

 Denver Instrument Company

IR - 100_____

MOISTURE ANALYZER

_____ **Operating Instructions**

900271.1

REV. E

Read all instructions prior to operating your moisture analyzer! Remember, this is a precision instrument and should be handled with care.

DISCLAIMER NOTICE

"Calibrate your balance using reference weights of the appropriate tolerance (class). An instrument can be no more accurate than the standard to which it has been compared. For assistance in the selection of reference weights, please contact the factory."

Manufactured by:



Denver Instrument Company

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SAFETY PRECAUTIONS

Every attempt has been made to make this instrument safe and easy to use. However, to avoid burns and possible exposure to harmful fumes from the material being tested, please observe the following precautions:

- Read all instructions prior to operating your unit.
- Upon completion of a procedure, always use tongs to remove the sample pan.
- **Do NOT touch** any metal part of the instrument while it is operating. Some parts will be very **HOT**, even after the completion of the test.
- Know your material being tested.
Do not test flammable or toxic materials!
The unit should be used in a fume hood.
- Know where the fire extinguisher is. Use only extinguishers rated for use on electrical fires.
- Keep the instrument clean. Always unplug the unit and cool it thoroughly before cleaning or servicing it.
- Wear safety glasses (or face shield), protective clothing, and gloves.
- Keep warning labels clean and observe their warnings at all times.
- **Do NOT** block the vent on top of the test chamber. The air coming out can be very hot.
- If necessary, pressing the **STOP** key during a test will abort the analysis and return the unit to the standby temperature.
- Locate the unit away from flammable materials. Provide at least one inch of space around all four sides of the instrument.
- Except as noted in the manual, this unit contains no user serviceable parts. Do not dis-assemble the unit. Unauthorized repair attempts may also void the warranty.

INTRODUCTION

Thank you for choosing our Denver Instrument Company **Moisture Analyzer** as your moisture determination system. This unique system combines the advanced technology of an infrared dryer with the precision weighing of an analytical balance. Yet, it is designed to make testing as easy and convenient as possible.

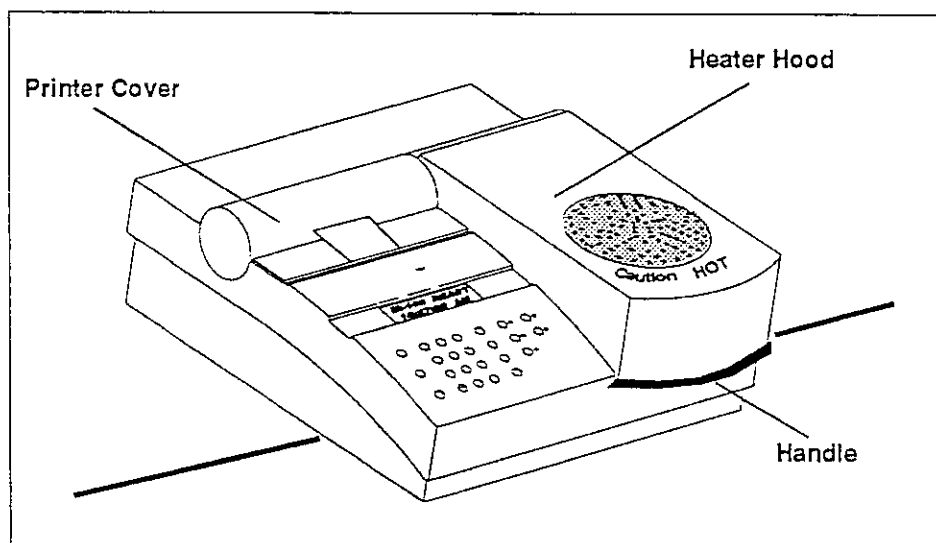


Fig. 1

Moisture Analyzer (with printer)

This instruction manual covers the proper installation and operation of your **Moisture Analyzer** and includes all warranty information. Use this manual for models with or without the printer. If you are using the model that does not have the internal printer, please disregard any information pertaining to the printer.

If we at Denver Instrument Company can be of further assistance to you, please call either:

1-800-321-1135

or

(303)-431-7255.

FEATURES

- Two line backlit LCD display (16 characters).
- Silicon sealed keyboard with numeric keys and 12 function keys.
- Adjustable heater (30°C - 210°C/86°F - 410°F). Electronic temperature control with platinum sensor. Four quartz infrared heaters.
- Two-step drying capability.
- Selectable standby temperature.
- Multiple calculation modes:
 - % Moisture content;
 - % Solids content;
 - % Volatiles;
 - % Moisture content, dry basis;
 - % Solids content, dry basis.
- High resolution balance (.001g) for high accuracy results (.01%).
- Three choices for end of analysis:
 1. Manual.
 2. Time-out.
 3. Slope (change of weight with time) or dry to constant weight.
- Six different sets of drying parameters. (See Figure 2.)
- Capability to store and recall ten drying procedures.
- Printer (optional on some models.)
 - Internal, 40 column dot matrix;
 - Prints test result, date, time, drying procedure, sample number, and other test data;
 - Prints intermediate values (if selected).
- Standard interfaces.
 - RS-232 Serial output;
 - Centronics-type parallel output.

Permissible Drying Parameter Combinations

temp 1	time 1	temp 2	time 2	slope	Balance Operation
x				x	Heater at temperature 1 with automatic shut off at slope setting.
x	x				Heater at temperature 1 for time 1.
x	x			x	Heater at temperature 1 for time 1; then heater at temperature 1 with automatic shut off at slope setting.
x	x	x		x	Heater at temperature 1 for time 1; then heater at temperature 2 with automatic shut off at slope setting.
x	x	x	x		Heater at temperature 1 for time 1; then heater at temperature 2 for time 2.
x	x	x	x	x	Heater at temperature 1 for time 1; then heater at temperature 2 for time 2; then heater at temperature 2 with automatic shut off at slope setting.

Fig. 2

INSTALLATION

Before installing your analyzer:

- Carefully unpack the carton. We recommend that you keep all packing materials for possible future use.

- Check the contents of the shipping carton. You should find the following:
 - Analyzer
 - Instruction Manual
 - Pan Support
 - Pan Shield
 - Power Cord
 - Spare Fuses
 - Warranty Card
 - Tweezers
 - Disposable Sample Pans (1 pkg./50)
 - Quartz Sample Pads (1 pkg./25)

- For models with the internal printer, lift up the printer cover. You should see the following items:
 - Printer Ribbon or Cartridge
 - Printer Paper

- Next, select a suitable work area by using the following guidelines:
 - Work area should be relatively free from drafts and vibrations.
 - Work surface should be level and rigid.
 - Allow for adequate ventilation (at least one inch of free space around all four sides of the analyzer).
 - Line voltage to your analyzer should be reasonably constant and free from fluctuations. It is **not** advisable to use an outlet that is shared with fluorescent fixtures or other electrical equipment that draws current in an inconsistent manner. If necessary, use an AC line filter and surge suppressor.
 - Do **not** locate near magnetic materials, equipment, or instruments which incorporate magnets in their design.
 - Avoid areas which have variations in room temperatures or have excessive room temperatures. Room temperatures above 40°C/104°F or below 15°C/59°F could affect the operation and accuracy of your analyzer.

- Set up your analyzer by following these steps: (See Figure 3.)
 - Lift up heating hood and place the pan shield so the center hole fits over the center ring in the base.
 - Slip the stem of the pan support into the center slot of the pan shield.
 - Verify AC power module by checking the identification on rear panel. **Input voltage must match the unit specification labeled on the rear panel.**
- Insert power cord into the receptacle located on the rear panel of the analyzer. Firmly push in the plug. (See Figure 4 on page 11.)
- Turn the analyzer ON by pressing the On/Off switch. Since a standby temperature of 60°C has been set at the factory, the heating elements begin warming up when you turn on your unit.

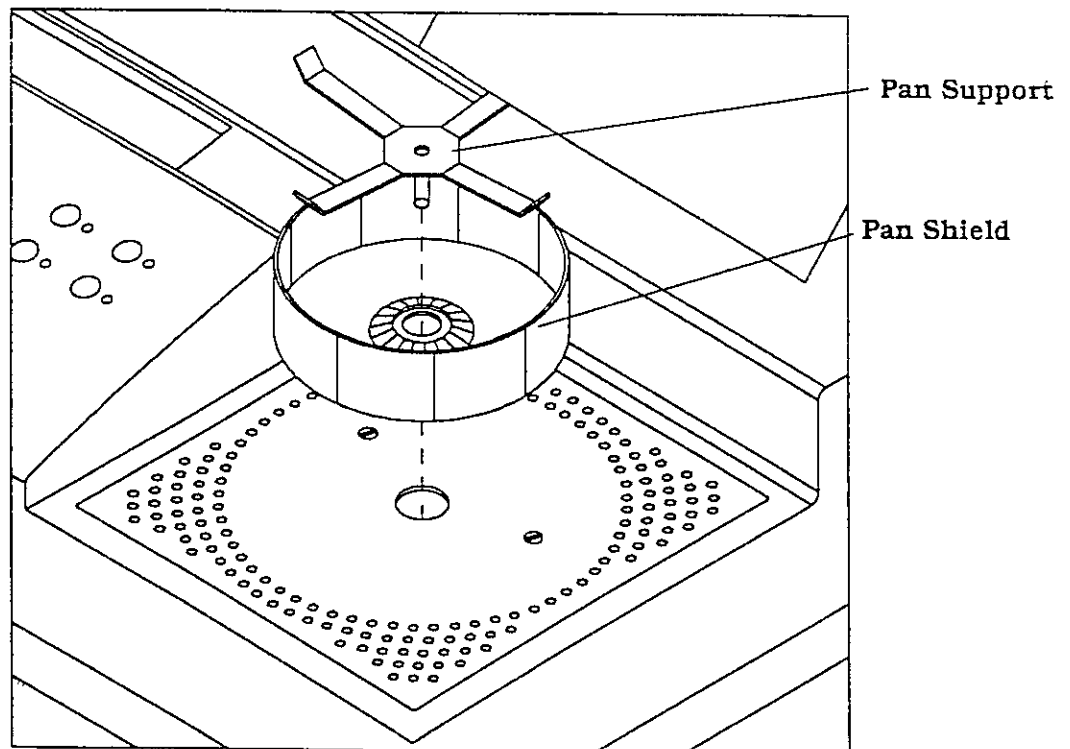


Fig. 3

Assembly Of Pan Shield And Pan Support

- The main screen shows the time of day and indicates the unit is ready for operation. (See Figure 5.) The analyzer is set to operate using the factory settings (defaults). For a list of those settings, see page 12.
- Allow a 30 minute warm up period before testing a sample.
- While you're waiting, it's okay to make any changes in the settings or store any drying procedures. For specific directions, see the appropriate section of this manual.
- Complete and return the enclosed warranty card. (Also record the warranty information in the space provided inside the front cover of this manual.)

Rear View

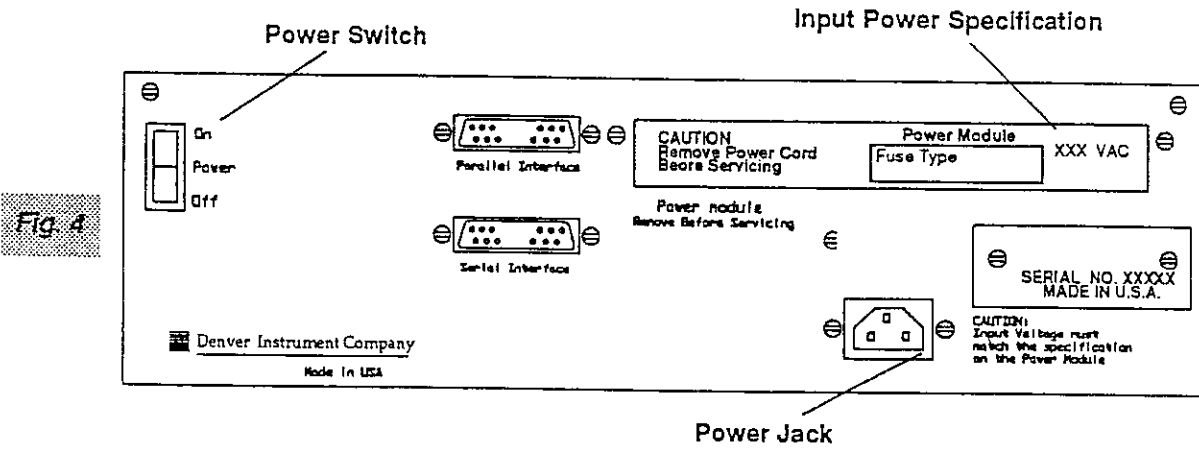


Fig. 4

Main Screen

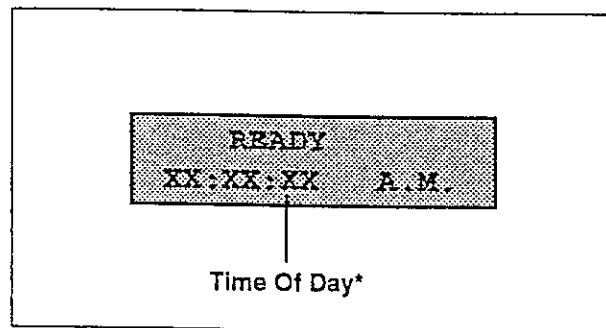


Fig. 5

* The time of day and date have been set at the factory and reflect our time zone. If you need to change it, see the *Set Up* section.

FACTORY SETTINGS

Your Moisture Analyzer is pre-programmed at the factory with the following default values:

<u>OPTION</u>	<u>SETTING</u>
percent display	Moisture
temperature display	Actual temperature
standby temperature	60°C
temp 1	105°C
temp 2	Off
time 1	Off
time 2	Off
slope	1.0 minute
	0.05% change
sample number	ON
	1
program number	1
I/O*	Internal printer
	Start and stop

To make changes, see the appropriate section of this manual.

*Applies only to models with the internal printer.

USING THE KEYBOARD

The keyboard has been designed for convenient and easy use. (See Figure 6.)

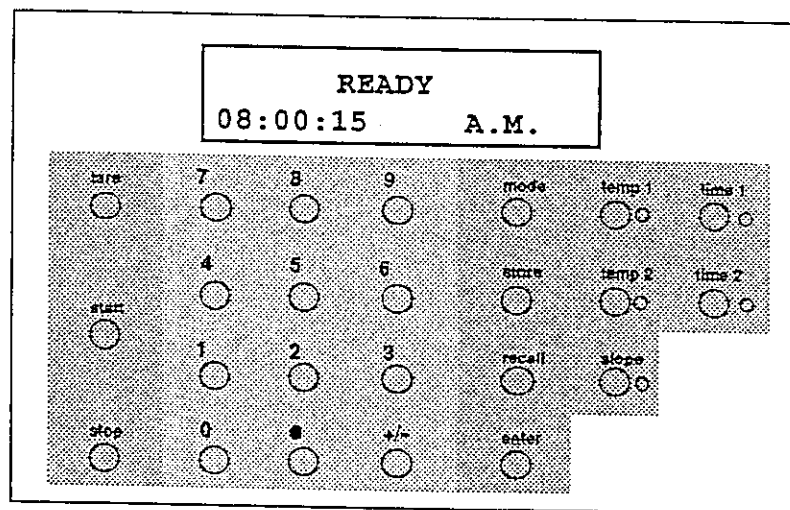
The **function** keys on the left hand side of the keyboard are used for the drying operation.

The **numeric** keys in the middle of the keyboard are used for entering specific values when required. These include entering the time of day and date, and entering values for the temperature, time, and slope settings.

The **function** keys on the right hand side of the keyboard are used for programming the many features of the analyzer. These keys are used to set time and temperature parameters, to store and recall drying procedures, and to print out the stored parameters.

To use a key, press it firmly and then release it. You should hear a slight click when pressing it. Do not hold the key down.

Fig. 6



Keyboard

KEYSDESCRIPTION

tare



- Sets the weight display to zero;

start



- Initiates the drying cycle

stop



- Stops any test cycle in progress; this will cause the message "***** USER ABORT *****" to be displayed.
- Exits set up menu to main screen

+/-








- Toggles between A.M. and P.M. when setting or changing *time of day*;
- Toggles between C (Celsius) and F (Fahrenheit) when setting or changing *temperatures*;
- Toggles between ON and OFF when setting *sample number*;
- Toggles between American date format (i.e., 03-25-91) and European date format (i.e., 25-03-91) when setting or changing *date*;
- Toggles between ON and OFF to select *standby temperature*. (Staying on indefinitely, or turning off 60 minutes after usage.)

mode



- Accesses the Set Up menu and is used to scroll through the options. (See Set Up Section on page 28.)

<u>KEYS</u>	<u>DESCRIPTION</u>
store 	<ul style="list-style-type: none">• Stores the current drying test conditions into memory. Up to ten drying procedure combinations (time, temperature, slope, calculation mode, standby temperature) can be stored;• Clears all stored programs when used in conjunction with the +/- key.
recall 	<ul style="list-style-type: none">• Recalls any of the preset programs when used with a # key. The parameters in the preset program that have been recalled are automatically used for the drying procedure when the start key is pressed;• Allows printer to print out the parameters of all stored program when used in conjunction with the enter key.
enter 	<ul style="list-style-type: none">• Selects option in SetUp menu;• Selects an entry from the numeric keypad;• Allows printer to print out the parameters of all stored program when used in conjunction with the recall key.
temp 1 	<ul style="list-style-type: none">• Turns the first temperature setting On/Off. Red light indicates key is activated.• Prompts input of a value for the first temperature to be used. Temperature range is 30°C - 210°C/86°F - 410°F.
temp 2 	<ul style="list-style-type: none">• Turns the second temperature setting On/Off. Red light indicates key is activated.• Prompts input of a value for the second temperature, if desired. Temperature range is 30°C - 210°C/86°F - 410°F. For this setting to be used, a value for temp 1 must be entered. If a temp 1 setting has not been entered, this value moves to the temp 1 key.

KEYS

DESCRIPTION

slope



- Turns the slope (constant weight) setting On/Off. Red light indicates key is activated.
- Prompts input of slope variables:
 (1) time interval; (0.1 to 99 minutes)
 (2) % of initial weight; (0.01 to 9.99% of initial weight change.)
- Allows the analyzer to automatically shut off when the slope condition is met. (See Setting Slope section on page 26 for detailed description.)

time 1



- Turns the first time setting On/Off. Red light indicates key is activated.
- Prompts input of a value for the first time limit. (Time range is 0.1 to 99 minutes).

time 2



- Turns the second time setting On/Off. Red light indicates key is activated.
- Prompts input of a value for the second time limit, if desired. (Time range is 0.1 to 99 minutes).
- For this setting to be used, a value for time 1 must be entered. If a time 1 setting has not been entered, this value moves to the **time 1** key.

CALIBRATION

Your analyzer is calibrated at the factory prior to shipment. Since this instrument determines the amount of weight loss in percent based upon the initial and final weight, routine calibration of the system is not necessary for accurate drying results. However, we suggest periodic calibration, especially if the unit is used in the manual mode as a standard electronic balance.

The calibration procedure is found in the Set Up menu by using the **mode** key.

To calibrate your analyzer:

Equipment required - 50 gram weight.

- Lift up the heater hood.
- Place an empty disposable pan on the pan support. (See Figure 7)
- Scroll through the Set Up Menu by continuously pressing the **mode** key until the display shows:

CALIBRATION

- Press the **enter** key to access the calibration procedure. Message prompts will guide you through this procedure. Display shows:

CALIBRATION - - - -
PRESS TARE NOW

- Press the **tare** key. Display shows:

CALIBRATION - - - -
PLACE 50g WEIGHT

- Place 50g weight on disposable pan. Display shows:

CALIBRATION - - - -
PRESS ENTER NOW

- Press the **enter** key. Display shows:

CALIBRATION - - - -
CALIBRATING

- When Calibration is complete, the display shows:

CALIBRATION

CALIBRATION DONE
or
CALIBRATION
NO CALIBRATION*

- Remove weight.
- Your analyzer proceeds to the SECURITY screen.

*If the analyzer does not calibrate, try repeating the procedure with the 50 gram weight. The unit must be stable (no vibrations) and must not have an obstructed pan.

DRYING A SAMPLE

After you have turned on your analyzer, and allowed a 30 minute warm-up, you are ready to begin drying a sample.

Read all instructions prior to operating this instrument. Always follow appropriate operating and safety procedures and observe all warning labels.

The red lights next to the **temp 1** key and the **slope** key are turned on to indicate the factory settings (defaults). If you need to change any of the settings, you can do that during the warm up period. (To make those changes, see the appropriate section of this manual.)

Since a standby temperature of 60°C has been pre-set at the factory, the heating elements begin warming up when you turn on the unit.

The display uses message prompts to guide you through the operating procedure.

The analyzer always uses grams as the unit of weight measurement.

We recommend using a test sample weighing between .5 and 10 grams for optimal results.

Example for this section - 3.002 g of non-dairy creamer.

- Lift up the lid and place an empty disposable pan on the pan support. (See Figure 7.)

See the Developing A Drying Procedure section for additional preparation techniques.

- Add any dispersing agents necessary, such as dry sand, or place glass filter pads on the support pan. (For our example, a dispersing agent was not needed.)

➤ Press the **start** key. Display shows:

```
SAMPLE NUMBER
NUMBER 1*
```

- The sample number is set to begin at number 1. If a different sample number is desired, use the numerical keys to select the desired sample number. You have 3 seconds to enter each digit. Any number between 1 and 8 digits long can be used.

*To turn off the Sample Number option, see page 36.

Display shows:

```
WT = 2.446*
TARE PAN WEIGHT
```

*Weights are in grams.

➤ Press **tare** key. Display shows:

```
WT = 0.000
PLACE SAMPLE ON
```

Place sample on the pan, spreading it evenly over the surface of the pan. (See Figure 8.)

- Close the hood. Display shows:

```
WT = 3.002
PRESS START
```

- Wait approximately 3 seconds for the unit to stabilize.

➤ Press the **start** key. Display shows:

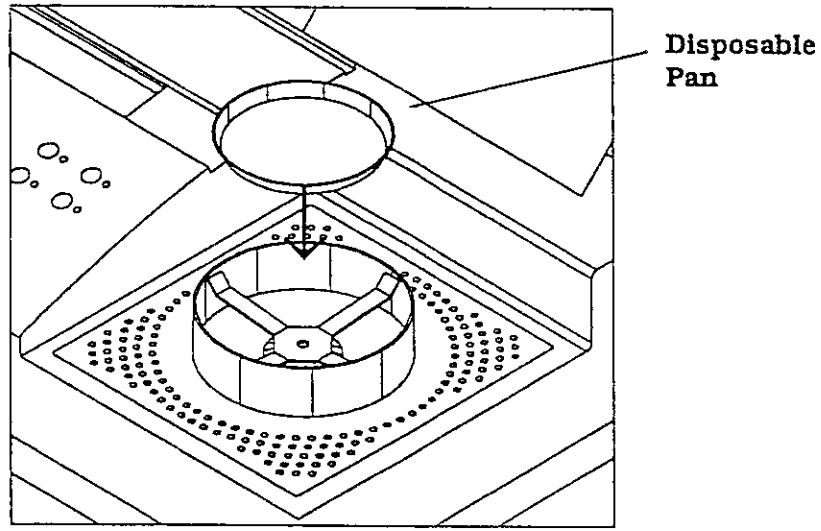
```
WT = 3.002
WORKING
```

then

```
P1 TIME = 00:01
105 C 0:00% M
```

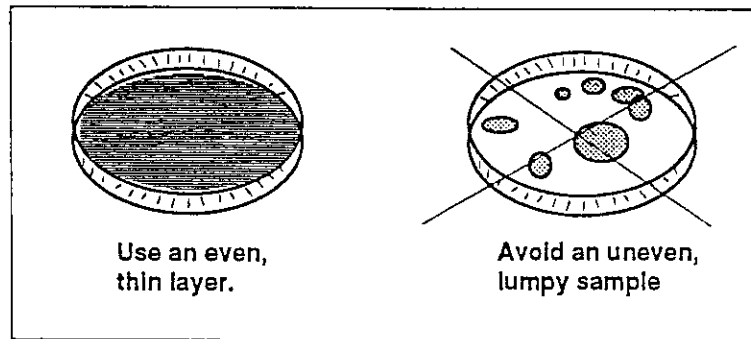
- The printer automatically prints out initial data when the drying cycle begins. (See Figure 9)
- Other printing options are available. See the I/O Section on page 41.
- The display continuously updates the drying data. (See Figure 10.)

Fig. 7



Placing The Disposable Pan

Fig. 8



Placing Sample On Disposable Pan

Fig. 9

```
START: 08-28-1990      02:39:40 PM
SAMPLE: 1
PROGRAM: 1
      Temp 1: 105C
      Slope: 0.05% 01:00 min
INITIAL WEIGHT: 3.002 grams
```

Print Out Of Initial Drying Data

- If you have set the unit to print out intermediate data using the appropriate I/O setting on page 41, the printer continues to output data as programmed.

In the example, figure 11 below, the printer has been set to update results every minute.

- When the drying cycle ends, the display shows:

I. WT = 3.002

F. WT = 2.91

then

DIFF = 0.86

PERC = 2.86

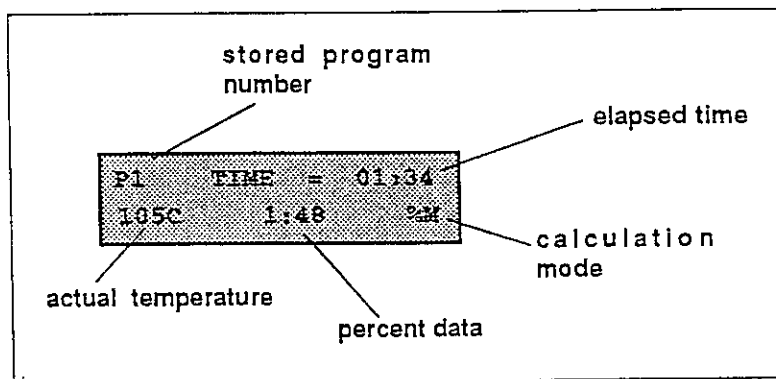
- The printer automatically prints final results when the drying cycle ends or the stop key is pressed. (See Figure 12 on page 22.)
- Use tweezers to remove disposable sample pan.

CAUTION: Pan and its contents could be too hot to touch.

- The display automatically returns to the main screen.

Drying Screen In Moisture Mode

Fig. 10



Print Out Of Intermediate Drying Data

Fig. 11

START: 08-28-1990		02:39:40 PM	
SAMPLE: 8			
PROGRAM: 6			
Temp 1:	130C	Time 1:	3:00
Temp 2:	120C	Time 2:	9:00
INITIAL WEIGHT: 0.667 grams			
temp/time	weight	% S	
degree/min	(g)		
130C	01:00	0.454	= 68.07
130C	02:00	0.367	= 55.02
120C	03:00	0.340	= 50.97
120C	04:00	0.334	= 50.07
120C	05:00	0.330	= 49.48

Print Out Of Final Drying Data

Fig. 12

START: 08-28-1990		02:39:40 PM	
SAMPLE: 1			
PROGRAM: 1			
Temp 1:	105C		
Slope:	0.05%	01:00 min	
INITIAL WEIGHT: 3.002 grams			
END: 08-28-1990		02:43:26 PM	
ELAPSED TIME:		3.7 min	
FINAL WEIGHT:		2.917 grams	
MOISTURE %:		2.86	

SETTING TEMPERATURES AND TIMES

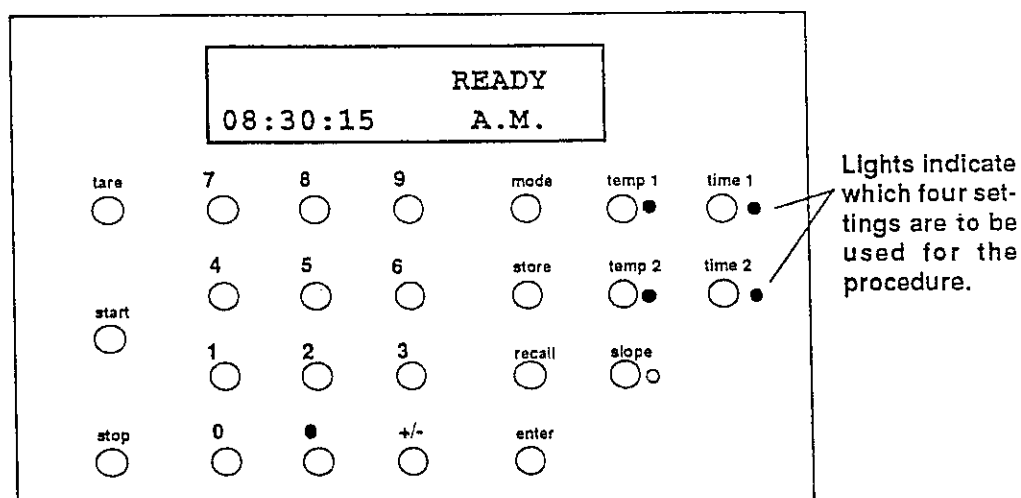
You can set the temperatures and times to fit your particular drying situation. Two different temperatures and two different times can be set for drying a single sample. Select all parameters desired before beginning the drying operation or storing the program.

Example - setting:
temp 1 for 120°C
time 1 for 10:00 minutes
temp 2 for 105°C
time 2 for 5:00 minutes

In this example, your analyzer runs for 10 minutes at 120°C and then runs for 5 minutes at 105°C. (Total drying time will be 15 minutes.) As illustrated in figure 13, the red light next to the function keys indicate which parameters are set for the next drying procedure.

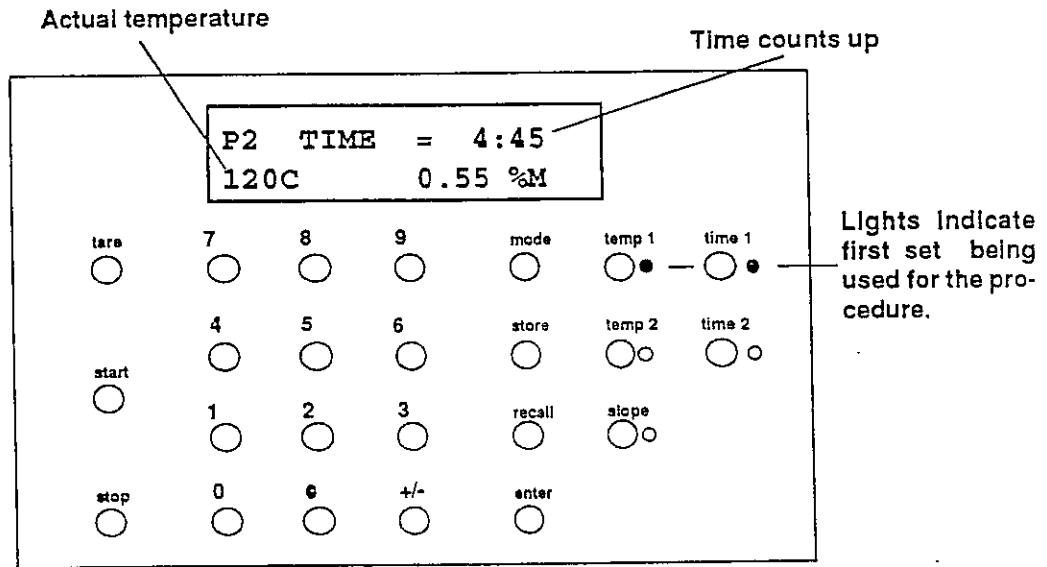
Keyboard Indicator Lights

Fig. 13



When you select a two-step drying procedure (as in this example), four lights initially are activated. However, when the analyzer begins its run, only the lights by the set of keys whose parameters are being used are illuminated. When a time parameter is being used, the display continuously counts up. If more than one time parameter is being used for drying a sample, the display continues to count up until the drying run has finished. (See Figure 14 on page 24.)

Fig. 14



The lights next to the keys change as the drying steps change.

To set or change the value for the **temp 1** (temperature 1) key:
(Maximum temperature setting is 210°C/410°F.)

- Press the **temp 1** key until display shows:

```
SET TEMP 1
TEMP = XXX C
```

- Using the numeric keys, press the desired temperature.
- If the temperature unit of measurement (F - Fahrenheit or C - Celsius) displayed on the screen is correct, go directly to the next step; if not, press the +/- key to change the unit.

- Press the **enter** key to store the temperature and to exit.
To set or change the value for the **time 1** key:
(Time range is 0.1 to 99 minutes.)

- Press the **time 1** key until the display shows:

```
SET TIME  1  
TIME  =  XX.X  minute
```

- Using the numeric keys, press length of time in minutes desired for the run.

- Do not enter the decimal point when entering the value.

- Press the **enter** key to store the time and to exit.

To set or change the value for the **temp 2** (temperature 2) key: (To activate this setting, a value for temperature 1 must be set. Maximum temperature setting is 210°C/410°F.)

- Press the **temp 2** key until display shows:

```
SET TEMP  2  
TEMP  =  XXX  C
```

- Using the numeral keys, press the desired temperature.

- If the temperature unit of measurement (F - Fahrenheit or C - Celsius) displayed on the screen is correct, go directly to the next step; if not, press the +/- key to change the unit.

- Press the **enter** key to store the temperature and to exit.

To set or change the value for the **time 2** key:
(Time range is 0.1 to 99 minutes.)
(To activate this setting, a value for time 1 must be set.)

- Press the **time 2** key until the display shows:

```
SET TIME  2  
TIME  =  XX.X  minute
```

- Using the numeric keys, press length of time in minutes desired for the run.

- Do not enter the decimal point when entering the value.

- Press the **enter** key to store the time and to exit.

SETTING SLOPE

As the moisture analyzer dries a sample, the sample loses weight. During a test, the loss of weight is monitored by the internal balance. Figure 16 illustrates a typical drying curve, showing the loss of weight over time. When the sample no longer loses weight, it is considered to be fully dry.*

The slope feature allows the moisture analyzer to automatically stop the test when it determines the sample is no longer losing weight. The user may define the conditions which the analyzer uses to determine a "dry" sample. For example, the factory default setting terminates a test when the sample loses less than 0.05% of its initial weight in a one minute period. As explained in the Application Section, the user typically chooses an appropriate slope setting for a sample material to give accurate, repeatable results in a reasonable length of time.

* If a sample is heated at extreme temperatures, the sample may scorch and continue to lose weight even after it is dry.

To set or change the slope.

- Press the **slope** key until display shows:

```
SET SLOPE TIME  
TIME = 01.0 min*
```

- Using the numeric keys, press the desired time. (Slope time range is 0.1 to 99 minutes.)
 - Do not press the decimal point key when entering the value.)
- Press the **enter** key to store the setting. Display shows:

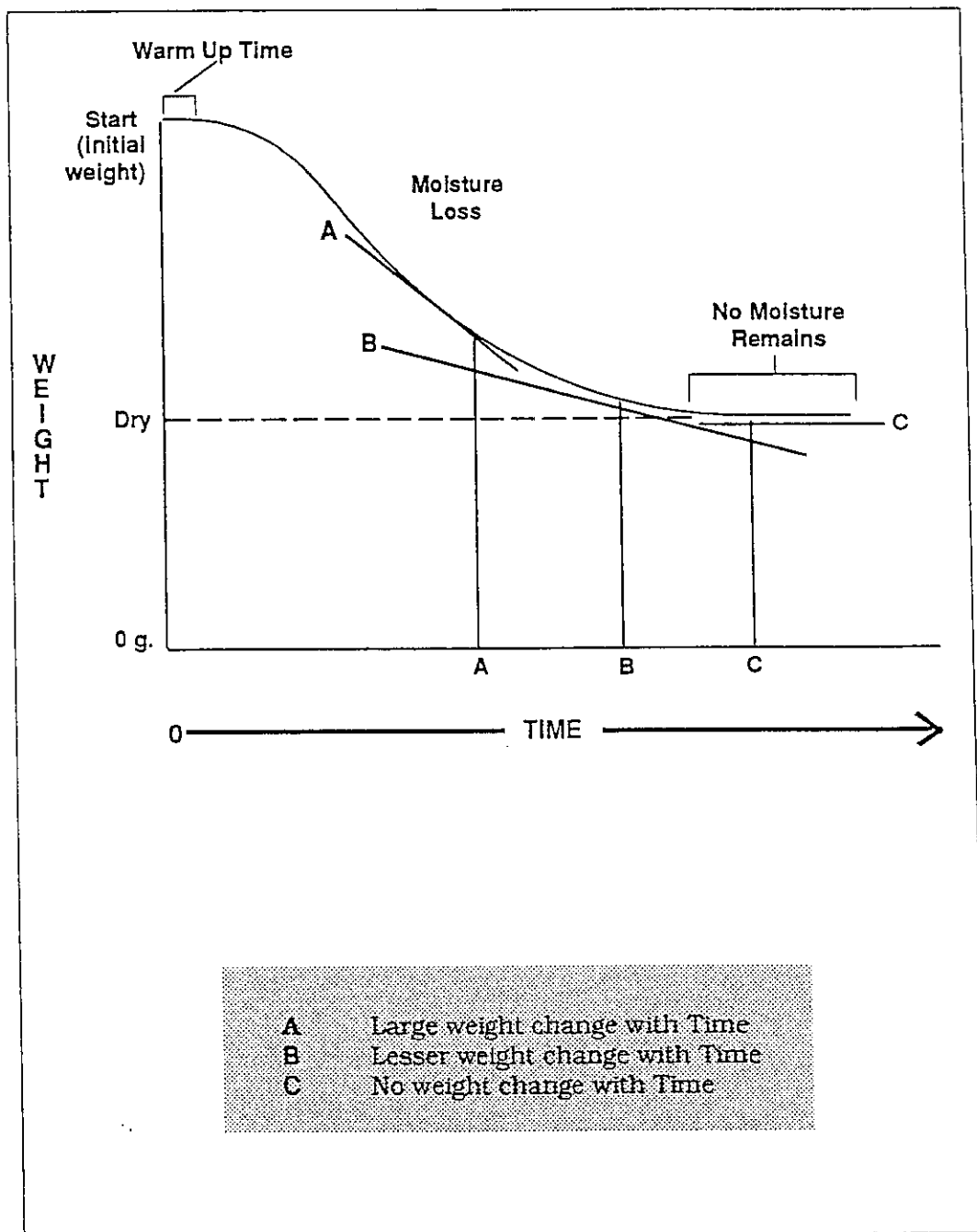
```
SET SLOPE PERC.  
0.05% change*
```

- Using the numeric keys, press the desired percentage of change. (Slope percent change range is 0.01% to 9.99% of initial weight.)
 - Do not press the decimal point key when entering the value.
 - If you enter an invalid number, the analyzer reverts to the last valid setting.
- Press the **enter** key to store and to exit.

When using the slope setting for a drying procedure, make sure the light by the slope key is turned ON.

*The default values initially are activated.

Fig. 15



Typical Drying Curve

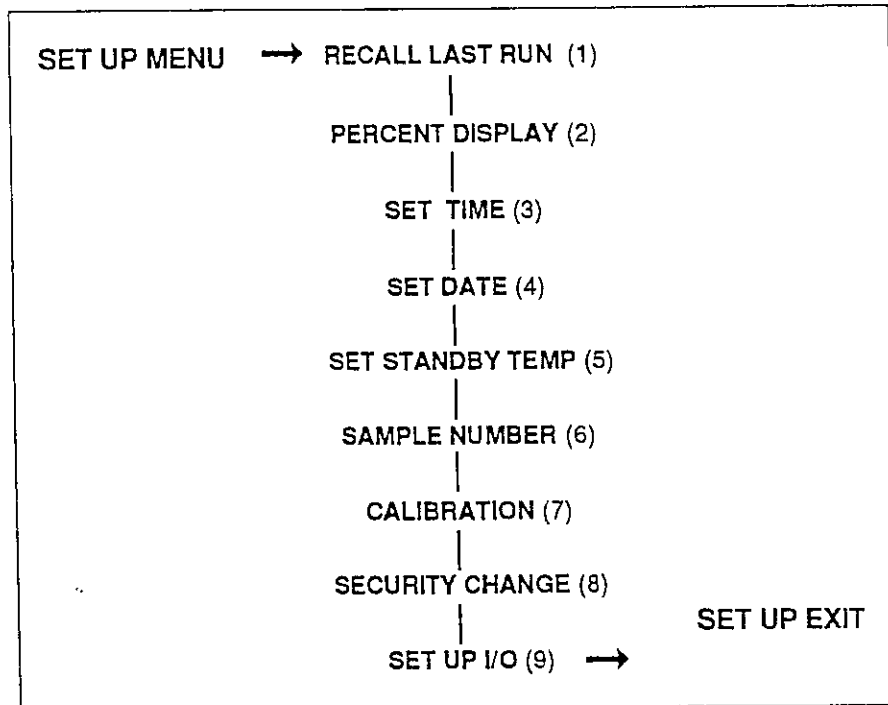
SET UP

The **mode** key is used to access the Set Up Menu. This menu offers a variety of options that can be used to "customize" the analyzer. It also provides the means for recalling test results from the last sample, setting the current time and date, setting a standby temperature, doing calibration, and for setting the I/O. By continuously pressing the **mode** key, you can scroll through the menu. (See Figure 16.)

A shortcut is available if you do not need to scroll through the entire menu. Once in the set up menu, you can press the corresponding option number to go directly to that option.

Example: By pressing **mode** key, 9 key goes directly to SET UP I/O.

Fig. 16



Recalling Last Run

You can recall test data from the last drying cycle, including Initial Weight, Final Weight, the Difference, and a Percentage (if any one of the six percentage options has been selected in the Percent Menu).

To recall results from last drying cycle:

- Press the **mode** key continuously to scroll through the Set Up Menu until the display shows:

RECALL LAST RUN

- Press the **enter** key to select it.
Display shows:

I. WT = X.XXX
F. WT = X.XXX

then

DIFF = X.XXX
ELAPSED = X.X

then

PERC = X.XXX

- The display automatically returns to the main screen.

Selecting Percent Display

The Set Up Menu allows you to select the calculation mode for determining your drying results. Six options are available. (See Figure 17.)

Five of the options use standard equations for calculating the percent moisture or percent solid content (wet or dry basis) of a sample. (See Figure 18.)

WEIGHT DISPLAY calculates in grams the actual weight loss during the drying cycle.

SET TEMP (set temperature) sets the display to show the temperature parameter(s) being used for the drying cycle as entered in **temp1** and **temp2**.

ACTUAL TEMP (actual temperature) sets the display to show the temperature of the heating chamber during the drying cycle. The temperature will ramp up to the set temperature.

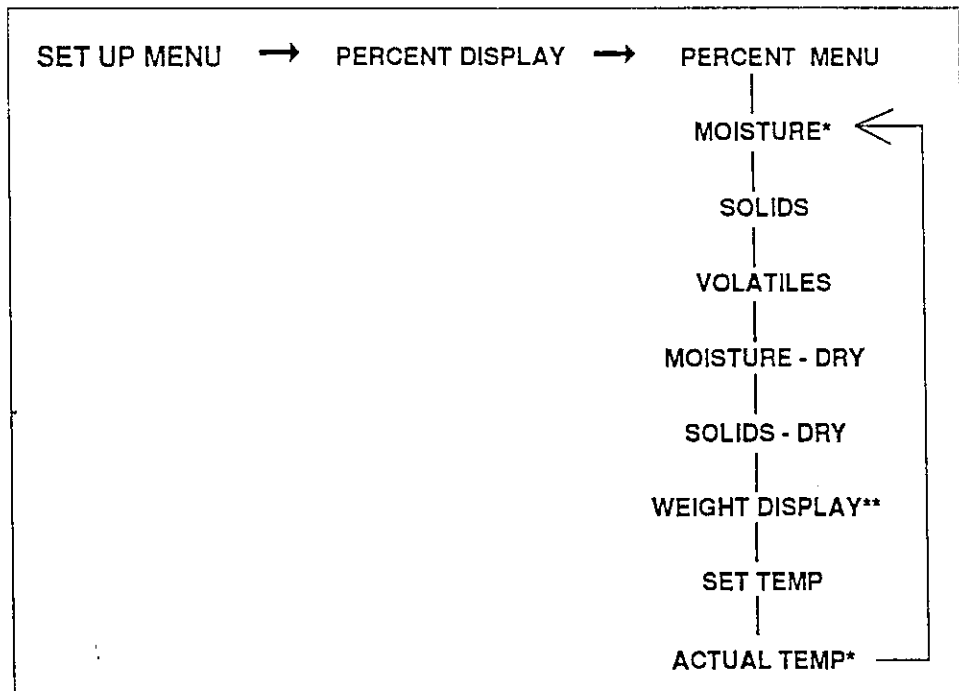


Fig. 17

*Default setting
**Weight is in grams

When you select one of the six options, the analyzer automatically changes to the appropriate calculation mode. During a drying procedure, the display always shows the selected mode. The final print out also includes the calculation mode with the results.

Listed below in Figure 18 are the options, the corresponding symbols shown on the display during the drying procedure, and the equation used for each mode.

Calculation Modes and Equations Chart

<u>OPTION</u>	<u>DISPLAY SHOWS</u>	<u>EQUATION</u>		
MOISTURE	%M	$\frac{\text{initial weight} - \text{final weight}}{\text{initial weight}}$	X	100
SOLIDS	%S	$\frac{\text{final weight}}{\text{initial weight}}$	X	100
VOLATILES	%V	$\frac{\text{initial weight} - \text{final weight}}{\text{initial weight}}$	X	100
MOISTURE - DRY	%Md	$\frac{\text{initial weight} - \text{final weight}}{\text{final weight}}$	X	100
SOLIDS - DRY	%Sd	$\frac{\text{initial weight}}{\text{final weight}}$	X	100
WEIGHT DISPLAY (grams)	W	initial weight - final weight		

Fig. 18

To select or change the display:

- Press the **mode** key continuously to scroll through the Set Up Menu until the display shows:

PERCENT DISPLAY

- Press the **enter** key to select it. Display shows:

PERCENT MENU

- Press the **mode** key continuously to scroll through the menu until the display shows the desired setting.

MOISTURE*
SELECTED

SOLIDS

VOLATILES

MOISTURE - DRY

SOLIDS - DRY

WEIGHT DISPLAY

SET TEMP

ACTUAL TEMP*

*Default setting

- Press the **enter** key to select it. Display shows:

SELECTED

- Your analyzer proceeds to the SET TIME screen.

The **mode** key remains operational during the drying procedure and can be used to scroll through the percent menu in order to change the calculation mode. Use the **enter** key to select the new mode. The display reflects the mode change.

Choosing Actual or Set Temperature

The analyzer may display the actual measured temperature in the heating chamber or the programmed set temperature as entered in the **temp1** and **temp2**.

- Press the **mode** key continuously to scroll through the Set Up Menu until the display shows:

PERCENT DISPLAY

- Press the **enter** key to select it. Display shows:

PERCENT MENU

- Press the **mode** key continuously to scroll through the menu until the display shows either:

ACTUAL TEMP

or

SET TEMP

- Press the **enter** key to when the desired mode is shown. Display shows:

SELECTED

- Your analyzer proceeds to the SET TIME screen.

Setting Time Of Day

You can set the analyzer to display the current time. Once set, it remains in memory and is updated automatically. The print out includes the time the procedure begins and the time it ends.

- Press the **mode** key continuously to scroll through the SetUp Menu until the display shows:

SET TIME

- Press the **enter** key to select it. Display shows:

CHANGE TIME - - - -

TIME XX:XX:XX A.M.

- Use the numeric keys to enter the time. Press the +/- key to toggle between A.M. and P.M.

- Press the **enter** key when the display shows the desired setting. Display shows:

```
SET TIME
TIME  XX:XX:XX P.M.
```

- ä Your analyzer proceeds to the SET DATE screen.

Setting Date

You can set the analyzer to print out the current date. Once set, it remains in memory and is updated automatically. The date prints with the initial results and the final results.

- Press the **mode** key continuously to scroll through the Set Up Menu until the display shows:

```
SET DATE.
```

- Press the **enter** key to select it. Display shows:

```
CHANGE DATE- - - -
DATE  XX-XX-19XX
```

- Use the numeric keys to enter the date, beginning with the month, day, and then the last two digits of the year (American Format.). Use zeros where necessary. Display shows:

```
SET DATE
DATE 03-25-1991
```

For European format (day-month-year), press the +/- key.

```
SET DATE
DATE 25-03-1991
```

(The +/- key toggles between the American format and the European format. The format selected appears on all print outs.)

- Press the **enter** key to select it. Display shows:

```
SET DATE
```

The analyzer proceeds to the SET STANDBY TEMP screen.

Setting Standby Temperature

In order to decrease the time needed for the analyzer to reach its pre-set temperature for a drying procedure, you can set a standby temperature. The analyzer automatically keeps the drying chamber at this standby temperature whenever the analyzer is idle and the hood is closed. A standby temperature of 60°C has been pre-set at the factory. When the analyzer initially is turned on, the heating elements immediately begin warming up until the 60°C standby temperature is reached.

The standby temperature can easily be changed to a value between 30°C - 175°C/86°F-347°F. However, the unit cannot obtain a temperature below the ambient room temperature. For optimal drying results, we recommend you set a standby temperature that is about 20° below temp1.

In the factory setting, the standby temperature feature will be active for a one hour time period. If the analyzer is not used within one hour, the heating elements will shut off and the unit will return to room temperature. As described in the next section, the unit may be programmed to always remain at the standby temperature when not in use.

- Press the **mode** key continuously until display shows:

```
SET STANDBY TEMP
```

- Press the **enter** key. Display shows:

```
SET STANDBY  
TEMP = 60°C
```

- Using the numeric keys, enter the desired temperature.
- If the temperature unit of measurement is correct (C -Celsius) go directly to the next step; if not, press the +/- key to change the unit. The +/- key toggles between F and C.
- Press the **enter** key to store the new standby temperature. Display shows:

```
SET STANDBY TEMP  
TEMP = XX C
```

Then display shows:

```
HEATER STANDBY C  
OFF
```

- Press the +/- key to toggle to ON to override the 60 minute standby heating element turn off.
- Your analyzer proceeds to the SAMPLE NUMBER screen.

Activating Sample Number Option

The Sample Number option allows you to choose whether or not a sample is identified by a sample number on the print out. (See Figure 19.)

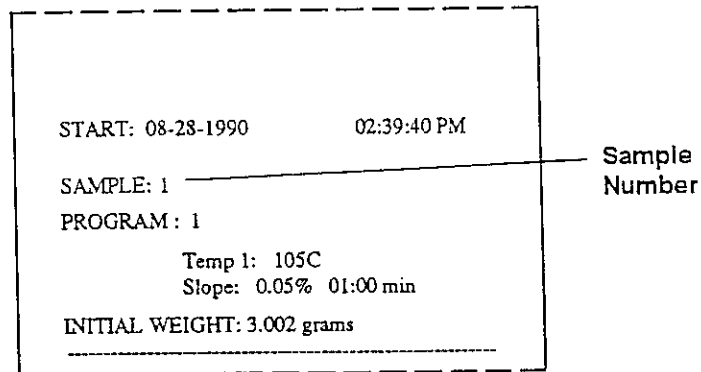
If the sample number option is turned on, during each drying procedure the display shows the sample number and allows you to accept that number or change it. You can enter a sample number between 1 and 8 digits long. Each time you begin a drying procedure you have 3 seconds to begin entering a new sample number. Otherwise, the the displayed number will be saved. The sample numbers continue to update sequentially unless you use the numerical keys to enter a different sample number.

If the sample number option is turned off, the display eliminates the above step during the drying procedure.

The analyzer will remember the last sample number assigned, even if the power to the unit had been turned off.

Initial Drying Data With Sample Number

Fig. 19



To activate/deactivate the sample number option

- Press the **mode** key continuously until display shows:

SAMPLE NUMBER

- Press the **enter** key. Display shows:

SAMPLE NUMBER
ON*

- Press the **+/-** key to change the setting. The +/- key toggles between ON and OFF.
- Press the **enter** key to select the displayed setting. Display shows:

SAMPLE NUMBER
OFF

- Your analyzer proceeds to the CALIBRATION screen

*default setting.

Security Lock

The software Security Lock option allows you to create a password of your choice and to lock in pre-set drying procedures. This feature can prevent possible operational errors due to inadvertent changes.

- With the security lock activated, only the following keys are enabled:

tare key
start key
stop key
mode key to recall last run; to change percent display or view what is already selected.
recall key to recall any pre-set, stored procedure.
numeric keys to use when recalling any pre-set, stored procedure.

- The following keys are informational only:

temp 1 key - shows temperature parameter.
time 1 key - shows time parameter.
temp 2 key - shows temperature parameter.
time 2 key - shows time parameter.
slope key - shows slope parameters.

- All other keys are disabled.

Once your drying procedures have been set, you can activate the security lock by using the following procedure:

- Press the **mode** key continuously until the display shows:

CHANGE SECURITY

- Press the **enter** key to select it. Display shows:

SECURITY CHANGE

- Press the numeric keys to create your Password Number. (Any number between 1 and 30000 can be used.) Display shows:

SECURITY CHANGE

NEW = XXXX

At this Point, Either:

- Press the **enter** key (once) to store the password. Display shows:

SECURITY CHANGE
then
SECURITY CHANGE
UNSECURE
then
SET UP I/O

- At this point, you can still scroll through the Set Up Menu to select your options.
- To activate the Password security system, press the Off switch on the rear panel to power down the analyzer; then press the On switch to power it up. The display indicates activation of the security system by showing:

MOISTURE SYSTEM
then
SECURITY
ENTER PASSWORD

Or

- Press the **enter** key (twice) to store the password and activate the lock. Display shows:

SECURITY CHANGE
CHANGED
then
SECURITY CHANGE
LOCKED

- Note: If a number outside the given parameters is entered, the display shows:

SECURITY CHANGE
INVALID NUMBER

The analyzer proceeds to the SETUP I/O MENU.

- The display automatically returns to the main screen.

If the security system is in place when turning on the analyzer, the display shows:

MOISTURE SYSTEM

then

SECURITY
ENTER PASSWORD

To **de-activate** the **security lock**, you can either enter the Password at this time or use the procedure below.

- If the incorrect Password is entered, the display shows:

SECURITY
LOCKED

- If the correct Password is entered, the display shows:

SECURITY
UNSECURED

To de-activate the security lock:

- Press the **mode** key continuously until the display shows:

SECURITY
ENTER PASSWORD

- Enter Password. Display shows:

SECURITY
PASSWORD = XXXXX

- Press the **enter** key. Display shows:

SECURITY
UNSECURED

- Press the **mode** key. Display returns to the SetUp Menu.

Note: A universal password of 6542 may be entered to clear the security lock.

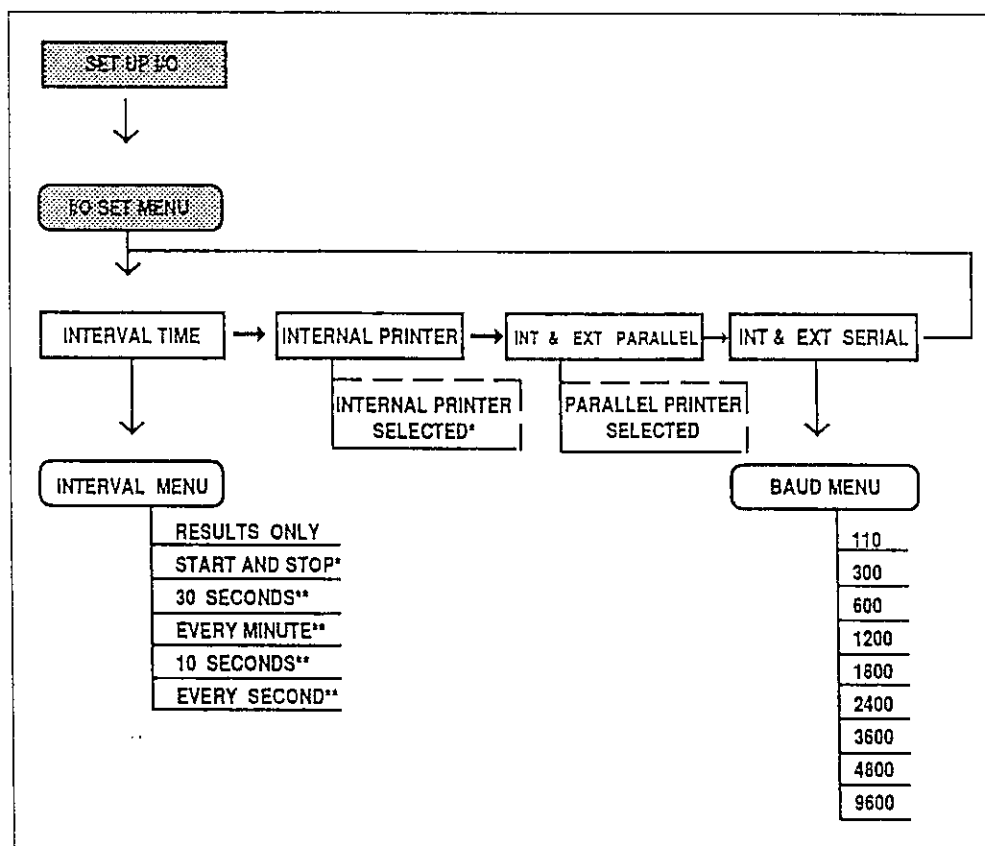
Setting The I/O

You may connect either an external serial device (printer or terminal) or an external parallel printer, whether or not you use the internal printer. Only one external device may be active at one time. Use the instructions below to select the appropriate output device.

Note: The output format will be the same on the internal printer, on an external serial device, or on an external parallel printer.

The I/O (Input/Output) Menu allows you to configure a printer or terminal for use with the unit. (See Figure 20.) The printer records all information relevant to a drying procedure, including test conditions, sample weight, results, program number, sample number, and analysis. If you have the model with the internal printer, it has been set at the factory to automatically print out test data at the beginning of drying procedure and to print out results at the end of a drying procedure. However, other printer options are available through the Interval Menu.

Fig. 20



- * Default setting
- ** Selecting this setting prints this interval in addition to the Start and Stop results.

Internal Printer Specifications *

Type: 40 column dot matrix.

Printing Speed: 60 characters/second (approx).
48 Lines/Minute (approx).

Character: 7 x 5 (Text Mode).

Character Size: 2.75 mm (H) x 1.25 mm (W).

Line Spacing: 5.5 mm (Text Mode).

Line Feed Speed: 6.0 lines/second (approx.).

Paper: Width 69 mm, 1-ply or 2-ply. External diameter 80 mm or less.

Ink Ribbon: Black, Width 13 mm. Spool Diameter: 30 mm or 35 mm.**

*The internal printer is optional for some models.

**Some models may be equipped with a replaceable ribbon cartridge rather than two separate ribbon spools.

Selecting The Interval Time

The Interval Menu provides a list of six options for selection.

RESULTS ONLY	Outputs test results at the end of a drying procedure;
START AND STOP	Outputs drying data at the beginning of a drying procedure and drying results at the end of the drying procedure;
30 SECONDS	Outputs drying data at the beginning of a drying procedure, every 30 seconds during the drying procedure, and results at the end of the drying procedure;
EVERY MINUTE	Outputs drying data at the beginning of a drying procedure, every minute during the drying procedure, and results at the end of the drying procedure;
10 SECONDS	Outputs drying data at the beginning of a drying procedure, every ten (10) seconds during the drying procedure, and results at the end of the drying procedure;
EVERY SECOND	Outputs drying data at the beginning of a drying procedure, every second during the drying procedure, and results at the end of the drying procedure.

To change the interval setting:

- Press the mode key continuously until the display shows:

SET UP I/O

- Press the enter key to access the Set Up menu. The display shows:

I/O SET MENU

- Press the mode key to access the Interval menu. The display shows:

INTERVAL TIME

- Press the enter key to select it. The display shows:

INTERVAL TIME
SELECTED

- Press the **mode** key to scroll through the Interval options. The display shows:

INTERVAL MENU

and then lists the options.

- When the display shows the desired setting, press the **enter** key to select it. The display shows:

(setting)
SELECTED

- Press the **mode** key to access the interface options. The display shows:

INTERNAL PRINTER

- Continue to press the **mode** key to scroll through the interface options.

(See the next section for information on these options.)

Using An External Centronics Compatible Parallel Printer

- When connecting an external centronics compatible parallel printer, use a standard cable for an IBM PC to the printer and insert it in the appropriate port in the rear of the unit.
- Select INT & EXT PARALLEL from the I/O Set Menu.

I/O Specifications

Connector: DB25S Female

CONNECTOR PIN OUT:

<u>PIN</u>	<u>SIGNAL</u>	<u>DIRECTION</u>
1	-STROBE	OUT
2	DO	OUT
3	D1	OUT
4	D2	OUT
5	D3	OUT
6	D4	OUT
7	D5	OUT
8	D6	OUT
9	D7	OUT
10	-ACKNOWLEDGE	IN
11	BUSY	IN
12	PARITY ERROR	IN
13	SELECT	IN
14	-AUTO FEED	OUT
15	-ERROR	IN
16	-INITIAL	OUT
17	-SELECT	OUT

ALL OTHER PINS GROUND

All signals are TTL levels.

To select the parallel printer setting:

- Press the **mode** key continuously until the display shows:

SET UP I/O

- Press the **enter** key to access the Set Up menu. The display shows:

I/O SET MENU

- Press the **mode** key continuously until the display shows the desired setting.

- Press the **enter** key to select it. The display shows:

```
INT & EXT PARALLEL  
SELECTED
```

then

```
SET UP I/O  
SELECTED
```

- Press the **mode** key to exit. The display shows:

```
SET UP EXIT.
```

- The display automatically returns to the main screen.

Using An External Serial Device

- When connecting an external serial terminal to the serial port, use a standard cable for an IBM PC to the printer and insert it in the appropriate port in the rear of the unit.
- Select INT & EXT SERIAL from the I/O Set Menu.
- Select the appropriate BAUD rate from the Baud Menu.

I/O Specifications

Connector: 25 pin subminiature D socket, Cinch DB-25P or equivalent. Pins used are as follows:

<u>PIN#</u>	<u>FUNCTION</u>
1	Case Ground Tied to earth through the power cord.
3	Data Output Voltage output compatible with RS-232C levels, 300 ohm source resistance and ± 10 volt swing minimum.
7	Signal Ground Tied internally to the case ground.

To select the external serial setting:

- Press the **mode** key continuously until the display shows:

SET UP I/O

- Press the **enter** key to access the Set Up menu. The display shows:

I/O SET MENU

- Press the **mode** key continuously until the display shows the desired setting.
- Press the **enter** key to select it. The display shows:

INT & EXT SERIAL
SELECTED

- Press the **mode** key to access the baud menu. The display shows:

BAUD MENU

- Continue to press the **mode** key to scroll through the baud menu.

- When the display shows the desired baud, press the **enter** key to select it. The display shows:

```
XXX BAUD  
SELECTED
```

where XXX is the Baud Rate. Then:

```
SET UP I/O  
SELECTED
```

- Press the **mode** key to exit. The display shows:

```
SET UP EXIT
```

- The display automatically returns to the main screen.

STORING AND RECALLING DRYING PROCEDURES

Your **Moisture Analyzer** allows you to store and recall up to ten different drying procedures. Each procedure includes the time(s), temperature(s), slope, calculation mode, and standby temperature used for the drying operation.

Storing a drying procedure involves first setting all the parameters for that procedure. These include the percent display (Calculation mode- see page 31), the time(s), the temperature(s), and/or the slope. (See Setting Temperatures And Times and Setting Slope on pages 24-37.)

One program is already stored under Number 1 with the factory settings (defaults). The parameters stored in this program are:

Temperature display	Actual temperature
Percent display	Moisture
Temp 1	105°C
Slope	01.0 min
Standby temperature	0.05% change
	60°C

Storing another set of parameters for Program Number 1 replaces the default settings previously stored.

To store a drying procedure:

- Set the percent display to be stored. (See Percent Display on pages 30-32.)
- Set the parameters to be stored. (See Setting Temperatures And Times and Setting Slope on pages 24-27.)
- If a different standby temperature is required, set that temperature. (See Setting Standby Temperature on page 35.) If no change is made, the default temperature of 60°C remains in memory and is stored with the procedure.
- Check that the appropriate lights by each key used for the complete drying procedure are turned on to indicate their selection.

➤ Press the **store** key. Display shows:

SAVE

Program Number ?

- Then press a number (0 - 9). Display shows:

```
SAVING  
PROGRAM NUMBER X
```

- Parameters are automatically stored, and the analyzer then returns to the main screen.

RECALLING A DRYING PROCEDURE

You can recall any of the ten stored procedures to use for a drying operation or to check the stored parameters. The display lists the stored parameters - percent mode, temperatures, times, slope, and standby temperature.

- Press the **recall** key. Display shows:

```
RECALL  
Program number?
```

- Then press a number (0-9). Display shows:

```
RECALLING  
PROGRAM NUMBER X
```

Then the display scrolls through all parameters of the recalled program:

```
RECALLING  
TEMP 1      = XXX C  
TIME 1      = XX:XX  
SLP         = X.XX%/XX.X  
STANDBY     = XXX C  
MOISTURE
```

- The analyzer then automatically returns to the main screen.

If the program number entered does not contain a stored drying procedure, the display shows:

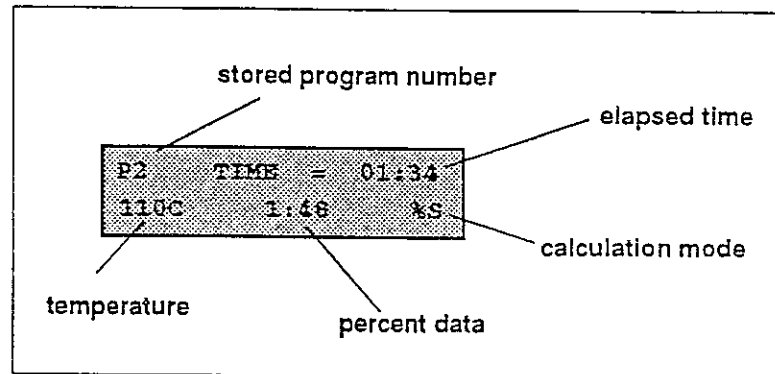
```
PROGRAM  
NOT STORED
```

and then returns to the main screen.

The recalled preset program becomes the current set of operating parameters. During a drying operation, the drying screen displays the program number being used in the upper left corner. (See Figure 21.)

Drying Screen Using Stored Procedure

Fig. 21



Printing Stored Procedures

The parameters of all stored drying procedures can be printed on the internal printer or an external device by using the following procedures:

To print all stored drying procedures:

- Press the **recall** key. Display shows:

```

RECALL
Program Number?
  
```

- Press the **enter** key. Display shows:

```

PROGRAM LIST
  
```

- All stored drying procedures are automatically printed (see Figure 22), and the analyzer automatically returns to the main screen.
- The analyzer automatically returns to the main screen.

Print Out Of Stored Programs

Fig. 22

PGM	TEMP1	TIME	TEMP2	TIME	SLOPE	%	STB
0	Md 110C	02:00	100C	1:00	0:30	0.05	60C
1	M 105C				0:60	0.05	60C
3	Sd 120C	05:00	110C	2:00			60C
4	S 115C	10:00	105C	3:00			60C

Clearing All Stored Programs

To clear all stored data and return to the original default factory conditions:

- Press the **store** key. Display shows:

SAVE
Program Number?

Then press the +/- key.

- Display shows:

CLEAR PROGRAMS
PRESS ENTER

- If your DO NOT wish to clear the programs, press the **tare** key. The unit returns to the main screen.
- If you wish to clear the programs, press the **enter** key. Display shows:

CLEAR PROGRAMS
CLEARING

- The analyzer returns to the main screen.

USING THE INTERNAL PRINTER

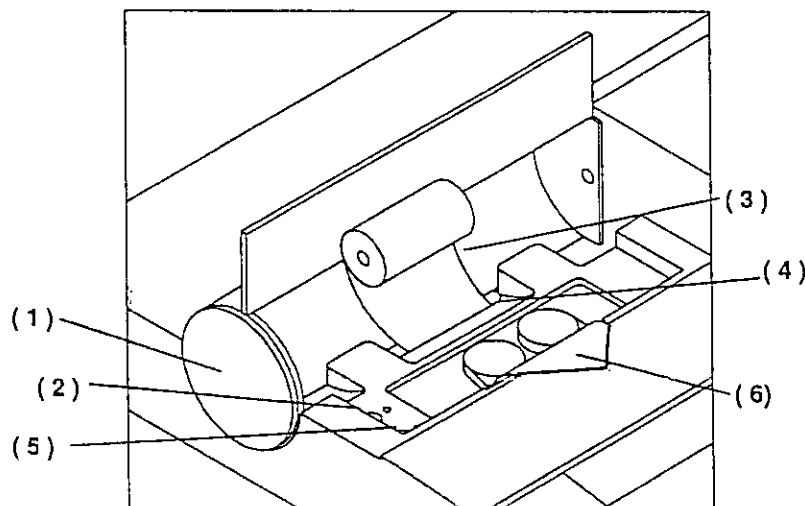
If your unit is equipped with an internal printer, it is set at the factory to automatically print test data at the beginning of a drying procedure and again at the end of the drying procedure, (start/stop). However, if you would like a different set of print intervals, see the I/O Section under Set Up for directions for changing this setting.

Loading The Printer Paper

One roll of paper has been installed in the analyzer for immediate use. When you need to install a new roll of paper, follow the steps outlined below. (See Figure 23.)

- Make sure the unit is turned on.
- Lift up the printer cover by turning the knob toward therear. (1)
- Press the **on/off** button to take the printer off line. (2)
- Cut the edge of the paper into a "V" shape in order to easily feed it through the paper slot. (6)
- Place the roll of paper on the metal plate with the paper dispensing from the bottom of the roll. (3)
- Feed edge of the paper through the slot, and push paper underneath the ribbon spools as far as possible. (4)
- Press the paper advance button until the paper moves to the printing position. (5)
- Press the **on/off** button again to put the printer back on line. (2)
- Place paper roll into paper dispenser. (Not shown)

Fig. 23



Loading Printer Paper

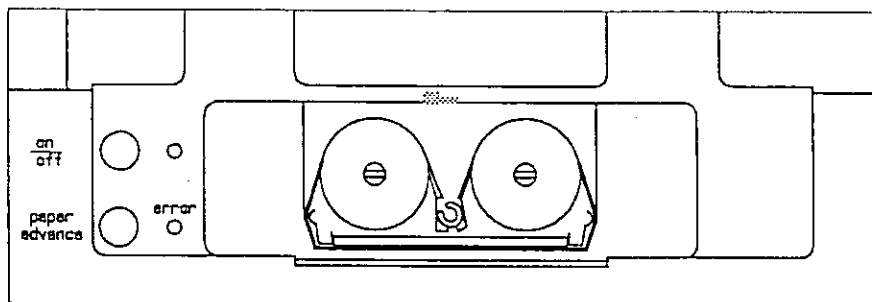
Replacing The Printer Ribbon Or Cartridge

Some models may be equipped with a replaceable ribbon cartridge (Figure 25) rather than separate ribbon spools (Figure 24). You must replace the ribbon with the same type. When you need to replace the printer ribbon, follow the steps outlined below.

- Lift up the printer cover by turning the knob toward the rear of the unit.
- Before removing the ribbon, check its position and note the appropriate grooves for re-threading it.
- Carefully remove the old ribbon either by lifting both spools up and out, or by grasping the cartridge in the location marked "pull".
- Insert the new ribbon spools or cartridge, making sure the pins slip securely into the appropriate slots.
- Thread ribbon (spool type only) around each side groove and in front of the printer hammer.
- Close the printer cover.

The printer ribbon automatically reverses itself when it comes to an end.

Fig. 24



Ribbon Spools

Fig. 25



Ribbon Cartridge

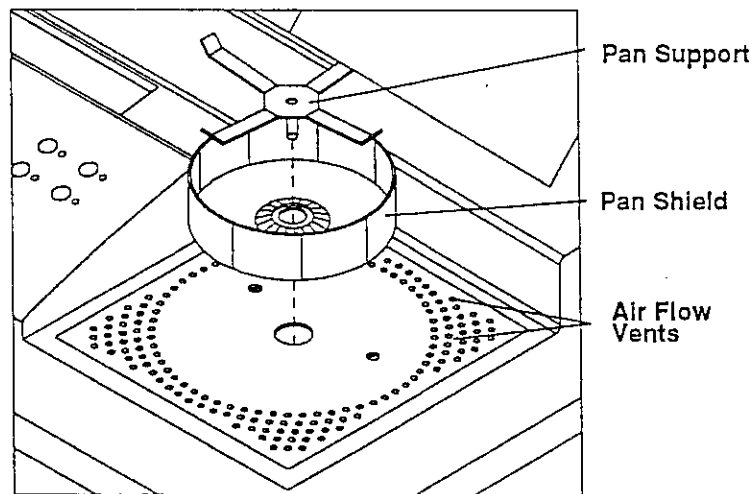
RECOMMENDED CARE

Your **Moisture Analyzer** is an integrated system designed to provide precise, fast determination of moisture content. Therefore, proper care and routine maintenance of the unit is required to prevent accidents, to ensure reliable results, and to avoid damage to the unit.

Before beginning the cleaning process:

- Unplug the unit.
- Allow the unit to cool for at least 30 minutes.
- Check that the unit is still unplugged.
- Use a mild detergent and a soft rag to clean the external surfaces of the unit .
- Do NOT immerse the unit in water or any other cleaning solution.

Fig. 26



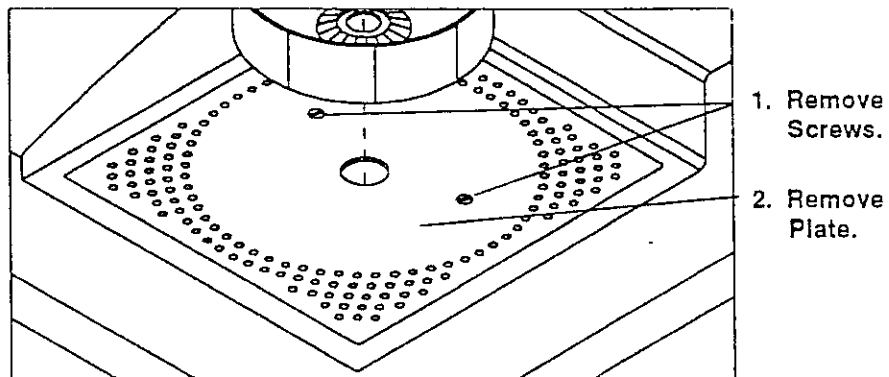
Clean Removable Parts And Air Flow Vents

Your daily regimen should include the following:

- Carefully remove Pan Support and Pan Shield to thoroughly clean them. (See Figure 26.)

- Keep all warning labels clean.
- Wipe dust and dirt from unit housing.
- Periodically, remove the perforated plate by unscrewing the two screws in order to clean the chamber below. Use extreme care in removing the accumulated residue with a clean, damp cloth. (See Figure 27.)
- Replace screws.
- For models with the internal printer, keep the mechanical part of the printer free from dirt and dust. Periodically lift up the printer cover to clean the printer mechanism with a soft brush.


Fig. 27



TECHNICAL SPECIFICATIONS

Measurement method:	Infrared radiation and detection of weight loss
Heat Source:	Four quartz infrared heaters
Temperature setting:	30° - 210°C (86° - 410°F) in one degree increments
Temperature sensor:	1000 ohm Platinum RTD
Temperature setting:	One or two temperature steps per procedure
Weighing pan:	100 mm (4" diameter)
Capacity:	100 grams
Tare range:	100 grams
Readability:	0.01% or 0.001 grams
Recommended Working range:	0.1 - 99.9% moisture
End analysis modes:	Time out: 1 - 99 minutes slope (constant weight): 0.01 - 9.99% of initial weight over 0.1 - 99 minutes
Units of results:	% moisture, % solid, or % volatiles (wet or dry basis)
Display:	Two line (16 characters) backlit LCD
Controls:	Silicon sealed keyboard (numeric keys and 12 function keys)
Programmability:	10 drying procedures
External I/O:	Serial output and centronics type parallel output
Optional printer:	Integral 40 column dot matrix; results only or intermediate value style printouts.
Power Requirements:	One of the following: 100, 115, 200 or 230 VAC, 50/60Hz 550 watts.
Dimensions (WxHxD):	375 x 177 x 420mm 15 x 7 x 16.5"
Shipping weight:	16Kg (35 lb.)

ACCESSORIES & SUPPLIES

<u>DESCRIPTION</u>	<u>PART #</u>
Breeze Shield	900337.1
Disposable Aluminum pans (pkg/50)	900274.1
100/115 VAC Fuses: 1/2 Amp (requires one each) 5 Amp	39890520.1 100340.1
200/230 VAC Fuses: 1/2 Amp (requires one each) 3 Amp	39890520.1 100453.1
Printer Ribbon: spools &  cartridge	900315.1 415 900740.1
Printer Paper: 1 ply	200643.1
Power Module: 100 VAC 115 VAC 200 VAC 230 VAC	900543.1 900207.1 900555.1 900371.1
Pan Support	900263.1
Quartz Sample Pads (pkg./200)	900298.1
50g. Calibration Weight (NIST class S-1)	820050.3
Vibrating Spatula	900239.1

THEORY OF OPERATION

The Moisture Analyzer uses infrared radiation to dry solid or liquid samples while continuously monitoring weight change on an integral balance. The percent of moisture or solids is calculated from the difference between the initial wet weight and the final dry weight.

Four quartz infrared elements uniformly heat the sample, which should be evenly dispersed on a disposable sample pan. (For more information on sample preparation, see the Application Section.) Setting the drying conditions involves either creating a drying procedure or selecting from one of ten programmable, stored procedures. Variables include drying temperature, two-step drying procedure, and an end of analysis mode (time or constant weight). After the initial sample weighing, the heating chamber is rapidly brought to the first heating temperature (30 °- 210° C) and controlled with a platinum temperature sensor ($\pm 1^{\circ}\text{C}$). When two step drying is desired, a second temperature is set along with an end of analysis mode.

The end of analysis may be determined either by the expiration of the heating time period(s) or after achieving a defined constant weight specification (slope). When the slope mode is selected, the test will automatically terminate when the sample is losing weight at a rate less than that specified.

Incident infrared radiation generated by the quartz elements irradiates the sample. Energy of the radiation is absorbed by the irradiated bodies (sample and dispersing agent), causing an increase in temperature of the heating chamber and the evaporation of water (and other volatiles). Absorption and hence the ability of the sample to use the incident infrared energy depends primarily on the surface properties of the sample (color, surface area, particle size, homogeneity) or on the thermal conductivity of the sample.

DEVELOPING A DRYING PROCEDURE

The Moisture Analyzer is applicable to a wide variety of samples including powders, liquids, pastes, slurries and some solids. Application considerations include sample compositions, sample preparation, sample presentation, sample size, drying parameters, desired accuracy, precision and analysis time.

Sample Composition: Is the Moisture Analyzer Applicable?

The chemical composition of materials applicable to the unit include primarily aqueous-based material or organic material with high flash points. Samples emitting toxic or corrosive fumes should not be analyzed unless the unit is placed in a hood. Samples that present a concern of exploding or igniting should be avoided.

Application Development: Where to Start

Drying samples on the Moisture Analyzer is relatively straight forward if a standard convection oven method has been already established. It can be as easy as drying at the same temperature and choosing the automatic default constant weight end-point setting. However, the unit has several features which allow the user to fully benefit from the analytical performance available with the unit. In addition, the use of a proper sample presentation technique using either quartz pads or sand can not only improve analytical performance. Improvements can result in more rapid analysis time, improved precision and better accuracy. Since speed of analysis is generally important for quality control applications and improved precision allows for tighter product specifications, it is advantageous to take the extra steps described below to optimize the drying procedure.

Sample Preparations: Preparing the Sample for Analysis.

Samples are prepared in the same manner as the standard oven method. Heterogeneous solid materials may require finer grinding which will result in better reproducibility. Increased surface area will also result in decreased analysis time. Liquid samples should be made homogeneous.

Sample Presentation: Selecting a Technique.

How the sample is exposed to the infrared radiation in the drying chamber will alter the drying characteristics of the sample. Generally, powder samples will be placed on an aluminum pan in the same fashion as using the oven method, however, liquids pastes, and slurries will use a dispersing agent. A dispersing agent such as sand or quartz pads may be necessary with some samples to provide an infrared absorbing substrate, because the sample by itself may not be a good infrared absorber. In addition, if the sample is not sufficient to cover the aluminum pan, more reflection off the pan occurs than absorption by the sample. This may also occur with samples that are light in color (or transparent).

Sample drying by infrared is generally more intense than by convection heating, resulting in more rapid analysis time. However, this can lead to crusting and splattering. As samples crust over, this locks in moisture which will not be released, causing low recovery and erratic results. Splattering results in erroneous weight loss as well as a maintenance concern. The use of a dispersing agent can prevent these problems.

Quartz Pads.

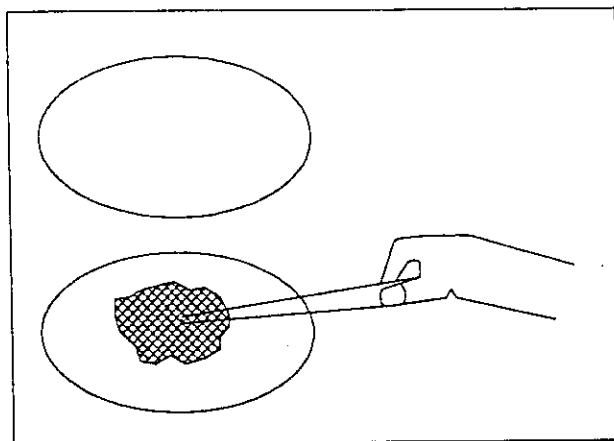
It is customary with a liquid sample to use the quartz pad technique. Either one or two pads are used depending on the sample consistency. Free flowing samples require only one pad. Sample is added either using a pipette or dunking the pad and shaking off the excess. The pad is then placed onto an aluminum pan for drying. For more viscous material, the sample is "sandwiched" between two pads. (See Figure 28.) When using one or two pads, approximately 1 to 2 grams of sample are used to minimize analysis time.

Note: Any dispersing agent may itself contain moisture. For most accurate results, dry the pads or sand prior to use and keep them in a dessicator.

Sand

Predried, laboratory grade sand can be used as a dispersing agent, generally as a second choice to the quartz pads. Sand would be the preferred agent for solid, moist material that is not suitable to be placed between two quartz pads. The sample should be embedded in approximately 20 grams of sand which has been tared. It will be necessary to completely cover any samples sensitive to charring or crusting.

Fig. 28



Step One: Duplicating the Convection Oven Method.

The convection oven method is the basis for starting to develop a drying procedure on the unit. The unit should be set up to dry at the same temperature as the oven method. To begin, use the default slope setting to achieve constant weight (.05%/1 min.). Select the appropriate units, %moisture or %solids. The default standby temperature of 60°C should be used. The sample should be presented to the unit in the same manner as the oven method. A weight of 2-10 grams should be used. The smaller the sample size, the quicker the analysis time. Samples should be analyzed and compared to the results obtained with the standard oven method, noting recovery, precision and sample appearance. Generally, good correlation between the methods occurs for powder materials. However, as described above for high moisture samples, a dispersing agent may be required.

Step Two: Using a Dispersing Agent and Changing Weight.

Sample presentation is the first consideration in developing a good drying procedure. As described above in the sample presentation section, choose an appropriate dispersing agent and repeat the test. This should provide better recovery and precision, while also reducing the analysis time.

Step Three: Choosing the Sample Weight.

This is the time to experiment with sample weight. A sample weight should be chosen that is representative of the material. However, too large a weight will greatly increase analysis time. For powder samples, generally 2-10 grams of sample is sufficient for moisture levels above 3%. The powder should be spread evenly across the aluminum pan keeping the depth between 1 to 2 mm. For less than 3% it is appropriate to increase sample size. However, sample depth should not exceed 2.5 mm or the top of the pan. For solid materials like paper, plastics, rubber or other solids, one should spread the sample over the entire pan surface.

Optimizing The Drying Procedure.

Optimizing the drying procedure can result in improved accuracy and reduced analysis time. The unit features software versatility to improve analytical performance.

The slope setting defines the point at which the analyzer will automatically halt the test. The slope setting consists of two parts: a) percent of initial weight, and b) a time window. The percent of initial weight should be adjusted to a lower value for sample moisture less than 3%. The percent initial weight setting also effects analysis time and accuracy. The larger the percent of initial weight, the quicker the analysis time. However, for some samples which release moisture slowly, it may mean a slightly low recovery. As a general guideline, the following should be set and then adjusted as desired for speed of analysis or accuracy:

If the moisture content is:	then set % initial weight to:
Greater than 3%	.05 or greater
Less than 3%, but greater than 1%	.03
Less than 1%, but greater than 0.5%	.01

The time window part of the slope setting can also be adjusted to optimize speed and accuracy. The default setting of one minute is generally sufficient for most applications. A shorter time window can decrease analysis time and maintain good recovery for samples that rapidly lose moisture. The longer time window is recommended for samples that lose moisture slowly.

Step Four: Optimizing Temperature

Increasing the drying temperature will reduce the analysis time, but may adversely effect the accuracy of the result. You should systematically increase the drying temperature 5°C at a time from the standard oven temperature until accuracy is affected or sample decomposition occurs (scorching, phase changing).

Step Five: Setting Standby Temperature.

The standby setting is the temperature that the oven chamber will maintain while the cover is down and the unit is not analyzing a sample. The default standby setting is 60°C. For samples which do not contain light volatiles, the standby temperature can be increased up to the drying temperature. Generally this is set at 10-20°C below the drying temperature to minimize analysis time. For samples with light volatiles which can be lost easily when exposed to heat, the standby temperature should be reasonably low as to be able to obtain a good initial weight.

Step Six: Developing a Two Step Drying Procedure.

When the material is high in moisture (above 15% moisture) and speed of analysis is important, it may be worth trying to reduce analysis time by using the two step drying feature of the unit. With this feature an initial high temperature is used to dry off much of the moisture quite rapidly. After the first time setting has elapsed, the temperature is decreased to the optimum value determined in step four. When developing a two step drying procedure, it is important to use a consistent sample size.

In developing the two step drying procedure, set a high temperature **TEMP1**, at approximately 30-50°C above the temperature established in step 4. Using the same slope as developed above, test a series of samples varying in the range of moisture expected and note to the nearest minute when approximately 85% recovery is obtained. The test should be aborted after 85% to prevent scorching. After a time has been determined, next set **TIME1** for this value and set **TEMP2** to your temperature established in step four above. Leave your slope and standby temperature the same. Analyze the same set of samples again allowing the unit to automatically switch from high to low temperature and then use the slope to terminate the analysis at constant weight. Some adjustment to **TIME1** may be necessary.

TWO YEAR LIMITED WARRANTY

Denver Instrument Company warrants to the original retail purchaser, for a period of two years from the date of invoice, that the Denver Instrument product is free from defects in material and workmanship. In the event of failure within the warranty period, Denver Instrument Company will repair or replace at its option, a defective product when used under normal conditions and in accordance with the operating limitations and maintenance procedures as outlined in the instruction manual and when not having been subjected to accident, alteration, misuse, or abuse. The defective Denver Instrument product, accompanied by a Return Authorization Number (see instructions below), must be delivered to Denver Instrument Company (or its authorized dealer), freight prepaid and securely packaged, during the warranty period by the original purchaser of the unit. DENVER INSTRUMENT COMPANY SHALL NOT BE LIABLE TO THE PURCHASER OR ANY THIRD PARTY FOR ANY LOSS, INCONVENIENCE, OR DAMAGE, WHETHER DIRECT, INCIDENTAL, CONSEQUENTIAL, OR OTHERWISE, RESULTING FROM ANY BREACH OF THIS WARRANTY OR ANY ACT OF OMISSION OF DENVER INSTRUMENT COMPANY, ITS DIRECTORS, OFFICERS, EMPLOYEES, OR AGENTS.

GENERAL DISCLAIMER: THIS WARRANTY IS MADE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED, OR STATUTORY, INCLUDING THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND DESIGN AND ALL WARRANTIES ARISING FROM THE COURSE OF DEALING OR USAGE OF TRADE.

Warranty Instructions

1. Please return the prepaid, pre-addressed Purchase Registration Card to Denver Instrument Company promptly upon your purchase of the Denver Instrument product. The return of the card is not a condition precedent to warranty coverage.
2. If you have any questions about your Denver Instrument product, please call our toll free number, 1-800-321-1135 (or fax description of problem to (303) 423-4831) for technical assistance.
3. If it becomes necessary to return your Denver Instrument product for service you must obtain a "Return Authorization Number". Please pack the product securely in its original approved packing carton or other suitable container and include your Return Authorization Number on the shipping label and as a precaution also a note inside the box. Shipping charges must be fully prepaid. Ship to: Denver Instrument Company, 6542 Fig Street, Arvada, CO 80004.

Some states do not all allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the limitations or exclusion above may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

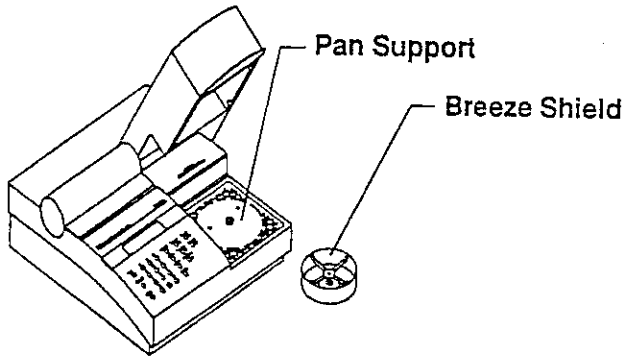
For your reference and protection, record:

Model Number _____

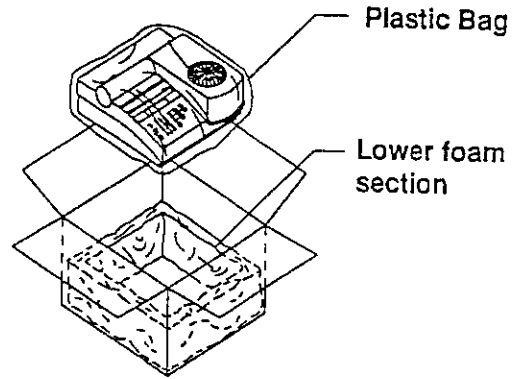
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Purchase Date _____

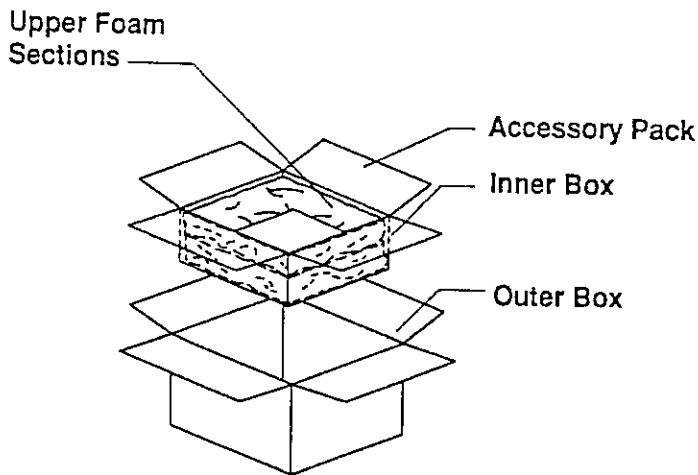
Moisture Analyzer Packing Instructions



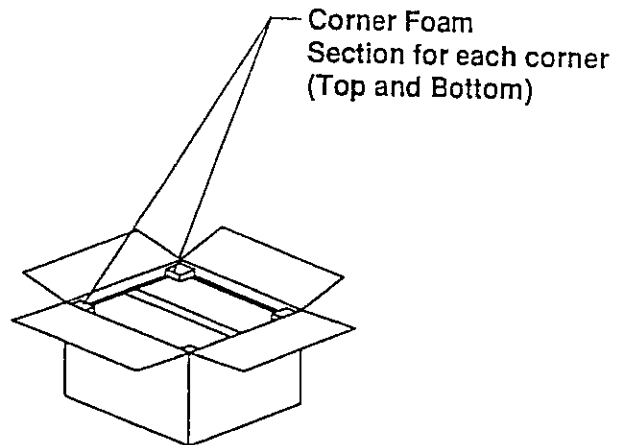
1. Remove the pan support and breeze shield from the Moisture Analyzer.



2. Place Moisture Analyzer inside plastic bag. Then center the Moisture Analyzer in the lower shipping foam section.



3. Align the upper foam sections on the Moisture Analyzer using the previous impressions as a guide. Place accessory pack on top of the upper foam sections. Place the inner box, with a corner foam section at each corner, into the outer box.



4. Tape the inner box and install the corner foam sections at each corner at the top and bottom of the inner box. Close and tape the outer box.