1	UK22-014	OP AMP, SINGLE	OP77
22	U1	1	UK22-001	OP AMP, SINGLE	OPA111
23	PC210	1	PC210	PC BOARD	
24	R1,10	2	PK01-005-34104	POTENTIOMETER	100K
25	U6	1	UK21-003	PREC. VOLT REF.	AD586
26	V1	1	QK12-011	REGULATOR	LM317
27	U5	1	QK12-001	REGULATOR, PREC.	LM723
28	R17	1	RK2-0031GF101	RESISTOR	100
29	R9,11	2	RK2-0031GF104	RESISTOR	100K
30	R39	1	RK3-106	RESISTOR	10M
31	R38	1	RK2-0031GF100	RESISTOR	10.0
32	R8,22	2	RK2-0031GF102	RESISTOR	1.00K
33	R24	1	RK1-011	RESISTOR	1.2 .5 WATT
34	R30,31,34,35	4	RK2-0031GF1581	RESISTOR	1.58K
35	R4	1	RK2-0031GF2003	RESISTOR	200K
36	R3	1	RK2-0031GF2052	RESISTOR	20.5K
37	R5	1	RK2-0031GF237	RESISTOR	237
38	R2	1	RK2-0031GF255	RESISTOR	255
39	R7,13,19	3	RK2-0031GF202	RESISTOR	2.00K
40	R29	1	RK2-0031GF3651	RESISTOR	3.65K
41	R6,23,25,26, R37	5	RK2-0031GF4000	RESISTOR	4.00K
42	R12,18	2	RK2-0031GF4751	RESISTOR	4.75K
43	R14,20	2	RK2-0031GF5110	RESISTOR	511
44	R33,36	2	RK2-0031GF6191	RESISTOR	6.19K
45	R15,21	2	RK2-0031GF753	RESISTOR	75.0K
46	R27,28,32	3	RK2-0031GF9761	RESISTOR	9.76K
47	U3	1	UK25-004	TIMER, DUAL	LM556CJA
48	T1	1	TJ01-001-01	TRANSFORMER	
49	Q1,2	2	QK02-00-6123	TRANSISTOR	2N6123
50	SOC1	3	HJ07-001-R014	14 PIN DIP SOCKET	
51	SOC2	2	HJ07-001-R008	8 PIN DIP SOCKET	
52	SOC3	1	HJ07-004-Y08	8 PIN ROUND SOCKET	
53	SPACER	2		.100Lx.130IDx.250OD	
54	SCREW	2		PAN HEAD	4-40x5/16
55	SCREW	2		PAN HEAD	4-40x1/2

Subassy P/N: **PC216**
Description: **Status Board**
Revision: **B**

Item	Ref.	Qty.	Part number	Description	Value
1	C1	1	CK10-00135C107	CAP	100u 5Vmin
2	C2-9	8	CK20-104A	CAP	.1uf
3	F1,F2	2		FUSE	.3A
3a	FH1,2	2	GJ01-001-250	FUSE CLIP FOR F1,F2	
4	K1-8	8	W117SIP-6	RELAY	
5	P1	1	HJ03-001	HEADER 25X2	
(MATE)			HJ01-019	CONNECTOR	
6	P2,P3	2	HJ01-013	CONNECTOR	

Item	Ref.	Qty.	Part number	Description	Value
7	P4	1	HJ13-003	CONNECTOR	
	(MATE)		HJ14-003	CONNECTOR	
8	P5	2	HJ13-001	CONNECTOR	
	(MATE)		HJ14-001	CONNECTOR	
8a	P6	1	HJ13-002	CONNECTOR	
	(MATE)		HJ14-002	CONNECTOR	
9	R1	1	RK2-4750	RESISTOR	4.7K
10	RN1-4	4	HJ07-A10	10 PIN SIP SOCKET	
11	RN4	1	RK8-103D	RESISTOR SIP	10K
12	RN5	1	RK9-563	RESISTOR SIP	56K
13	SW1-8	8	SJ07-001	SWITCH	SSA22
14	TP1-11	11	TESTPOINT	TESTPOINT	TP
15	U1,U2,U5	3	UK09-004	OCTAL FLIP-FLOP	74LS374
16	U3	1	UK07-002	OCTAL BUS TRANS.	74LS245
17	U4	1	UK29-003-006	PLD	22V10
18	U6,U10	2	UK32-001	OPTO COUPLER	PS2501-4NEC
19	U7	1	UK02-002	DUAL, QUAD INVERTER	74LS240
20	U8	1	UK29-001-007	PLD	16L8
21	U9	1	UK01-008	DUAL, QUAD BUFFER	74HC244
22	PC216	1	PC216	PC BOARD	
23	SOC1	7	HJ07-001-R020	20 PIN DIP SOCKET	
24	SOC2	2	HJ07-001-R016	16 PIN DIP SOCKET	
25	SOC3	1	HJ07-001-R024	24 PIN DIP SOCKET	