CHAPTER 1 - INTRODUCTION

1.1 PRODUCT OVERVIEW

Molbox1 is a microprocessor controlled *molbloc* support unit that reads raw data from a *molbloc* and processes it into fully corrected instantaneous and average flow rates for various reference gasses. Two built-in 300 kPa (45 psia) absolute, high accuracy quartz crystal-based pressure transfer standards read upstream and downstream *molbloc* pressures. Two PRTs in the *molbloc* monitor the *molbloc* temperature which is measured by the *molbox*. This measurement circuit includes two precision standard resistors to calibrate the circuit every 30 seconds.

The *molbox* interfaces to an external *molbloc* to become a portable mass flow calibrator. A regulated gas supply of less than 300 kPaa must be supplied to the inlet port of the external *molbloc*. No changes to the *molbox* are needed to change ranges. The user only needs to use a different range *molbloc*.

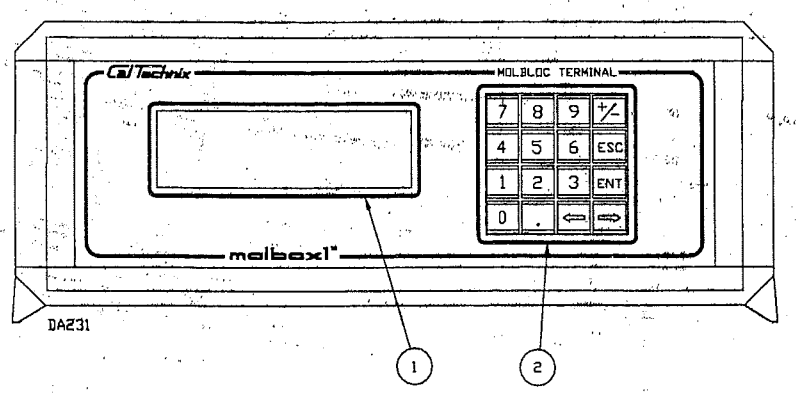
The *molbox* also includes an electronic module, a user interface via front panel display and keypad, a computer interface via a standard RS232 interface (COM1) and an optional GPIB (IEEE488) interface.

From the *molbox* front panel the user can monitor mass flow, set and measure an external DUT (device under test), display average flows, DUT error and standard deviation. All other *molbox* functions such as adjusting operational limits, setting up and using an external *molbloc*, etc. can be accessed through front panel commands.

1.2 LOCATION OF THE COMPONENTS

FRONT PANEL

1) 2 x 20 display
2) Multi-function keypad



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Analog input:
- 0-5.0 V with 1.28 mV resolution
- ±0.10% F.S. accuracy at 0-50° C (32-122° F)
- ±0.05% F.S. accuracy at 15-25° C (59-77° F)

DUT supply voltage:
- +15 V at 1 500 mA
- -15 V at 300 mA

Temperature Range:
- Operation: 0-50° C (32-122° F)
- Storage: -25 to 85° C (-15 to 185° F)

Power Requirements:
- 85-264 VAC, 47-440 Hz, 22 VA max. consumption

Weight & Dimensions:
- 11 kg (22.2 lb.)
- 32 cm (W) x 12.8 cm (H) x 34 cm (D) [12.62" x 5.04" x 13.4"]

NOTE: Due to the policy of continual product improvement, all specifications are subject to change without notice.

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1.4 SPECIFICATIONS

Ranges (external *molbloc* dependent):
- 10 sccm, 50 sccm, 200 sccm, 1 slm, 5 slm, 20 slm

Pressure Specifications:

Transducer Ranges:
- 300 kPaa (45 psia)

Accuracy:
- ±0.02% F.S. for one year (directly traceable to NIST)

Repeatability:
- ±0.005% F.S.. An autozero sequence of the differential pressure at null mass flow and a coherence test on the readings of the two transducers are included.

Temperature Measurement Specifications:

Temperature measurement ranges
- 0-41° C (32-105.8° F)

Accuracy:
- ±0.05° C (auto-calibrated every 30 seconds)

Resolution
- ±0.01° C

Engineering Pressure Units Supported:
- psia, bara, mbara, Paa, kPaa, mmHga, inHga, inWaa, mmWaa, kcm^2a

Engineering Flow Units Supported:
- mol/s, kg/s, mg/s, slm, sccm, scfm, scfh

User definable Flow Units supported:
- ulm, uccm, ucfm, ucfh

Gas types available:
- N2, He, Ar, H2, O2, CH4, C2H4, Air, C2F6, N2O, CF4, SF6, CHF3, CO2, C3H6 C3H8

Interfaces:
- External Communications: RS232, GPIB (IEEE488) optional
- Remote Measurement Device: external *molbox*
- Analog I/O port (for an external DUT)

Pressure Connections:
- Transducers: 1/8" Swagelok 300 kPaa maximum

External Analog port:

Analog output:
- 0-5.0 V with 1.28 mV resolution
- ±0.10% F.S. accuracy at 0-50° C (32-122° F)
- ±0.05% F.S. accuracy at 15-25° C (59-77° F)

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CHAPTER 2 - INSTALLATION

2.1 UNPACKING AND INSPECTION

The *molbox* is delivered with plugs installed in the pressure connections on the rear panel. The following accessories are included:

- User's manual
- Connection kit
- Accessory kit
- Power cable
- Utility software
- Demo software

2.2 SITE REQUIREMENTS

The *molbox* can be placed on any flat, stable surface at a convenient working height. The front feet are retractable so that the unit can be used either flat or with the front panel raised for easier viewing. These feet are also designed so that other DH Instruments equipment with the same size module may be interlocked for stacking.

A convenient source of clean gas regulated to not more than 300 kPaa should be nearby as well as 85-264 VAC.

2.3 INITIAL SETUP

- **Pressure connections** - Two pressure connections are included on the rear panel of the *molbox*. The system into which flow is to be measured is connected to the external *molbloc* to be used. Ensure that the gas source does not exceed 300 kPaa and that the flow direction corresponds to the arrow on the external *molbloc*.

  The source of gas to be used as the pressure medium is connected to the *molbloc* inlet. A regulator must be used to set the *molbloc* inlet pressure to not more than 300 kPaa with a mandatory two micron filter used before the *molbloc* inlet. The "high" *molbox* transducer port is connected to the *molbloc* on the inlet side (tail side of the *molbloc* arrow). The "low" *molbox* transducer port is connected to the *molbloc* on the outlet side (arrowhead side of the *molbloc* arrow).

  The external *molbloc* must be connected electrically to the *molbox* before turning the *molbox* on. Use the 15-pin cable supplied.

- **Interface connections** - An RS232 interface connector is included on the *molbox*. The connection should be made to the desired device using a standard 9-pin cable. This port is for communication to the *molbox*.

- **Analog I/O port** - An external DUT can be connected to this port to allow measurement and control of the DUT. See Section 4.8 DUT Wiring Diagram for pin definitions.

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- **Power connections** - The *molbox* should be located close to a convenient source of AC power. The *molbox* has a universal input which will operate on 85-264 VAC with no jumper change.

- **Taring the system** - For the *molbox* to control properly, the internal transducers must be tared at a zero flow condition at normal operating line pressure (see Section 3.3.6 Special - Tare).

The *molbox* should be connected to a convenient source of AC power using the supplied power cable.

Upon power-up a memory test is run to test the integrity of the internal data RAM. If the memory has been corrupted or the internal battery has failed, the front panel will display a message to alert the user. If a memory failure has occurred all default operating parameters will be loaded into memory.

After the memory test is complete the *molbox* will load the calibration data from the external *molbloc*. If the *molbloc* data cannot be loaded, then an error message will appear on the *molbox* display. After the data is loaded the Main Menu should be displayed. Once the Main Menu is displayed selections can be made by either pressing the number of the desired option or by pressing the (Left/Right) arrow keys to place the blinking cursor to the desired option and then pressing the [ENT]er button. The [ESC]ape button will cause the menus to 'back up' to the previous menu selection in most cases. It will also cause some selections to be skipped when the *molbox* is to use values already stored in its internal memory.

If an error message appears when you turn on the *molbox* and the Main Menu does not appear, please contact DH Instruments Technical Service.

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CHAPTER 3 - OPERATION

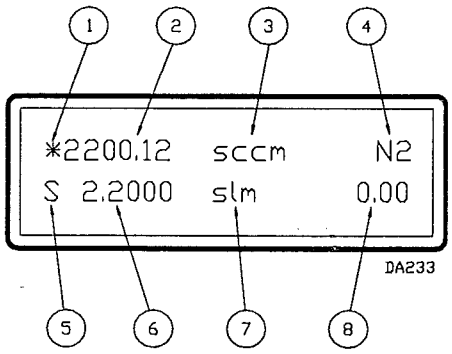
3.1 MANUAL OPERATION

The *molbox* is ready for use when all initialization and self test procedures have passed during power up and if the Main Menu is displayed. Run Mode is accessed by selecting #1 "RUN" from the Main Menu. Run Mode can be left to return to the Main Menu by pressing [ESC]ape.

FRONT PANEL DISPLAY

The front panel, keypad and special function keys are used for accessing user menus/prompts, entering of numeric data and the execution of special commands. Flow values are also read from this display.

To place the *molbox* into Run Mode select #1 from the Main Menu by either pressing '1' or using the arrow keys to place the blinking cursor over the number '1' and then pressing [ENT]er to select that option.



1. '*' - flow is "READY"
   '<' - flow is "NOT READY" and decreasing
   '>' - flow is "NOT READY" and increasing
   'r' - flow is above the maximum limit

2. 2200.12 - current flow value (scientific notation will be used if needed)

3. sccm - current flow units of measure
   Note: a "K" will appear after the flow units if the Kfactor is enabled (see Section 3.2.9 - Settings - "K" Factor).

4. N2 - the currently selected gas type (this text will not appear if the flow is in scientific notation)

5. M An "S" or an "M" appears here. An "S" appears when the value displayed to the right is the setpoint value. An "M" appears when the value is the measurement back from the DUT. Pressing the "->" key toggles between these two modes.

6. 2.200 - The external DUT measurement or last flow target set (see above)

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7. slm - Current DUT set or measured point flow units of measure. If this unit is the same as the current flow units (Item #3), then this space will be blank.

8. 0.00 - Rate of change in flow in the current units of flow/second. If the flow measurement (Item #2) is in scientific notation, then the rate will be in the same power as the flow display.

NOTE: For manual flow setting and monitoring, ensure that you are in the Run Mode (#1).

ADDITIONAL - Each bordered box of the items listed in the following sections contain the menu selections necessary to reach the desired function. All the user needs to do is press the number which corresponds to the menu text which appears on the front panel display and the bordered box in this manual. If there are additional menu items that are not visible on the display, a right arrow will be displayed in the lower right hand corner. Moving the cursor beyond that point will display those menu items.

3.1.1 READY/NOT READY INDICATION

When in Run Mode, the *molbox* constantly displays a Ready/Not Ready indication. The indication is a symbol to the left of the current pressure. The symbols used are:

1. '*' - flow is "READY"
   '<' - flow is "NOT READY" and decreasing
   '>' - flow is "NOT READY" and increasing
   'r' - flow is above the maximum limit

A "Ready" condition will exist only if the flow stability criteria is met. The remaining symbols will flash when the flow condition is "Not Ready". If "CALC ERR" appear in this field check to make sure that the external *molbloc* is connected properly.

NOTE: The Stability Test is set by the user in the #2 Settings Menu.

3.1.2 SINGLE FLOW POINT SETTING

In Run Mode the *molbox* can be commanded to set a single flow point. You must first setup, connect and select a DUT (device under test) [see Section 3.3.3.1 Special - DUT - Select].

While in Run Mode, press [ENT]er. The Target Setting Menu is displayed and shows the last target value set.

The flow unit used for setting the flow target and for measuring the DUT is separate from the actual flow units. Both of these units can be selected in the Settings Menu (see Sections 3.2.2 Settings - Flow Unit and 3.2.8 Settings - Set Point Units).

Key in the desired target value (use the arrow keys to move the cursor and edit if necessary). Once the value of flow entered is correct press [ENT]er. If the target is outside of the selected DUT voltage limits or 20% over the *molbloc* range, the entry will not be accepted. Otherwise, the *molbox* will set the proper voltage output to the external DUT and indicate "*" when ready.

The setpoint can be displayed in the lower left hand corner of the Run display. Pressing the "->" key when in the Run screen toggles between displaying the setpoint (S) and the readback from the DUT (M).

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The *molbox* also calculates the average flow, standard deviation and percent full scale DUT error over a user defined averaging period (see Section 3.2.6 Settings - Averaging). These results can be viewed in two screens. These are accessed by pressing the [+/-] key.

The first screen displays the current DUT target and the current average % F.S. error which is calculated as:

$$\% \text{ F.S. DUT error} = \frac{\text{DUT average measured flow - actual } \textit{molbloc} \text{ average reference flow}}{\text{DUT F.S. flow}}$$

These results are updated at the end of each reoccurring averaging period. Pressing the [+/-] key again will display the current "actual average flow" and the "standard deviation of the actual flow over the averaging period". Pressing the [+/-] key again will return to the Run screen.

3.2 SETTINGS (SETS)

Settings are the criteria the *molbox* uses for flow measurement and display. The settings determine such things as stability and units.

3.2.1 SETTINGS - GAS TYPE

There are sixteen gas types available to choose from. The correct gas type must be set for the flow calculations to be correct. These gas types are broken up into three categories. You need to first choose the proper gas category: inert, flammable or other.

After you choose a gas from the menu, the *molbox* will load the calibration specific for the selected gas from the *molbloc*. If the *molbloc* has not been calibrated for the selected gas, then the calibration for Nitrogen gas will be used.

3.2.1.1 SETTINGS - GAS TYPE - INERT

Choose an inert gas from the displayed menu. Once chosen, you must verify the chosen gas type by pressing the [ENT]er key. Available inert gas types:

N2	Nitrogen
He	Helium
Ar	Argon

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3.2.1.2 SETTINGS - GAS TYPE - FLAMMABLE

Choose a flammable gas from the displayed menu. Once chosen, you must verify the chosen gas type by pressing the [ENT]er key.

H2	Hydrogen
O2	Oxygen
CH4	Methane
C2H4	Ethylene
C3H6	Propylene
C3H8	Propane

3.2.1.3 SETTINGS - GAS TYPE - OTHER

Choose a gas from the displayed menu. These gasses are other than inert or flammable. Once chosen, you must verify the chosen gas type by pressing the [ENT]er key.

Air	Air
C2F6	Hexafluoroethane
N2O	Nitrus Oxide
CF4	Carbon Tetrafluoride
SF6	Sulfur Hexafluoride
CHF3	Fluoroform
CO2	Carbon Dioxide

3.2.2 SETTINGS - FLOW UNIT

The flow menu selects which unit will be used for all flow measurements and settings that are displayed locally and remotely except for flow target setting and DUT measurement.

Up to six flow units can be displayed and selected from the units available. **NOTE:** see Section 3.3.2 Special - FlowU.

If you select a unit which will result in very small numbers (kg/s, mole/s, mg/s), the value of the flow will be displayed in scientific notation.

3.2.3 SETTINGS - TEMPERATURE UNITS

The *molbloc* temperature can be viewed in degrees Celsius or degrees Fahrenheit. This menu selects the desired units. This will affect remote and local temperature measurement.

3.2.4 SETTINGS - PRESSURE UNITS

Determines which pressure units are to be used when viewing the upstream or downstream pressures.

Up to six units can be displayed and selected from the units available. **NOTE:** see Section 3.3.1 Special - PresU.

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3.2.5 SETTINGS - STABILITY

The Stability Setting is used as the criteria in determining whether Ready or Not Ready will exist. For a Ready condition to exits, the rate of change in flow unit/second must be less than the current Stability Setting.

The Stability Setting should be set to the maximum rate of change of flow at which it is acceptable to take readings.

3.2.6 SETTINGS - AVERAGING

The *molbox* displays instantaneous and average flow measurements. The averaging period determines how long the *molbox* will average the flow and DUT measurements before calculating the new average values and the standard deviation. See Section 3.1.2 - Single Flow Point Setting for details on viewing the results. The averaging period must be greater than 4 seconds and less than 1 000 seconds.

3.2.7 SETTINGS - MODE

The *molbox* can modulate the set voltage of an external DUT and regulate its actual flow using the *molbloc* as the reference. When this regulation mode is turned off (default), the DUT set voltage is just set to the target once with no active control.

The regulation mode is enabled by selecting "YES" in this screen. Then you will be queried for the Regulation delay. This delay will set the period of time that the *molbox* will wait between DUT set voltage adjustments. If the DUT is slow to respond, or there is a significant volume between the *molbloc* and the DUT, this delay should be increased to slightly longer than the response time exhibited by the DUT. The entered delay value must be between 2 and 20 seconds.

3.2.8 SETTINGS - SET POINT UNITS

The DUT target set and measurements have a unit that is separate from the normal flow unit. The first two selections are "V" and "%FS". The %FS unit will set and display flows relative to the full scale specification of the currently selected DUT (see Section 3.3.2 - Special - FlowU). The third available unit will be the same unit as the current DUT range unit. If you have selected this third unit and you change the current DUT specification, this unit will change to the new DUT range unit.

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3.2.9 SETTINGS - "K" FACTOR

The K factor is used to modify the flow measurement for when the user wants to use a calibration gas supported by the *molbox* other than the process gas for which the DUT is being calibrated. The *molbloc* flow measurement is multiplied by the K factor before the flow value is displayed. If the K factor is disabled then no modification is done.

If the K factor is enabled, then a "K" will appear after the flow units in the Manual screen and in the Flow Request command (FR) reply string.

The value of K factor to use in converting from one gas to another is recommended by the manufacturer and varies by brand.

3.3 SPECIAL

The Special Menu allows the user to access special functions affecting *molbox* operation:

3.3.1 SPECIAL - PRESU (PRESSURE UNITS)

Determines the pressure units that will be available in the Settings Menu (see Section 3.2 Settings - Sets). The units are divided into SI and other units and includes a user defined unit.

The user will be queried for the user unit number which corresponds to the unit menu selections #1 through 6. The user must select the unit type and then the actual unit. This adds this unit to the unit menu in the SETTING - PRESU menu, overwriting the previous unit.

Limits: Six units are available in the settings menu at any one time. The six units are set up by the user and then can be accessed from the Settings Menu.

3.3.2 SPECIAL - FLOWU (FLOW UNITS)

Determines the flow units that will be available in the Settings Menu (see Section 3.2 Settings - Sets). The units are divided into standard, user defined, %FS and volts.

The user will be queried for the user unit number, which corresponds to the unit menu selections #1 through 6. Then the user must select the unit type.

Selecting "%FS" will reference the full scale range of the currently selected DUT. Selecting "V" will just set and measure the DUT target in volts. Once selected, the unit is added to the unit menu in the SETTING - FLOWU menu, overwriting the previous unit.

Limits: Six units are available in the settings menu at any one time. The six units are set up by the user and then can be accessed from the Settings Menu.

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3.3.2.1 SPECIAL - FLOWU (FLOW UNITS) - STD (STANDARD)

If "Std" is selected, then the user must select one of the standard flow units. Once selected, the unit is added to the unit menu in the SETTING - FLOWU menu, overwriting the previous unit.

3.3.2.2 SPECIAL - FLOWU (FLOW UNITS) - USER

If "User" flow unit is selected, the user must select one of the user defined unit types. The user defined units are the equivalent of the standard slm, sccm, scfm, and scfh units, but the temperature reference for the user versions can be changed (see Section 3.3.7 -Special - RefTemp). Once selected, the unit is added to the unit menu in the SETTING - FLOWU menu, overwriting the previous unit.

3.3.3 SPECIAL - DUT (DEVICE UNDER TEST)

A voltage controlled DUT (such as a mass flow controller) can be connected to the *molbox* analog I/O port for flow control, regulation and calibration. A DUT must be defined and selected before it can be used with the *molbox*.

The *molbox* can store up to 25 different DUT definitions. Each definition is assigned an DUT index number from 1 to 25. This number is used to specify the DUT to use in local and remote operation. See Section 4.8 - DUT Wiring Diagram for information on the analog I/O port.

3.3.3.1 SPECIAL - DUT (DEVICE UNDER TEST) - SELECT

Specifies which DUT to use in local operation. Once a DUT has been defined and selected, you may enter a flow target in the run screen and the *molbox* will set the correct DUT control voltage. If the regulation mode is on the *molbox* will regulate the DUT flow using the *molbloc* as the flow reference (see Section 3.2.7 - Settings - Mode).

If you select a DUT that has not been defined, an error message will appear. After you select a DUT, the DUT serial number, range and full scale voltage will be displayed as a confirmation. Pressing the [ENT]er key will activate the DUT data. Pressing the [ESC]ape key will void the DUT selection.

If the DUT that you have selected has a range that is in a user defined unit, you must ensure that the reference temperature is set the same as when you defined the DUT. (see Section 3.3.7 - Special - RefTemp).

3.3.3.2 SPECIAL - DUT (DEVICE UNDER TEST) - EDIT

Allows editing of a previously defined DUT. You must enter the DUT index number to edit it. After you enter a valid DUT index number, a DUT serial number entry field will appear with the current DUT serial number in the field. You may accept the current number by pressing the [ENT]er key, or enter a new serial number.

The current DUT full scale voltage output will now be displayed in volts. You may accept it or enter a new value.

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Before you specify the range, you must select the range flow unit. This unit is also used as one of the possible set point units available in the Settings menu (see Section 3.2.8 - Settings - Point Units) when the DUT is selected. If you select a user definable unit, then you must make sure to select the reference temperature before defining the DUT. You also must ensure that this temperature is set the same when you use the DUT as when you defined it (see Section 3.3.7 - Special - RefTemp).

The DUT range will now appear in the selected flow units. You may accept it or enter a new value.

3.3.3.3 SPECIAL - DUT (DEVICE UNDER TEST) - ADD

Allows you add a new DUT and define it. It will select the next open DUT index number and use that number to identify the DUT. Defining the DUT is similar to editing an DUT (see Section 3.3.3.2 - Special - DUT - Edit). Once you have defined an DUT, you must select it to use it (see Section 3.3.3.1 - Special - DUT - Select). The *molbox* will use this data to determine the voltage to send out to the DUT when a flow target is specified.

3.3.4 SPECIAL - MLBC (*molbloc*)

Reloads the external *molbloc* data and reviews the *molbloc* serial number, calibration date and range. Pressing the [+/-] key will list the gasses that the *molbloc* has been calibrated for (up to twelve).

If you change the *molbloc* with the power on, this menu function must be performed to reload the new molbloc data.

3.3.5 SPECIAL - PDISP (PRESSURE DISPLAY)

Displays the current upstream and downstream pressures and the difference of these two pressures (upstream - downstream). All of these measurements are adjusted for tare (see Section 3.3.6 - Special - Tare).

Also, the external *molbloc* PRT measurement is displayed in the selected temperature units. Pressing the [ESC]ape key will return to the Special Menu.

3.3.6 SPECIAL - TARE

The *molbox* uses two pressure transducers to measure line pressure and differential pressure across the *molbloc*. This difference should be 0 when there is no flow and at operational line pressure. Taring ensures that this occurs.

From the Tare Menu, you can select to tare or to set the tare ready stability setting.

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3.3.6.1 SPECIAL - TARE - TARE

You must ensure that the external *molbloc* outlet is plugged and that the line pressure on the *molbloc* inlet is set correctly. You can view the current average pressure and the tare pressure value after selecting SPECIAL - TARE. **NOTE: Do not exceed 300 kPaa when setting the line pressure!**

Once the line pressure is set ensure that there are no leaks. The current average *molbloc* pressure will be displayed on top of the display with the tare stability criteria located just before it. This criteria is the same as in the Run screen (see Section 3.1.1 - Ready/Not Ready Indication). The tare value (differential) will be displayed on the bottom in Pascal (Pa). This tare value should not be greater than 120 Pa.

Pressing the [ENT]er key will capture the tare value displayed if the pressure is stable. If the pressure does not meet the tare stability criteria "Pressure Unstable" will appear on the screen. If the tare is greater than 120 Pa, the key pressed will be ignored (see Section 3.3.6.2 - Special - Tare - Stability).

The valid captured tare value will now be displayed at the bottom of the screen and the previous tare value will be displayed at the top of the screen. Pressing the [ENT]er key will place the new tare value into effect and overwrite the previous tare. Pressing the [ESC] key will restore the previous tare value.

3.3.6.2 SPECIAL - TARE - STABILITY

The user must enter the tare ready criteria in Pa/sec. When taring, the pressure must be within the tare stability criteria to enable a valid tare (see Section 3.3.6.1 - Special - Tare -Tare).

3.3.7 SPECIAL - REFTEMP (USER UNIT REFERENCE TEMPERATURE)

Four user definable flow units are available (see Section 3.3.2.2 - Special - FlowU - User). The user defined units are the equivalent of the standard slm, sccm, scfm, and scfh units, but the temperature reference for the user versions can be changed from the default of 20° Celsius. The reference temperature applies to all of the user flow units and is in the current temperature units.

The nominal pressure reference is always 10 135 Paa (1 atmosphere or 760 mmHga). This temperature is used to calculate the new conversion factor using the new temperature and compressibility factor for the user defined flow unit.

3.3.8 SPECIAL - INTERNAL

Allows the user to reset options, select user levels and passwords. Generally, this option is only selected by individuals with advanced knowledge of *molbox* operations.

3.3.8.1 SPECIAL - INTERNAL - RESET

Resets operational parameters and returns the *molbox* to a known state. These commands should be used with care because specific configuration information will be lost.

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3.3.8.1.1 SPECIAL - INTERNAL - RESET - UNIT

Clears **ALL** user defined units and sets system units to their default values:

Flow units menu:

1 sccm	2 slm	3 mol/s
4% F.S.	5 mg/s	6 uccm

Unit #1 "sccm" will be selected.

Pressure units menu:

1 psia	2 Paa	3 kPaa
4 MPaa	5 inWaa	6 inHga

Unit #1 "psia" will be selected.

Temperature units:
Celsius

3.3.8.1.2 SPECIAL - INTERNAL - RESET - ALL

Resets all *molbox* parameters for system, units, communication ports and user level settings. It is a combination of all of the other resets. All of these settings will be set to manufacturer's defaults.

NOTE: If this option is selected the user must redefine all Settings information and user defined units. This option must be selected with care because it resets **ALL** user definable information except for permanent EEPROM calibration data. This function can also be performed on power up by pressing and holding the "2" key while power is applied.

3.3.8.1.3 SPECIAL - INTERNAL - RESET - SYSTEM

Sets the settings and communications ports to manufacturer's default values:

Serial port COM1 port spec = "2400, E, 7, 1"
Optional IEEE port set to address = 10, CR-LF terminators
Clears the transducer tare
Tare stability set to 10 Pa/second
Gas type = N2
Flow unit is set to the first unit in the FlowU menu in Settings
Pressure unit is set to the first unit the PresU menu in Settings
DUT set/measure flow unit is set to volts
Temperature unit is set to Celsius
Flow stability criteria is set to 0.01% of the range of the molbloc
The selected DUT is set to #1
The "K" factor is disabled
The averaging period is set to 4 seconds
Flow regulation is disabled
The user level restrictions are disabled

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3.3.8.1.4 SPECIAL - INTERNAL - RESET - DUT (DEVICE UNDER TEST)

Clears out **ALL** DUT configuration information for the 25 available DUT definitions. Resets the first DUT to 5 volt full scale with the range same as the current *molbloc*. This DUT is then selected.

3.3.8.2 SPECIAL - INTERNAL - REMOTE

Allows the user to configure the communications ports. The COM1 data framing parameters can be set up along with the IEEE bus address (optional). The COM1 port can be set up as follows:

Baud Rate:	300, 600, 1200, 2400, 4800 or 9600
Parity:	none, odd or even
Word Length:	7 or 8
Stop Bits:	1 or 2

3.3.8.2.1 SPECIAL - INTERNAL - REMOTE - IEEE

Allows the user to configure the optional IEEE ports. This selection will not be present if the IEEE option is not installed. The IEEE port can be set up as follows:

IEEE address	1 to 31
IEEE Term1	A decimal number representing the first terminating character
IEEE Term2	A decimal number representing the second terminating character

If only one terminating character is desired, you can set the first terminating character to "0" which will disable it. EOI is always asserted along with the second terminating character and is always accepted as string terminator.

3.3.8.3 SPECIAL - INTERNAL - USER LEVEL

Establishes user levels with restrictions and password protection for each restricted level.

Restrictions at User Levels

USER LEVEL:	None	Low	Med	High
PROCEDURE:				
Reset Menu		x	x	x
Setup Units			x	x
Manual Generation			x	x

Each restriction level has its own password. Passwords are numeric and the length may not exceed 4 digits.

The user must select the restriction desired before entering a new password. The current password must be entered before entering a new password. A password of "0000" will disable the existing password.

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NOTE: The password should be recorded and stored in a secure location for later use if necessary. If you forget the password(s) you must reset the *molbox* memory by holding the "2" key while powering the *molbox* up or send the "RESET" command to the *molbox* using the COM1 or IEEE port. This will disable ALL passwords and also reset all settings (see Section 3.3.8.1.2 - Special - Internal - Reset - All).

3.3.8.4 SPECIAL - INTERNAL - ADDER/MULT

The user flow measurement adder and multiplier can be used to modify the flow measurement. The result is:

displayed flow = Kfactor x ((actual flow x multiplier) + adder)

The adder is normally set to 0.
The multiplier is normally set to 1.

CAUTION: Changing these numbers will change all displayed flow measurements.

NOTE: If the "K" factor is enabled, then it will be applied to the result of the adder/multiplier modification.

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CHAPTER 4 - INTERFACING

4.1 INTERFACING

Most of the front panel functions can also be executed by commands from a computer. The host controlling device is interfaced to the *molbox* using either COM1 or the GPIB interface (optional).

Initiating communications with the *molbox* will automatically place the *molbox* into Remote Mode. When in Remote, the *molbox* will display a screen similar to the Run screen. All of the front panel controls are locked out in Remote Mode. You may return to Local Mode by using the "Local" command, or, by pressing the [ESC]ape key. If you have sent the "Remote" command the only way to return to Local is by using the "Local" command. The use of "DUT" refers to an external device under test that controls flow using a voltage signal.

4.2 COMMAND SUMMARY

ABORT	Halt all current operations and stop DUT regulation.
BEEPER(=)	Enable or disable the internal beeper.
COM1(=)	Set or return the COM1 port configuration.
DEVICE=EXT	Loads the external *molbloc* data.
DP	Return the current transducer pressure difference.
DUT(=)	Select or return the current DUT to use.
DUTx(=)	Define or return the specified DUT specifications.
ERR	Return last error message.
FA=	Start a single flow averaging cycle.
FCOEF	Return the coefficient to convert kg/s to the current flow units.
FR	Return the current flow.
FRA	Return the results of a completed flow averaging cycle.
FS=	Set a flow target for the DUT in the set point units (SUNIT).
FUNIT(=)	Set or return the flow unit.
GAS(=)	Set or return the gas type being used.
KFACT(=)	Set or return the current *molbox* "K" factor.
LOCAL	Enables the front panel controls.
MEM	Return the memory test status.
MODE(=)	Set or return current DUT regulation mode and period.
MOLBLOC	Return the *molbloc* header data.
PCOEF	Return the coefficient to convert Pa to the current pressure units.
PR	Return the current average *molbloc* pressure.
PRHI	Return the current upstream pressure (tare corrected).
PRLO	Return the current downstream pressure (tare corrected).
PSTAB(=)	Set or return the current tare pressure ready criteria.
PUNIT(=)	Set or return the pressure unit.

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RANGE	Return the range of the *molbloc* that is in use.
RATE	Return the current rate of change of flow
RE	Return the current Reynolds number.
READYCK(=)	Set or return a flag that is cleared by "Not Ready".
REMOTE	Remote (Local lockout) only operation.
RESET	Reset the *molbox* to the default operating parameters.
SN	Return the serial number of the *molbox*.
SR	Return the current ready status.
SS(=)	Set or return the stability setting (flow unit/sec).
SS%(=)	Set or return the stability setting (% F.S./sec).
SUNIT(=)	Set or return the current set point flow unit.
TARE	Return the current tare and the tare conditions.
TARESET	Tare the upstream and downstream pressure transducers.
TEMP	Return the *molbloc* temperature in the temperature unit.
TF	Return the last DUT flow target in the set point flow unit.
TUNIT(=)	Set or return the PRT temperature unit.
UL(=)	Set or return the internal transducers maximum pressure.
USERCAL(=)	Set or return the user flow adder and multiplier.
UTEMP(=)	Set or return the temperature ref used for the user flow units.
VER	Return the *molbox* software version.
VIN	Return the measured DUT measurement voltage.
VOUT(=)	Set or return the voltage sent out to an external DUT.
VS=	Set a new flow target voltage in volts for the DUT.
VSENSE	Return the measurement of the voltage used to set the DUT.

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4.3 OVERVIEW

Anytime the *molbox* receives a command, it will respond back with a reply string. You must wait for and receive the reply string before issuing another command. You should also check this reply for error messages. If the response is "ERR# n" ("n" is an integer error number), your program should take appropriate action. Sending the "ERR" command to the *molbox* following the reception of "ERR# n" will get the error message description. The reply time is less than three seconds for all commands.

There are in addition three errors that can be returned by any of the listed commands:

ERR# 27: Internal device #1 timeout error (internal failure)
ERR# 28: Internal device #2 timeout error (internal failure)
ERR# 30: Fatal Mass flow calc error (*molbloc* or transducer error)

The following program has been written in GWBASIC and is intended as a demonstration program only.

10	CLS	Clear screen
20	OPEN "COM1:2400,E,7,1,CS,CD,DS,LF" AS #1	Set up computer COM1 port for 2400 baud, even parity, 7 data bits, 1 stop bit, no handshaking, send line feed
30	PRINT #1,"ABORT"	Stop all action in *molbox*
40	INPUT #1, REPLY$	Read returned reply
50	PRINT "Received data => ";REPLY$	Print reply
60	PRINT #1,"FR"	Request flow reading
70	INPUT #1,flow$	Read reply
80	flow=VAL(MID$(flow$,3,10))	Pull the numeric part out
90	PRINT "Current flow reading => ";flow$	Print reply
100	CLOSE #1	Close COM1 port
110	END	END program

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ABORT

PURPOSE: To stop an averaging cycle

SYNTAX: "ABORT"

REMARKS: The "FA" command starts an averaging cycle that can be aborted by sending an "ABORT" command.

EXAMPLE: Typical command: "ABORT"

typical reply: "ABORT"

ERROR: none

BEEPER(=)

PURPOSE: Enables/disables the internal beeper

SYNTAX: "BEEPER=n"
"BEEPER"

DEFAULTS n=1

REMARKS: n=1 enable the beeper
n=0 disable the beeper

The *molbloc* internal beeper is used to signal the change of the ready condition, if the user enters an invalid entry, or if the transducers are over the UL pressure limit.

EXAMPLE: Typical command: "BEEPER=0"

typical reply: "BEEPER=0"

ERROR: ERR# 6: Numeric argument missing or out of range

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COM1(=)

PURPOSE: To set or return the configuration of the COM1 port

SYNTAX: "COM1=baud,parity,data,stop"
"COM1"

DEFAULT: COM1=2400,E,7,1

REMARKS: The parameters must be separated by commas. The available parameters are listed below. Once the port is set up the configuration is stored in permanent memory and becomes active on power up.

When the configuration of COM1 is changed, the returned reply will be sent at the original COM1 settings but all subsequent replies will be sent at the new configuration settings.

Serial parameters:

Baud rates:	150, 300, 600, 1200, 2400,4800, 9600
Parity:	O - Odd E - Even N - None
Data bits:	7, 8
Stop bits:	1, 2

EXAMPLE: Typical command: "COM1=9600,E,7,1"

typical reply: "9600,E,7,1"

ERROR: ERR# 7: Missing or improper command arguments
ERR# 11: Command missing argument

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DEVICE=EXT

PURPOSE: To load the data from the external molbloc

SYNTAX: "DEVICE=EXT"

DEFAULTS n/a

REMARKS: The *molbloc* calibration data is loaded on powerup. If the *molbloc* is changed while the power is on the user must reload the molbloc data using this command.

EXAMPLE: Typical command: "DEVICE=EXT"

typical reply: "DEVICE=EXT"

ERROR: ERR# 7: Missing or improper command arguments
ERR #24: *molbloc* not detected

DP

PURPOSE: Return the measured pressure across the *molbloc*

SYNTAX: "DP"

DEFAULTS n/a

REMARKS: The differential pressure across the *molbloc* is used in the flow calculation. The next available differential measurement is read in the units previously selected. The data string also contains flow ready information. The string is in the format "ssx dddddddd uuuuu".

The ready information is either "R" for Ready or stable, or "NR" for Not Ready or unstable. The criteria for "N" or "NR" is the pressure stability value that has been set using PSTAB.

For more information on the available units, see PUNITS.

For more information on the ready setting, see SS.

EXAMPLE: Typical command: "DP"

typical reply: "R 0.1456 psi"

ERROR: none

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DUT(=)

PURPOSE: To set or return the currently selected DUT (device under test)

SYNTAX: "DUT=n"
"DUT"

DEFAULTS DUT=1

REMARKS: n is the DUT index number from 1 to 26.

Up to 26 DUT configurations can be setup at once. Each of these DUT setups is assigned an index number from 1 to 26. DUT setup #26 is reserved for remote access only and cannot be accessed locally. Once a DUT is defined using the "DUTn" command, it can be selected using the "DUT=n" command.

If you are specifying a user flow unit for the range (see FUNIT) you must first set the reference temperature (see UTEMP before doing this).

EXAMPLE: Typical command: "DUT=26"

typical reply: "26"

ERROR: ERR #6: Numeric argument missing or out of range
ERR #10 DUT not defined or selected

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DUTx(=)

PURPOSE: Returns or defines a DUT setup. This must be done before selecting a DUT to use (see DUT=n).

SYNTAX:

"DUTn=s,v,r,u,g"
"DUTn"

DEFAULT: n/a

REMARKS:

n= the number to assign or assigned to this DUT (1 to 26)
s= the serial number of the DUT (0 to 99999 numeric only)
v= the voltage needed by the DUT for F.S. output (volts)
r= the range of the DUT
u= the range units (see FUNIT for a list of valid flow units)
g= the DUT gas type (4 character alphanumeric field)

The *molbox* sends a control voltage to the DUT to set the DUT flow to a specific target. The *molbox* must know some information about the DUT before this can be done. You can define up to 26 DUTs at a time and then select which DUT to use by using the "DUT=n" command.

To define an DUT serial number 1234, 10 slm at 5 volts, N2 gas:

EXAMPLE: Typical command: "DUT3=1234,5,10,slm,N2"

typical reply: "1234,5,10,slm,N2"

ERROR:

ERR# 2: Text argument is too long
ERR# 6: Numeric argument missing or out of range
ERR# 7: Missing or improper command argument(s)
ERR# 10: DUT not defined or selected

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ERR

PURPOSE: To read the error message of the last command

SYNTAX: "ERR"

DEFAULT: ERR# 0 = OK

REMARKS: If the last response returned from the *molbox* was an error (ERR# xx) then the error message that corresponds to that error can be read. If an error is received and a valid command is sent to the *molbox* before the "ERR" command has been sent, the error pointer is reset and an "ERR# 0 = OK" will be returned with the next "ERR" command.

ERROR MESSAGES:

"ERR# 0 = OK"
"ERR# 1 = *molbloc* flow is too great"
"ERR# 2 = Text argument is too long"
"ERR# 3 = User defined coefficient cannot be 0"
"ERR# 6 = Numeric argument missing or out of range"
"ERR# 7 = Missing or improper command argument(s)"
"ERR# 9 = Unknown command"
"ERR# 10 = DUT not defined or selected"
"ERR# 11 = Command missing argument"
"ERR# 12 = System overpressured"
"ERR# 13 = Text detected in numeric field"
"ERR# 14 = User unit not defined"
"ERR# 15 = File does not exist"
"ERR# 16 = DUT malfunction"
"ERR# 17 = Selected gas not available"
"ERR# 18 = Command not yet available"
"ERR# 22 = Pressure is not stable"
"ERR# 23 = Option not available or installed"
"ERR# 24 = *molbloc* not detected"
"ERR# 25 = Transducer out of calibration"
"ERR# 26 = COM port failed to initialize"
"ERR# 27 = Internal device#1 timeout error"
"ERR# 28 = Internal device#2 timeout error"
"ERR# 29 = Busy averaging"
"ERR# 30 = Fatal mass flow calc error"
"ERR# 31 = *molbloc* EPROM is full"
"ERR# 32 = *molbloc* gas not found"

EXAMPLE: Typical command: "ERR"

typical reply: "ERR# 0 = OK"

ERROR: none

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FA=

PURPOSE: To start a single flow averaging cycle

SYNTAX: "FA=n"

DEFAULTS n/a

REMARKS: n is the averaging period in seconds (from 4 to 999).

This command is used to start an averaging period that results in the average flow, DUT measurement and standard deviation of the flow. After sending the "FA=" command you can monitor the averaging cycle by using the "FR" command to determine when the averaging cycle is complete. Once the cycle is done, you must use the "FRA" command to collect the results.

The averaging cycle can be canceled by sending a number of commands. "ABORT" should be used if you specifically wish to cancel the cycle. Other commands that will also cancel it are:

DEVICE=EXT
FA=
FS=
FUNIT(=)
GAS(=)
LOCAL
PUNIT(=)
RESET
SUNIT(=)
VS=

EXAMPLE: Typical command: "FA=20"

typical reply: "20 s"

ERROR: ERR #6: Numeric argument missing or out of range

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FCOEF

PURPOSE: To read the value of the current flow unit converter

SYNTAX: "FCOEF"

DEFAULT: FCOEF=4.798073e+07

REMARKS The Flow Coefficient (FCOEF) is a value that is used to convert kg/s to the current flow units. It will change if you change the current flow unit (FUNIT) or the current gas type (GAS).

The conversion coefficients are listed under the "FUNIT" command and they are dependent on the gas type used.

EXAMPLE: Typical command: "FCOEF"

typical reply: 4.798073e+07"

The above example returned the value used to change kg/s to sccm using nitrogen gas.

Flow in current units = kg/s x FCOEF

ERROR: none

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FR

PURPOSE: Read the next available flow measurement

SYNTAX: "FR"

DEFAULT: n/a

REMARKS: The next available flow value is read in the units previously selected. The data string also contains ready information. The string is in the format "ssx ddddddd uuuuuu".

The ready information is either "R" for Ready or stable, or "NR" for Not Ready or unstable. The criteria for "R" or "NR" is the stability value that has been set using the SS command.

An additional "R" will be appear in the third position if the *molbloc* flow is exceeds the maximum Reynolds number of 1 200 allowed.

An "a" will appear in the third position if the *molbox* is in an averaging cycle (see FA=).

The data is the returned flow in the corresponding units. For more information on the available units, see the FUNITS command.

For more information on the ready setting, see SS.

EXAMPLE: Typical command: "FR"

typical reply: "R 56.10 sccm"

The length of the returned string is 20 characters. The numeric portion of the reply will be in scientific notation if necessary. To strip off the stability data and the units and convert the string to a real number, the following command can be added at Line 35.

```
35 IN=VAL(MID$(IN$,4,10))
40 PRINT IN
```

typical reply: "56.10"

ERROR: none

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FRA

PURPOSE: To check on or collect the results of an averaging cycle started by using the FA command

SYNTAX: "FRA"

DEFAULTS none

REMARKS: This command is used to check on the status of or collect the results of an averaging cycle that was started earlier using the "FA=" command. During the averaging cycle this command will reply "BUSY" until the averaging cycle is complete. The reply will be the results of the averaging cycle. If the cycle is aborted before it is complete (see FA=) the data will be lost.

The data that is returned from the command consists of multiple numeric fields delimited by commas. The flow numbers are in the current flow units and the voltages are in volts. The actual data fields returned are as follows:

An "H" will appear as the first character of the reply string if the flow stayed within the sequence hold setting during the integration period. An "S" will appear as the second character of the string if the flow stability stayed within the sequence stability setting. From the fourth position on, the numeric data fields exist:

1 Average flow over the integration period
2 Standard deviation of flow over the integration period
3 The minimum flow reached during the period
4 The maximum flow reached during the period
5 The target flow (in the current set point flow units)
6 Average DUT voltage output over the integration period (volts)

EXAMPLE: Typical command: "FRA"

typical reply: " S 98.234,98.123,99.0823,100.00,0.9973"
typical reply: " 98.234,98.123,99.0823,100.00,0.9973"
typical reply: "BUSY" (if currently averaging)

ERROR: ERR# 6: Numeric argument missing or out of range
ERR# 15: File does not exist

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FS=

PURPOSE: To set a desired flow with an external DUT

SYNTAX: "FS=n"

DEFAULT: FS=0

REMARKS: n= the flow target in the current set point flow units (see SUNIT).

The flow command is interpreted in whatever set point flow unit the system has last been set (see SUNIT). If a flow is requested that is greater than the DUT range or 20% over the range of the *molbloc*, the flow request will not be implemented and an error will returned. You must make sure that adequate line pressure is available to maintain the requested flow. The DUT must be connected to the *molbox*, defined and selected before executing a flow set.

If DUT regulation is enabled (see MODE), the *molbox* will regulate the flow of the DUT using the *molbloc* as a reference (see MODE).

EXAMPLE: Typical command: "FS=50"

typical reply: "50.00 sccm"

ERROR: ERR# 6: if n >100% of the DUT F.S. range or >120% of the *molbloc* range

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FS=

PURPOSE: To set a desired flow with an external DUT

SYNTAX: "FS=n"

DEFAULT: FS=0

REMARKS: n= the flow target in the current set point flow units (see SUNIT).

The flow command is interpreted in whatever set point flow unit the system has last been set (see SUNIT). If a flow is requested that is greater than the DUT range or 20% over the range of the *molbloc*, the flow request will not be implemented and an error will returned. You must make sure that adequate line pressure is available to maintain the requested flow. The DUT must be connected to the *molbox*, defined and selected before executing a flow set.

If DUT regulation is enabled (see MODE), the *molbox* will regulate the flow of the DUT using the *molbloc* as a reference (see MODE).

EXAMPLE: Typical command: "FS=50"

typical reply: "50.00 sccm"

ERROR: ERR# 6: if n >100% of the DUT F.S. range or >120% of the *molbloc* range

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FUNIT(=)

PURPOSE: Set or change the current flow units

SYNTAX: "FUNIT=x"
"FUNIT"

DEFAULT: FUNIT=mol/s

REMARKS: x= the valid flow unit to change to

The units in which the *molbox* interprets and executes commands can be changed. These units represent flow in local and remote operation. The available units are:

Standard Flow units:

mol/s	scfm
kg/s	scfh
mg/s	%FS
slm	V
sccm	

User Flow units:

ulm	ucfm
uccm	ucfh

Listed below are the conversion coefficients for converting kg/s to sccm and mole/s flow units for each type of gas.

GAS TYPE	SCCM	MOLE/S
N2	4.798073e+07	3.569720e+01
Ar	3.363413e+07	2.503250e+01
He	3.362098e+08	2.498380e+02
H2	6.674809e+08	4.960320e+02
O2	4.199031e+07	3.125120e+01
Air	4.641082e+07	3.453160e+01
N2O	3.033217e+07	2.272060e+01
CF4	1.523856e+07	1.136240e+01
CH4	8.363512e+07	6.233251e+01
CHF3	1.901278e+07	1.428370e+01
SF6	9.066020e+06	6.846970e+00
C2F6	9.604304e+06	7.245330e+00
C2H4	4.758121e+07	3.564550e+01
CO2	3.034900e+07	2.272210e+01
C3H6	3.138613e+07	2.376430e+01
C3H8	2.985163e+07	2.267780e+01

The User defined flow units are similar to the standard units except that the user may change the temperature reference for the user units using the UTEMP command.

EXAMPLE: Typical command: "FUNIT=mol/s"

typical reply: "mol/s "

ERROR: ERR #6: an invalid unit was specified

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GAS(=)

PURPOSE: Sets or returns the gas type used

SYNTAX: "GAS=x"
"GAS"

DEFAULT: GAS=N2

REMARKS x= the gas type to change to

The gas type used must be specified before valid flow measurements are made. If the *molbloc* has not been calibrated for the selected gas then the calibration for N2 will be used.

N2	Nitrogen
Ar	Argon
He	Helium
H2	Hydrogen
O2	Oxygen
Air	Air
N2O	Nitrus Oxide
CF4	Carbon Tetrafluoride
CH4	Methane
CHF3	Fluoroform
SF6	Sulfur Hexafluoride
C2F6	Hexafluoroethane
C2H4	Ethylene
CO2	Carbon Dioxide
C3H6	Propylene
C3H8	Propane

EXAMPLE: Typical command: "GAS=Ar"

typical reply: "Ar"

ERROR: ERR# 6: Numeric argument missing or out of range
ERR# 17: Selected gas not available

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KFACT(=)

PURPOSE: Enable/disable and define the "K" factor

SYNTAX: "KFACT=x"
"KFACT"

DEFAULT: "1.0000" (Disabled)

REMARKS: The "K" factor is used to modify the displayed measured flow to allow the use of different gases with a DUT. It is multiplied by the measured flow before the flow is displayed. Setting it to 1.00 will disable it.

EXAMPLE: Typical command: "KFACT=0.911000"

typical reply: "0.911000"

ERROR: none

LOCAL

PURPOSE: Place the device in the LOCAL mode

SYNTAX: "LOCAL"

DEFAULT: n/a

REMARKS: In Local mode all front panel operations are available. The Local command deactivates Remote mode.

EXAMPLE: Typical command: "LOCAL"

typical reply: "LOCAL"

ERROR: none

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MEM

PURPOSE: Read the status of the internal data RAM since the last power up

SYNTAX: "MEM"

DEFAULT: n/a

REMARKS: On power up a memory test is run to check the integrity of the internal data RAM. If the memory has been corrupted then "MEMORY FAULT" will be displayed on power up to alert the user. The status of the memory can be read from a remote computer.

Return string:
"MEM=1" system memory is OK
"MEM-0" system memory has been corrupted and the default operating parameters have been loaded into memory

EXAMPLE: Typical command: "MEM"

typical reply: "MEM=1"

ERROR: none

MODE(=)

PURPOSE Reads or sets the current mode of DUT voltage control

SYNTAX: "MODE=n"
"MODE"

DEFAULT: MODE=0

REMARKS: n= 0 to disable flow regulation
2 to 20 to enable and specify regulation period

The *molbox* can regulate the flow of a DUT by using the *molbloc* as a reference. The period that the *molbox* adjusts the DUT can be set from 2 to 20 seconds. This is to allow compensation for a DUT that is slow to react to voltage adjustments or if there is significant volume between the *molbloc* and a DUT. Setting MODE to 0 disables it and the *molbox* will set the DUT voltage only when a new target flow is specified.

EXAMPLE: Typical command: "MODE=3"

typical reply: "3 sec"

ERROR: ERR #6: Numeric argument missing or out of range

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MOLBLOC

PURPOSE: Returns the external *molbloc* header data

SYNTAX: "MOLBLOC"

DEFAULT: n/a

REMARKS: The external *molbloc* header data includes the serial number, range, calibration date and PRT calibration data. This data is stored in the *molbloc* and is downloaded to the *molbox* on power up. The data is returned in a single comma delimited string in the following order:

Serial number
Range
Range flow units
Calibration date (mm/dd/yy)
PRT resistance at 0°C
PRT slope (°C/ohm)

EXAMPLE: Typical command: "MOLBLOC"

typical reply: " 100,1000,sccm,12/10/92,199.998,0.7792"

ERROR: none

PCOEF

PURPOSE: To read the value of the current pressure unit converter

SYNTAX: "PCOEF"

DEFAULT: PCOEF=0.0001450377

REMARKS: The Pressure Coefficient (PCOEF) is a value that is used to convert Pascal units to the current pressure units.

EXAMPLE: Typical command: "PCOEF"

typical reply: 1.45038e-04"

The above example returned the value used to change psi to Pascal.

Pressure in current units = Pressure in Pascal x PCOEF

ERROR: none

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PR

PURPOSE: Read the next available average pressure value

SYNTAX: "PR"

DEFAULT: n/a

REMARKS: The next available average pressure value is read in the units previously selected. It is the average of the upstream and the downstream transducers. The data string also contains flow ready information. The string is in the format "ss dddddddd uuuuuu".

The ready information is either "R" for Ready or stable, or "NR" for Not Ready or unstable. The criteria for "R" or "NR" depends on the pressure stability value that has been set using the "PSTAB" command. If the current average pressure rate of change is greater than the stability value, then the pressure value will become Not Ready.

The data is the returned pressure in the corresponding units.

For more information on the available units, see PUNITS.

EXAMPLE: Typical command: "PR"

typical reply: "R 26.1214 psia"

The length of the returned string is 20 characters. To strip off the stability data and the units and convert the string to a real number, the following command can be added at Line 35.

```
35 IN=VAL(MID$(IN$,3,10))
40 PRINT IN
```

typical reply: "26.1214"

ERROR: none

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PRHI

PURPOSE: Read the current upstream pressure value

SYNTAX: "PRHI"

DEFAULT: n/a

REMARKS: The current upstream pressure value (corrected for tare) is read in the pressure units previously selected. The string is in the format "dddddddd uuuuu". The data is the returned pressure in the corresponding units.

For more information on the available units, see PUNITS.

EXAMPLE: Typical command: "PRHI"

typical reply: "26.4014 psia"

ERROR: none

PRLO

PURPOSE: Read the current downstream pressure value

SYNTAX: "PRLO"

DEFAULT: n/a

REMARKS: The current downstream pressure value (corrected for tare) is read in the units previously selected. The data is the returned pressure in the corresponding units.

For more information on the available units, see PUNITS.

EXAMPLE: Typical command: "PRLO"

typical reply: "25.8414 psia"

ERROR: none

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PSTAB(=)

PURPOSE: Read or set the tare pressure stability criteria

SYNTAX: "PSTAB=n"
"PSTAB"

DEFAULT: PSTAB=10 Pa/s

REMARKS: n= the tare stability in Pascal/second

The tare stability criteria is used to determine if the internal transducers can be tared. If the current pressure rate of change exceeds this criteria a tare will not be allowed (see TARE and TARESET).

EXAMPLE: Typical command: "PSTAB=20"

typical reply: "20 Pa/s"

ERROR: none

PUNIT(=)

PURPOSE: Set or change the current flow units

SYNTAX: "PUNIT=x"
"PUNIT"

DEFAULT: PUNIT=psia

REMARKS: x= the pressure unit in which the *molbox* interprets and executes pressure commands. The available units are:

Unit	Coefficient
psia	0.000145038
bara	0.00001
mbara	0.01
Paa	1.0
kPaa	0.001
mmHga	0.00750063 @ 0°C
inHga	0.0002953 @ 0°C
inWaa	0.004021732 @ 20°C
mmWaa	0.1019716 @ 4°C
kcm2a	0.0000101972
user	user defined

EXAMPLE: Typical command: "PUNIT=mbara"

typical reply: "mbara"

ERROR: ERR# 7: Missing or improper command arguments

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RANGE

PURPOSE: To read the range of the *molbloc* currently in use in the *molbloc* range unit

SYNTAX: "RANGE"

DEFAULT: n/a

REMARKS: The range of the external *molbloc* can be read from the *molbox*.

EXAMPLE: Typical command: "RANGE"

typical reply: "1000.0 sccm"

ERROR: none

RATE

PURPOSE: To read the current rate of change of flow

SYNTAX: "RATE"

DEFAULT: n/a

REMARKS: The current rate of change of flow in units per second can be read. A positive value indicates that the flow is increasing while a negative value indicates that the flow is decreasing.

EXAMPLE: Typical command: "RATE"

typical reply: " 0.02 sccm/s"

ERROR: none

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RE

PURPOSE: Returns the current Reynolds number

SYNTAX: "RE"

DEFAULT: n/a

REMARKS: The Reynolds number varies with the *molbloc* flow. If it exceeds 1 200, the accuracy of the laminar flow calculation may not meet the *molbloc* accuracy.

EXAMPLE: Typical command: "RE"

typical reply: "88.24"

ERROR: none

READYCK(=)

PURPOSE: To set or check the ready check flag, or, used to determine if a Not Ready condition has occurred

SYNTAX: "READYCK=1"
"READYCK"

DEFAULT: READYCK=0

REMARKS: The internal ready check flag is cleared whenever the *molbox* reaches a Not Ready (NR) condition. The "READYCK" command will return the status of this flag. This flag can be set only by sending the "READYCK=1" command while the *molbox* is in a Ready condition. If you send the "READYCK=1" command when the *molbox* is in a Not Ready (NR) condition, the reply will be "READYCK=0".

If you set READYCK=1 when the *molbox* achieves a Ready (R) condition, you can use READYCK later to determine if a Not Ready (NR) condition has occurred. If NR has occurred, READYCK will return "0". If NR has not occurred, READYCK will return "1".

EXAMPLE: Typical command: "READYCK=1"

typical reply: "READYCK=1" (if *molbox* condition is Ready)
typical reply: "READYCK=0" (if *molbox* condition is Not Ready)

ERROR: ERR# 6: Numeric argument missing or out of range

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REMOTE

PURPOSE: To place the device into a Remote lock-out mode

SYNTAX: "REMOTE"

DEFAULT: n/a

REMARKS: A REMOTE command deactivates the front panel. All front panel controls will be disabled.

The REMOTE command can only be cancelled by a LOCAL command or by turning off the *molbox* power then re-applying it.

EXAMPLE: Typical command: "REMOTE"

typical reply: "REMOTE"

ERROR: none

RESET

PURPOSE: To reset all operating parameters to factory default settings

SYNTAX: "RESET"

DEFAULT: n/a

REMARKS: The RESET command can be given to return the *molbox* to a known state. This command should be used with care because all configuration information will be lost (see Section 3.3.8.1.2 - Special - Internal - Reset - All). The reset process can take up to 15 seconds to complete so the user must wait this time interval before attempting to communicate to the *molbox* again.

EXAMPLE: Typical command "RESET"

typical reply: "RESET"

ERROR: none

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SN

PURPOSE: To return the current *molbox* serial number

SYNTAX: "SN"

DEFAULT: n/a

REMARKS: The *molbox* serial number will be returned.

EXAMPLE: Typical command: "SN"

typical reply: "108"

ERROR: none

SR

PURPOSE: To read the current Ready status

SYNTAX: "SR"

DEFAULT: n/a

REMARKS: The current Ready status can be read directly using this command. If the reply is "NR" then the flow is Not Ready within the limits set by "SS". If the reply is "R" then the flow is Ready within the limits.

An "R" will appear as the third character if the *molbloc* flow is over the maximum flow allowed for a valid measurement.

EXAMPLE: Typical command: "SR"

typical reply: "R"

ERROR: none

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SS(=)

PURPOSE: Set or read the stability limit in flow unit/sec

SYNTAX: "SS=nn"
"SS"

DEFAULT: SS= 0.1% F.S./sec

REMARKS: The stability setting is one of the criteria that determines whether the ready light will go on and whether the flow values returned by "FR" will be preceded by "R" or "NR". Stability is set in terms of flow. If the rate of change of flow is greater than the current setting then the Not Ready status will be displayed and any corresponding flow readings ("FR") will return "NR" at the beginning of the string.

nn is a value in flow unit/sec

EXAMPLE: Typical command: "SS=.1"

typical reply: "0.10 sccm"

ERROR: ERR# 6: Numeric argument missing or out of range

SS%(=)

PURPOSE: Set or read the stability limit in % F.S./sec

SYNTAX: "SS%=nn"
"SS%"

DEFAULT: SS=0.1% F.S./sec

REMARKS: The stability setting is one of the criteria that determines whether the ready light will go on and whether the flow values returned by "FR" will be preceded by "R" or "NR". Stability is set in terms of flow. If the rate of change of flow is greater than the current setting then the Not Ready status will be displayed and any corresponding flow readings ("FR") will return "NR" at the beginning of the string.

nn is a value in % F.S./sec.

EXAMPLE: Typical command: "SS%=.1"

typical reply: ".1%"

ERROR: ERR# 6: Numeric argument missing or out of range

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SUNIT(=)

PURPOSE: Set or change the target set point units

SYNTAX: "SUNIT=xxxxxx"
"SUNIT"

DEFAULT: SUNIT=V

REMARKS: The flow units in which the *molbox* uses for targets ONLY can be changed. These units represent set points in Local and Remote operation. The available units are:

V	volts
%FS	percent full scale of the DUT
DUTUNIT	same as the current DUT range units

This unit is used whenever you set or read back a set point target ONLY. Actual measured flow is always displayed in the current flow unit (see FUNIT). When DUTUNIT is selected the unit will be the same as the currently selected DUT range unit and it will change if the DUT is changed.

EXAMPLE: Typical command: "SUNIT=DUTUNIT"

typical reply: "DUTUNIT"

ERROR: ERR# 7: Missing or improper command arguments

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TARE

PURPOSE: Returns the current average pressure stability, the differential pressure, and the previous tare value

SYNTAX: "TARE"

DEFAULT: n/a

REMARKS: The user should check the tare conditions before taring the internal transducers (see TARESET). The returned data will allow the user to determine if the current conditions will allow a valid tare.

The reply contains three fields which are separated by commas. The first field starts with an "R" if the pressure stability criteria has been met (see PSTAB) or an "NR" if the criteria is not met. The "R" must be present to tare the transducers. The actual pressure rate in Pascal/sec will follow this text.

The second field displays the current difference of the upstream and downstream transducers without tare correction in Pascal. The absolute value of this pressure must be less than 120 Pascal to tare the transducers.

The third field displays the last tare value that is currently utilized.

EXAMPLE: Typical command: "TARE"

typical reply: "R -1 Pa/s,25 Pa, 27 Pa"

The current pressure rate is -1 Pa/second, the last tare value saved was 27 Pa, and the current differential pressure is 25 Pa.

ERROR: none

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TARESET

PURPOSE: To execute the tare of the two internal transducers at zero flow

SYNTAX: "TARESET"

DEFAULT: n/a

REMARKS: The two internal pressure transducers are used to measure a differential pressure across a restriction. They must be tared at a zero flow condition if the line pressure is changed significantly. The *molbloc* must be at normal operational pressure with no leaks and no flow before executing a tare.

The user should check the tare conditions before taring the internal transducers. The TARE command will return data that will allow the user to determine if the current conditions will allow a valid tare.

EXAMPLE: Typical command: "TARESET"

typical reply: "25 Pa"

NOTE: The returned tare value is always in Pascal.

ERROR: ERR# 22: Pressure is not stable
ERR# 25: Transducer out of calibration

TEMP

PURPOSE: Return the current mobloc PRT temperature measurement in the current temperature units

SYNTAX: "TEMP"

DEFAULT: n/a

REMARKS: The *molbloc* temperature is measured with two PRTs. The measurement is in ohms and is an average of the PRT pair. This number is then converted to the proper temperature unit. Two internal standard resistors are used to calibrate this measurement on power up and every 30 seconds while in Remote and in Local when in the Run screen.

EXAMPLE: Typical command: "TEMP"

typical reply: "24.12 C"

ERROR: none

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TF

PURPOSE: To read the value of the last specified target flow

SYNTAX: "TF"

DEFAULT: 0.0000 V

REMARKS: The current target flow value can be read using this command. It will be returned in the current set point flow units (see SUNIT).

EXAMPLE: Typical command: "TF"

typical reply: "1.000 V"

ERROR: none

TUNIT(=)

PURPOSE: To set or return the PRT temperature units

SYNTAX: "TUNIT=x"
"TUNIT"

DEFAULT: x = C (degrees Celsius)

REMARKS: The PRT temperature can be read using the PRT command. The returned measurement can be in degrees Celsius or degrees Fahrenheit.

x = 'C' or 'c' for Celsius
x = 'F' or 'f' for Fahrenheit

EXAMPLE: Typical command: "TUNIT=F"

typical reply: "F"

ERROR: ERR# 6: the argument is a character other than "C" or "F"

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UL(=)

PURPOSE: Set or read the upper pressure limit for the internal transducers

SYNTAX: "UL=n"
"UL"

DEFAULT: UL=363 kPaa

REMARKS: n= the upper limit in the current pressure units

If the pressure of either internal transducer exceeds this value the internal beeper will sound even if it has been disabled.

EXAMPLE: Typical command: "UL=40"

typical reply: "40.00 psia"

ERROR: ERR# 6: Numeric argument missing or out of range

USERCAL(=)

PURPOSE: Set or read the user definable adder and multiplier

SYNTAX: "USERCAL=a,m"
"USERCAL"

DEFAULT: USERCAL=0,1

REMARKS: a= the adder in the current flow units (see FUNIT)
m= the multiplier

The user definable calibration lets the user modify the measured flow. The adder and multiplier are separated by a comma. The measured flow is modified using the following calculation:

displayed flow = (actual flow x multiplier) + adder

EXAMPLE: Typical command: "USERCAL=.08,0.99986"

typical reply: "0.08 sccm,0.99986"

ERROR: none

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UTEMP(=)

PURPOSE: Set or return the temperature reference used with the user defined flow units *uccm*, *ulm*, *ucfm*, and *ucfh* (see FUNIT)

SYNTAX: "UTEMP=n"
"UTEMP"

DEFAULT: UTEMP=20 C

REMARKS: n= the reference temperature in the current temperature units

The user defined units are similar to the standard units, but the user can set the temperature reference for the user units.

If you are going to define a DUT using a user defined unit you must first set the reference temperature of this unit using UTEMP (see DUTn also).

EXAMPLE: Typical command: "UTEMP=20"

typical reply: "20.00 C"

ERROR: none

VER

PURPOSE: Read the version number of the internal software

SYNTAX: "VER"

DEFAULT: n/a

REMARKS: The software version of the *molbox* can be read.

EXAMPLE: Typical command: "VER"

typical reply: "DH INSTRUMENTS, INC molbox1 Ver 3.03 "

ERROR: none

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VIN

PURPOSE: Returns the voltage measurement of the DUT flow output

SYNTAX: "VIN"

DEFAULT: n/a

REMARKS: The external DUT normally outputs a voltage that corresponds to a flow measurement made inside the DUT. This voltage measurement is accessed with the VIN command. The voltage is returned as volts DC. The absolute maximum allowed input is 5.10 volts.

EXAMPLE: Typical command: "VIN"

typical reply: "4.322 v"

ERROR: none

VOUT(=)

PURPOSE: Returns or sets the voltage output to the DUT

SYNTAX: "VOUT="1.234"
"VOUT"

DEFAULT: n/a

REMARKS: The *molbloc* sends a control voltage to the DUT to set the DUT flow to a specific target. The VOUT command can directly set the voltage or read the current voltage setting from 0 to 5.00 volts.

This command will not change the current flow target. If flow regulation is currently enabled (see MODE) the regulation will continue to regulate at the current target even if you try to use the VOUT command to change the DUT voltage.

EXAMPLE: Typical command: "VOUT = 2.50"

typical reply: "2.500 V"

ERROR: ERR# 6: Numeric argument missing or out of range

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VS=

PURPOSE: Return or set a desired flow with an external DUT

SYNTAX: "VS=n"

DEFAULT: n/a

REMARKS: n= 0 to F.S. voltage of the DUT (in volts)

This command is similar to the FS command except that the VS command argument is interpreted in volts. If a voltage is requested that is not in the normal range of operation the voltage request will not be implemented and an error will returned. Otherwise, the DUT voltage will be set to the target value. You must make sure that adequate line pressure is available to maintain the requested flow. The DUT must be connected to the *molbox*, defined and selected before executing a flow set.

EXAMPLE: Typical command: "VS=1.50"

typical reply: "1.50 V"

ERROR: ERR# 6: Numeric argument missing or out of range

VSENSE

PURPOSE: Return the measurement of the DUT set voltage

SYNTAX: "VSENSE"

DEFAULT: n/a

REMARKS: When the *molbox* sets a target voltage for the external DUT, a sense input measures this voltage at the DUT and is used to correct the set voltage. This corrects for line losses that could occur. This measurement is accessed using VSENSE.

EXAMPLE: Typical command: "VSENSE"

typical reply: "1.256 V"

ERROR: none

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4.4 SAMPLE PROGRAM

The following program demonstrates a procedure that could be followed to correctly set a desired flow. The COM commands reply contains commas that most basic programs recognize as line delimiters. If the data is to be read correctly it may be necessary to use the LINE INPUT command found in most BASICS.

```
10   ' Sample program
20   CLS
30   OPEN "COM1:2400,E,7,1,CS,CD,DS,LF" AS #1      Open computer COM1 port
40                                                  for communications:
50                                                  2400 baud, even parity,
60                                                  7 data bits, 1 stop bit,
70                                                  no handshaking, send
80                                                  line feed
90
100  PRINT #1, "ABORT"                             Stop any current averaging
110  INPUT #1, IN$                                 Read returned data
120  PRINT IN$                                     Display returned data
130  '
140  PRINT #1, "RANGE"                             Read the range of molbox
150  INPUT #1, RG$                                 Read returned data
160  PRINT "Range => ";RG$                         Display returned data
170  RG=VAL(RG$)                                   Set RG value
180  '
190  '
200  PRINT #1, "SUNIT=V"                           Set point units to volts
210  INPUT #1, UNIT$                               Read returned data
220  PRINT "Set Unit => ";UNIT$                    Display returned data
230  '
240  PRINT #1, "SS%=.1"                            Set flow stab to 0.1% F.S.
250  INPUT #1, SS$                                 Read returned data
260  PRINT "Stability Setting => ";SS$;"%"         Display returned data
270  '
280  PRINT #1, "FS=2.5"                            Request flow target of 2.5 V
290  INPUT #1, PS$                                 Read returned data
300  PRINT "flow targ=";PS$;                       Display returned data
310  '
320  PRINT #1, "FR="                               Request flow measurement
330  INPUT #1, PS$                                 Read returned data
340  PRINT "flow=";PS$;                            Display returned data
350    GOTO 320                                    Loop back
360
```


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4.5 SERIAL SIGNAL DESCRIPTION

The *molbox* is equipped with a serial port. COM1 is configured as a DCE type device for RS232 communications which means COM1 always transmits data on Pin 2 and receives data on Pin 3. This port is designed to communicate with a host computer.

PIN DESIGNATION

COM1

2	TxD
3	RxD
5	Gnd

TxD - Transmit Data - Output
This pin transmits serial data from the *molbox* to the host computer.

RxD - Receive Data - Input
This pin accepts serial data sent by the host computer.

Gnd - Ground
This pin sets the ground reference point for the other RS232 inputs and outputs.

4.5.1 SERIAL CABLE WIRING DIAGRAMS

If a cable was not purchased with the *molbox*, the following diagrams will be helpful in making your own cable for communication with the host.

IBM PC/XT/PS2 to *molbox*

DB-25 Female			DB-9 Male	
TxD	2	---------->	3	RxD
RxD	3	<----------	2	TxD
Gnd	7	<---------->	5	Gnd

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IBM AT to *molbox*				
DB-9 Female			DB-9 Male	
TxD	3	---------->	3	RxD
RxD	2	<----------	2	TxD
Gnd	5	<---------->	5	Gnd

4.5.2 SERIAL PORT CONFIGURATION

The default operating parameters for COM1 are:

2 400 baud
Even Parity
7 Data Bits
1 Stop Bit
Serial Terminator CR-LF

These parameters can be changed using the COM1 command or through the front panel (see 3.3.8.2.1 - Special - Internal - Remote - IEEE).

The *molbox* looks for a carriage return and a line feed to terminate the received data string. The host computer should make certain that a carriage return and a line feed are at the end of the string.

The *molbox* always transmits a reply or error message after receiving a command. You must wait to receive this command before issuing another command.

4.6 IEEE OPTION

The command syntax is the same for IEEE as it is for RS232. Please refer to the programming section in the manual for proper format.

- **IEEE Defaults**

  Address: 10
  Bus terminator: CR, LF, EOI enabled

- **IEEE functions supported**

  SH1, AH1, T4, L2, RL2, DC2

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4.7 REAR PANEL CONNECTOR PINOUT

Analog Port (for DUT connection)	
1) N/C	6) DUT Set (+)
2) DUT Measure (+)	7) DUT Measure (-)
3) +15 Volts	8) DUT Set (-)
4) Supply Common	9) Sense
5) -15 Volts	

molbloc Connector	
1) Source (+)	9) N/C
2) Measure (+)	10) N/C
3) Measure (-)	11) N/C
4) Source (-)	12) Chip select
5) +5 Volts	13) Clock
6) N/C	14) Data to EPROM
7) N/C	15) Data from EPROM
8) Ground	

4.8 DUT WIRING DIAGRAM

When connecting a DUT to the *molbox* the following diagram should be used to ensure that the device is connected properly. Try to minimize the cable length to ensure low line losses.

MOLBOX ANALOG PORT TO DUT WIRING			
molbox **ANALOG PORT**		**<----------->**	**DEVICE UNDER TEST**
1)	N/C		
2)	DUT Output (+)	--------<--------	DUT Output (+)
3)	+15 Volts	----------	+15 Volt Supply
4)	Supply Common	----------	Supply Common
5)	-15 Volts	----------	-15 Volt Supply
6)	DUT Setpoint (+)	--------->-----*--	DUT Setpoint (+)
7)	DUT Outpoint (-)	--------<-----|--	DUT Outpoint (-)
8)	DUT Setpoint (-)	--------->-----|--	DUT Setpoint (-)
9)	Setpoint Sense	*--------<-----|	

BR red or yel gr bl V+ GRy

OUTPUT

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CHAPTER 5 - MAINTENANCE AND ADJUSTMENTS

No special maintenance or adjustments are required for the *molbox*.

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CHAPTER 6 - TROUBLESHOOTING

6.1 CONTROL HARDWARE PROBLEMS

There are conditions which could occur both internal and external to the *molbox* that can either cause damage to the unit or hinder proper operation. A list of possible problems is given below. If additional help is required, contact a DH Instruments Technical Services representative.

SYMPTOM	***POSSIBLE CAUSE***	***SOLUTION***
• Unit inoperable	• No AC power • Blown main fuse	• Plug in unit • Replace fuse
• No computer communication	• Wrong terminating character • Bad interface cable • Improper data framing • Wrong IEEE address • Wrong term character	• See Chapter 4 • Replace cable • See Chapter 4 • Use correct address • Use correct character
• External molbloc load errors	• Check molbloc cable • molbloc damaged	• Correct cabling • Call DH Instruments
• Flow measurement errors	• Check for test leaks • Inlet pressure low	• Correct leaks • Tare transducers • Set pressure
• "CALC ERR" message	• Check *molbloc* connection	• Connect properly
• "TIMEOUT" message	• internal transducer error	• Call DH Instruments

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APPENDIX

The menu trees shown below are provided in the following pages:

molbox1 Menu Tree - Run/Settings

molbox1 Menu Tree - Special

molbox1 Menu Tree - Internal

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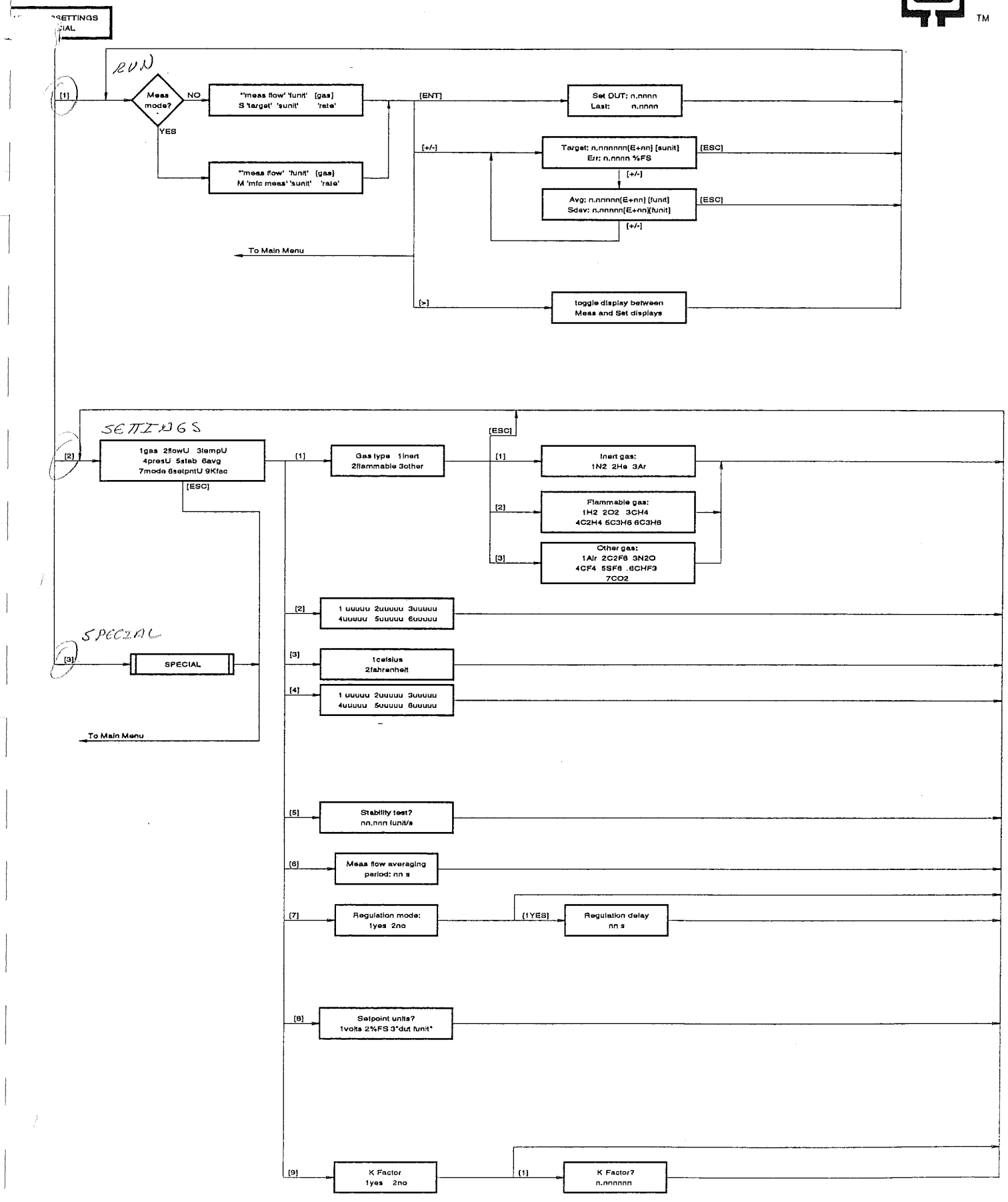
MOLBOX1 MENU TREE - RUN/SETTINGS

TM



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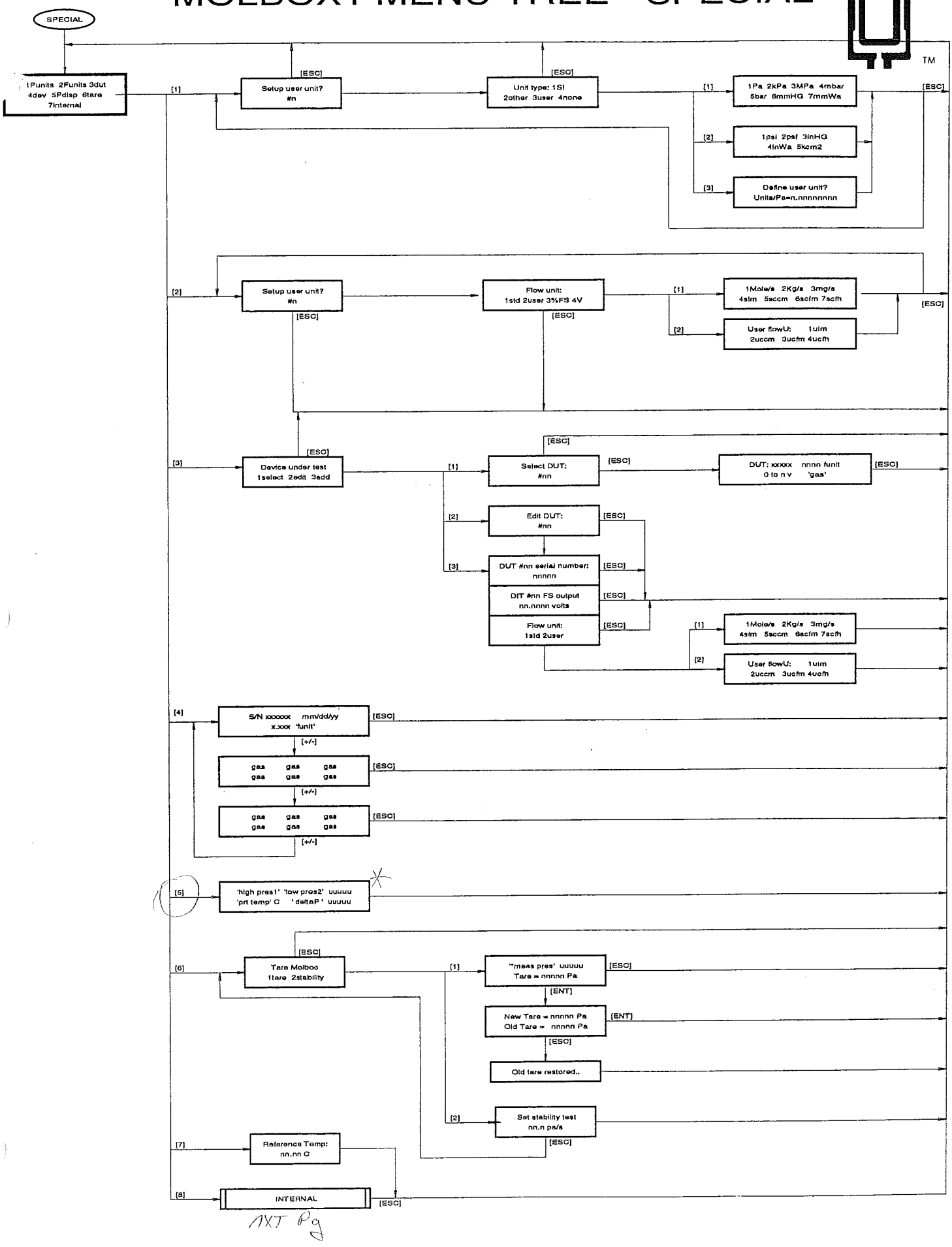
MOLBOX1 MENU TREE - SPECIAL



NXT Pg

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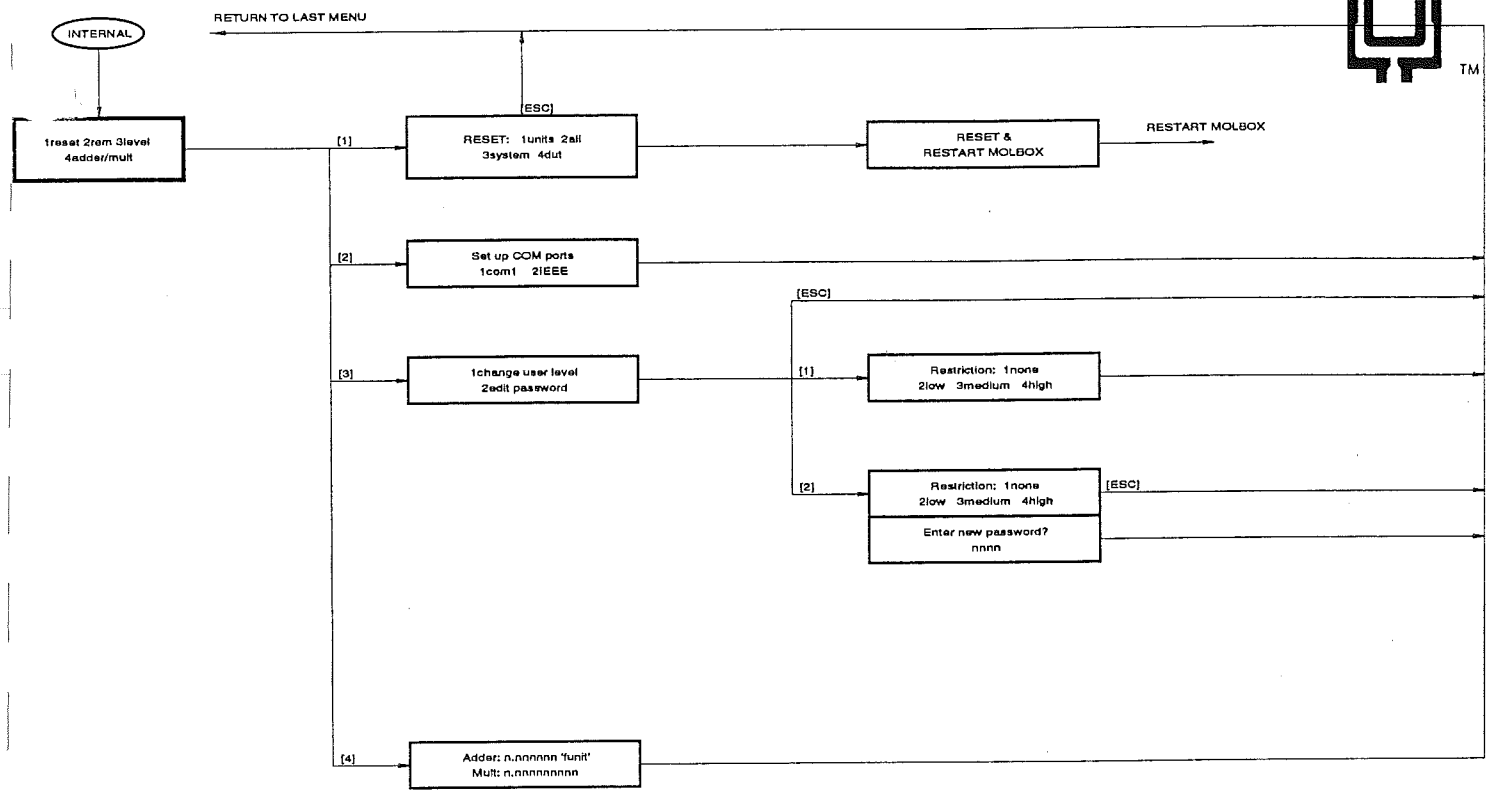
MOLBOX1 MENU TREE - INTERNAL



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