

Portable Moisture Tester PMT-330 User Manual



The Measurement and Control Company

Sensortech Systems, Inc.
2221 E. Celsius Ave. Unit B
Oxnard, CA 93030
805-981-3735 main
805-981-3738 fax
www.sensortech.com

Introduction

The PMT-330 continues a long tradition of battery powered portable moisture testers manufactured by Sensortech Systems, Inc. It incorporates many new features as well as a microprocessor and surface-mount electronic components providing a compact, reliable product.

The PMT-330 is powered by a rechargeable NiMH battery pack for quick recharge and long service life. Typical continuous operating time is 3 hours and the 3-minute time-out feature saves power and significantly extends the length of the operating time by conserving the battery charge.

The operation of the PMT-330 will be familiar to PMT-220 users and the digital display and keyboard will be simple to operate for new users.

There are two versions of portable moisture testers, the PMT-330V and the PMT-330G.

The PMT-330V is designed for veneer and thin sheet applications where the effective penetration depth is approx. 1/8 inch (3mm). The contact moisture measurement does not damage the product being measured. A measurement is made by pressing the Sensor Electrode onto the product surface. The Sensor Electrode contains a flexible electrode in the center that adjusts to the contour of the product surface and is made of hard anodized aluminum.

The PMT-330G is designed for gypsum and other board applications where the effective penetration depth is approx. 3/4 inch (20mm). The contact moisture measurement does not damage the product being measured. A measurement is made by pressing the Sensor Electrode onto the product surface. The Sensor Electrode contains a fixed electrode in the center and is made of hard anodized aluminum.

A unique feature of the PMT-330G is that it is designed to work with the on-line IMPS-4400 moisture profiling system. The Sensor Electrode and the RF electronic circuits are similar to that used by the IMPS-4400 system sensors. The PMT-330 portable moisture tester can be calibrated to match the IMPS-4400 on-line system over a wide range of product moisture. The PMT-330 and IMPS-4400 system will follow the same response curve and the RF penetration into a product being measured will be similar.



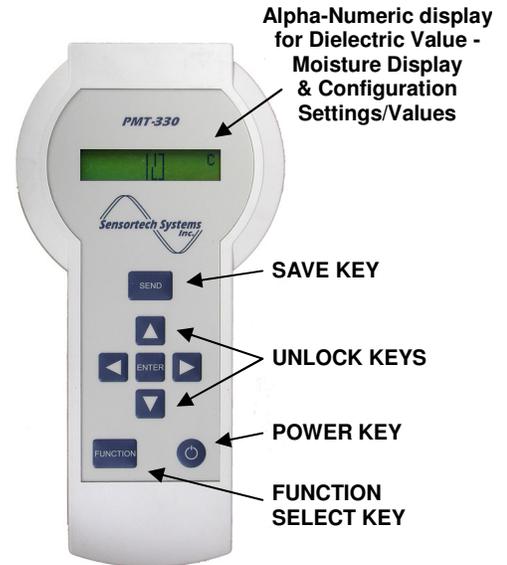
Figure 1. G - type Sensor Electrode
Gypsum and Board Products
Penetration Depth ~3/4 inch (20mm)

V - type Sensor Electrode
Veneer & Thin Sheet Products
Penetration Depth ~1/8 inch (3mm)

Quick Start Guide

To ensure best results, place the PMT-330 on the battery charger cradle and allow to fully charge for approx. 90 minutes before use or calibration. After the PMT-330 is fully charged perform the following:

1. Remove the PMT-330 from the charger and press the **Power** key.
2. Hold the PMT-330 upright in the air ensuring there is nothing near the Sensor Electrode located on the opposite side of the unit below the display and press the **ENTER** key <ENTER>. This performs the Zero/Reference Operation which calibrates the PMT-330 to the air humidity, temperature, mechanical and electrical conditions and zeros the moisture display. Do this anytime you wish to use the PMT-330.
3. Simultaneously press the **Up** ▲ and **Down** ▼ keys to unlock the PMT-330 to enable user changes to the configuration and calibration. The message 'Unlocked' will be displayed momentarily to indicate the user can change the configuration and Standardize the PMT-330.
4. Press the **FUNCTION** key <FUNCTION> one time. This displays the current Product Code. There are 10 Product Codes that can be configured for 10 different calibration settings. Pressing <FUNCTION> repeatedly cycles thru the various menus and functions used to configure and Standardize the PMT-330.
5. Press <FUNCTION> until 'Span' is displayed. The Span value specifies the span (slope) value. The initial Span value should be equal to +01.00 and can be changed by pressing the **Up** ▲, **Down** ▼, **Left** ◀ and **Right** ▶ keys. Press the **SEND** key <SEND> to save a new Span value.
6. Press <FUNCTION> until 'Zero' is displayed. The Zero value specifies the zero (offset) value. The initial Zero value should be equal to +00.00 and can be changed by pressing the ▲, ▼, ◀ and ▶ keys. Press <SEND> to save a new Zero value.
7. Press <FUNCTION> until 'Diagnostics' is displayed. Press <ENTER> to select the Diagnostics menu then press <FUNCTION> repeatedly to cycle thru the diagnostic parameters until 'Std. Factor' is displayed.
8. Place a clean and dry Standardization Reference Block onto a table and position the PMT-330 with the Sensor Electrode in the center of the block. Press down firmly on the PMT-330 and press <ENTER>. Note the new 'Std. Factor' value and press <ENTER> several times until the value displayed is approx. the same for each press of <ENTER>.
9. Press <SEND> to save the new 'Std. Factor' value to memory.
10. Verify the Moisture display equals 25. Note that the 'Moisture' display = 25 when Span = 1 and Zero = 0. For other Span and Zero values see page 10.
11. To check the PMT-330 moisture measurement, place the Sensor Electrode against your hand and verify the Moisture display is greater than 500 and then place the Sensor Electrode on Standardization Block to verify Moisture display is 25. Repeat steps 1 thru 11 as needed on a weekly, monthly or quarterly basis.
12. The PMT-330 has been calibrated for Zero and Standardized to the reference target (Standardization Block) and is now ready for use.



Press the Sensor Electrode firmly onto the center of the Standardization Block

Note: Place the PMT-330 on the charging cradle when not in use.

Operating the PMT-330

Keyboard Controls

- The **Power** key turns the PMT-330 on and off. After pressing the <Power> key, the PMT-330 performs internal diagnostic checks and enters the Continuous Measurement mode. If the PMT-330 is not manually powered off by pressing the <Power> key, it automatically turns off after a selectable time-out period of 1, 2 or 3 minutes. The default time-out period is 3 minutes.
- The **FUNCTION** key <FUNCTION> advances thru measurement and configuration modes.
- The **ENTER** key <ENTER> is used to select modes and enter parameter value changes. Pressing <ENTER> after power on performs the PMT-330 Zero/Reference calibration.
- The **Left** ◀ and **Right** ▶ keys control the cursor position in the display when setting Span and Zero. Simultaneously pressing the ◀ and ▶ arrow keys turns the power-off.
- The **Up** ▲ and **Down** ▼ keys increment or decrement the digit highlighted by the cursor. In Continuous Measurement mode, the ▲ key toggles the Peak Measurement Mode on and the ▼ key returns the device back to Continuous Measurement mode. Simultaneously pressing the ▲ and ▼ keys unlocks Parameter Protection, allowing changes to be stored in microprocessor memory.
- The **SEND** key <SEND> is a multi-operation key. In Continuous Measurement mode, pressing <SEND> will Hold the reading until the <SEND> key is released which clears the measurement. In any other mode except Peak Measurement mode, this key saves changes to microprocessor memory then returns the PMT-330 to Continuous Measurement mode.



Figure 2 – PMT-330 Keyboard

Measurement Modes

Continuous Measurement

This is the default mode when the PMT-330 is powered on. The moisture measurement is continuously displayed.

Peak Measurement

Pressing the ▲ key while in Continuous Measurement mode places the PMT-330 in Peak Measurement mode. The display will now hold the highest moisture measurement. To return to the Continuous Measurement mode, press ▼ key.

Hold Measurement

Pressing the <SEND> key while in Continuous Measurement mode places the PMT-330 in the Hold Measurement mode. The display will now hold the last moisture measurement. Release the <SEND> key to return to Continuous Measurement mode.

Parameter Protection / Unlock

All parameters may be displayed, but no changes can be made until a key sequence unlocks microprocessor memory. To unlock the PMT-330 microprocessor memory, press ▲ and ▼ keys simultaneously. The display momentarily shows 'Unlocked'. Except after changing the Product Code, the PMT-330 microprocessor memory remains unlocked until <Power> is pressed or the PMT-330 time-out occurs (power off).

The PMT-330 will re-lock microprocessor memory when <SEND> is pressed from the Product Code screen. This will also save the new product code parameters into microprocessor memory.

Product Codes

The PMT-330 can store product calibrations for ten different product codes. Each product code has its own associated Span and Zero. To change product codes, unlock the PMT-330 and press the ▲ and ▼ keys to select a new product code. Press <SEND> to save the product code selected to be used for measurement.

Set-up Mode

Set-up mode parameters are global settings that are pre-set at the factory prior to shipment.

To select the Set-up mode, press <FUNCTION> repeatedly until 'Set-up' is displayed.

1. Press <ENTER> to select the Set-up mode. The first parameter is 'Decimal Places'. Press ▲ and ▼ keys to select '0', '1' or '2' decimal places to be displayed on the measurement.
2. Press <FUNCTION> to advance to the 'Time Out' parameter. Press ▲ and ▼ keys to select the desired time-out period of '1', '2' or '3' minutes. The PMT-330 will power off after this time-out period to save battery charge.
3. Press <SEND> to save changes to microprocessor memory and return to Continuous Measurement mode. Press <FUNCTION> to advance to the Diagnostics mode.

Diagnostics Mode

The Diagnostics mode parameters are stored and real-time measurement values, calibration values and battery voltage.

To select the Diagnostics mode press <FUNCTION> repeatedly until 'Diagnostics' is displayed.

1. Press <ENTER> to select the Diagnostics mode.
2. Press <FUNCTION> repeatedly to advance through each parameter. Each parameter is displayed on the top line and the parameter value is displayed on the bottom line of the display.
3. Unlock the Parameter Protection and press <SEND> to save changes to microprocessor memory.

The Diagnostic mode parameters are as follows:

- **'Vref'** - The lower display shows the reference raw-dielectric voltage level. This value should be between 2.3 and 2.7 volts.
- **'Vmeas'** - The lower display shows the measured raw-dielectric voltage level. This will decrease with increasing moisture (dielectric). This value should be similar to the Vref value between 2.3 and 2.7 volts and decrease with increasing moisture near the Sensor Electrode.
- **'Raw Diel.'** - The lower display shows the ratio of Vref/Vmeas which is the raw-dielectric. The raw-dielectric value is the basic engineering unit proportional to moisture. In order to display actual moisture, the PMT-330 applies a linear function involving a slope multiplier (Span) and offset (Zero). This value should be approx. 1 in free air and increase with increasing moisture near the Sensor Electrode.
- **'Pre-Zero'** - The lower display shows the value that is computed when pressing <ENTER> while 'Moisture' is displayed. This is the value calculated during the Zero/Reference Operation calibration. 'Pre-Zero' value is subtracted from subsequent measurements. This value should be approx. 1 in free air i.e. PMT-330 held upright with no moisture near the Sensor Electrode.
- **'Std. Factor'** - The lower display shows the value that is computed during Standardization using the Standardization Block. This value should be between 10 and 50.
- **'Vbatt'** - The lower display shows the PMT-330 battery voltage. The PMT-330 continually monitors the battery voltage and displays a warning when the battery is low. The Vbatt value will display approx. +5.5 volts when the NiMH batteries are fully charged. When the PMT-330 needs to be recharged, a 'LB' (low battery) warning appears on the sides of the moisture display. When the battery is below operational voltage, a warning message 'Recharge Batteries' will be displayed and the PMT-330 must be recharged before further use. If the voltage is less than the minimum operating voltage, the PMT-330 will not power on and needs to be recharged for 30 minutes or longer.

Mode Selection

The PMT-330 modes are organized in modules. Each module represents a measurement or configuration mode e.g. Continuous Measurement mode, Product Code mode, Set-up mode, Diagnostics mode, etc.

At initial power-up, the PMT-330 enters Continuous Measurement mode. Each push of the <FUNCTION> key advances to the next mode, allowing Product Code selection, Span and Zero entry. The Set-up and Diagnostics modes are for measurement configuration and calibration. These modes contain multiple parameters which may be accessed by pressing <ENTER>. Figure 3 illustrates how to step through the various modes using the <FUNCTION> key. Press <SEND> to return from any mode to Continuous Measurement mode.

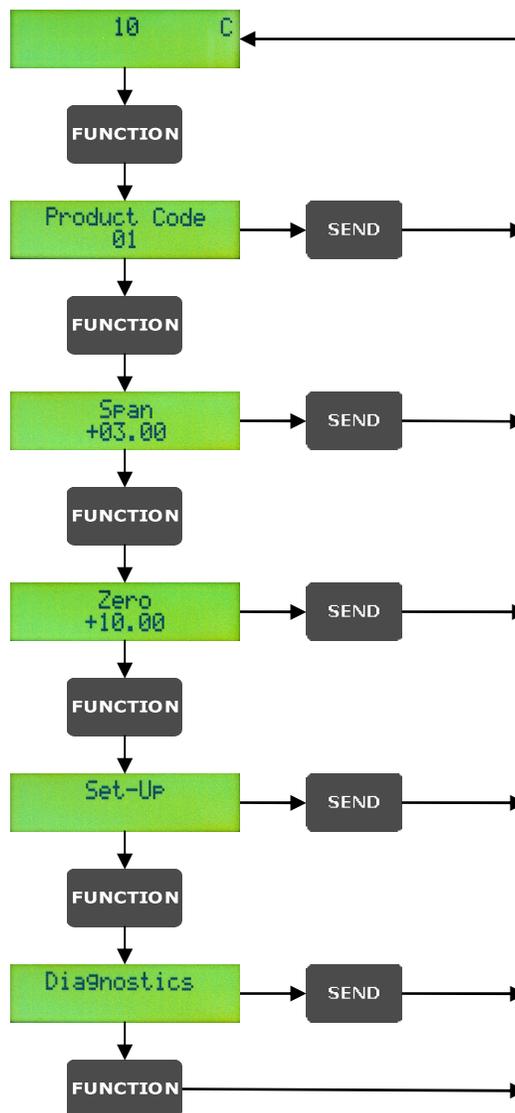


Figure 3. Using FUNCTION & SEND keys to navigate through the Modes

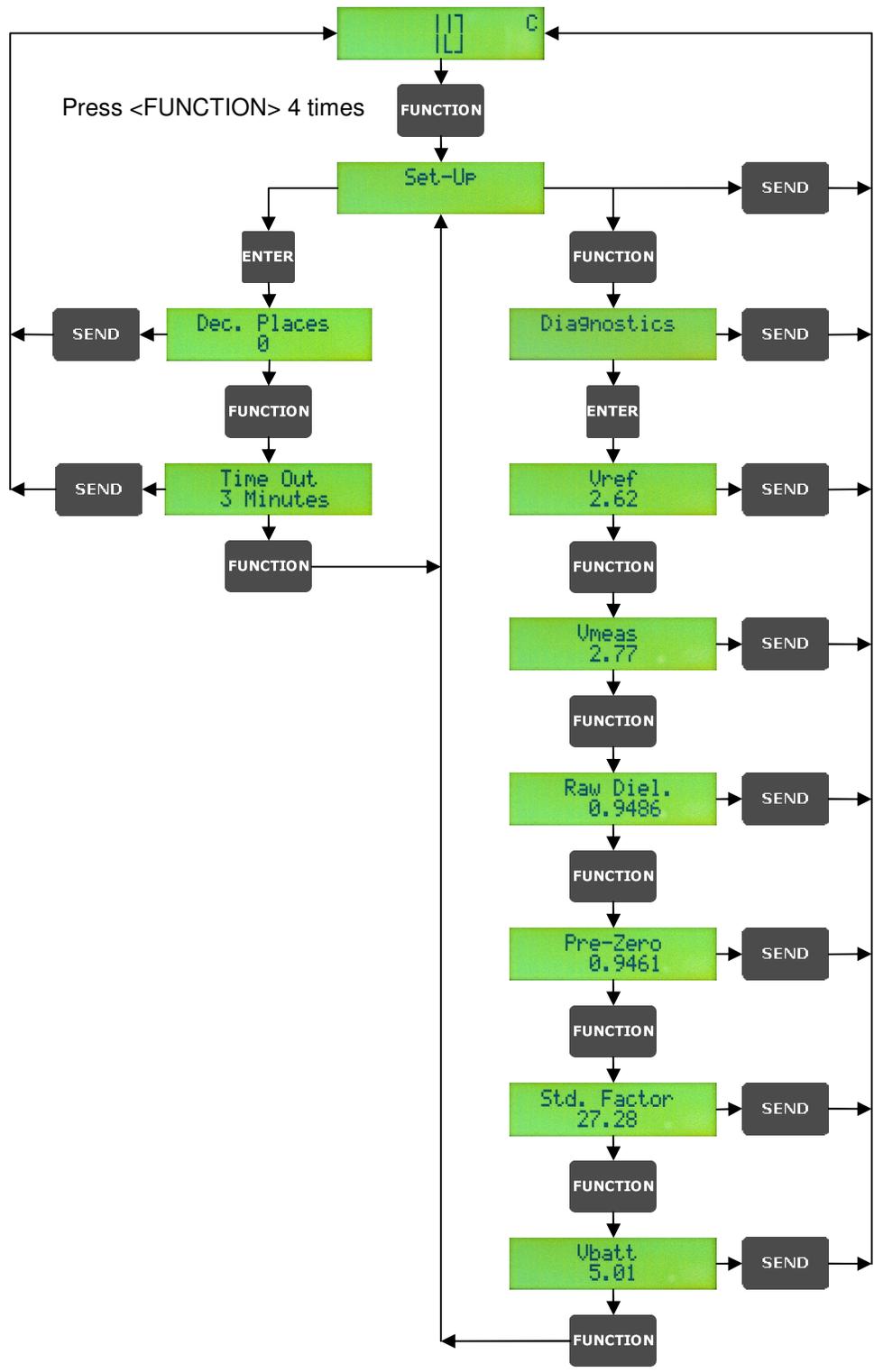


Figure 4. Set-Up & Diagnostics Mode Module Parameters

PMT-330 Tester Calibration

Zero/Reference

The Zero/Reference calibration calculates the Pre-Zero by taking a measurement of the air humidity, temperature, mechanical and electrical conditions of the PMT-330 before measuring product moisture, i.e. with no moisture or material near the Sensor Electrode. This calibration value is subsequently subtracted from measurements to indicate only product moisture. At completion of the Zero/Reference calibration, the message 'Zero/Reference Done' will be displayed. The PMT-330 then returns to Continuous Measurement mode.

The Zero/Reference calibration is intended to be performed before each use of the PMT-330.

To perform a Zero/Reference Calibration:

1. Hold the PMT-330 off the table and away from product with the Sensor Electrode clear of any objects, moisture or material.
2. Press <ENTER> to start the Zero/Reference calibration. After a short period (approx. 1 second), the message 'Zero/Reference Done' will be displayed and the calibration is complete.

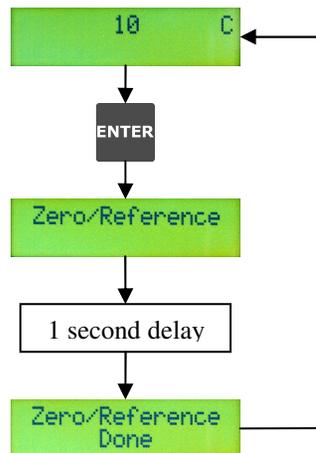


Figure 5. Zero/Reference Calibration Sequence

PMT-330 Tester Calibration (continued)

Standardization

In addition to the Zero/Reference calibration, the PMT-330 is calibrated to a known reference, the Standardization Block, to ensure the best accuracy for moisture measurements. This process is referred to as Standardization and calibrates the PMT-330 to a known Standardization Block reference with the current air humidity, temperature, mechanical and electrical conditions. A Standardization Block consisting of a phenolic plate fixed to a high-density foam support which is provided with each PMT-330. The Standardization block should be kept dry and clean, and is typically stored near the PMT-330 charger.

The Standardization value is calculated so that, when using a Span = 1 and a Zero = 0, the PMT-330 will show a moisture value of 25 when placed on the Standardization Block. This value is multiplied by the Span and offset by the Zero. For different Span and Zero values, a different moisture value will be displayed. Example, if Span = 4 and Zero = -30 the moisture displayed when pressed against the Standardization Block will be 70: i.e. $(25 * 4) - 30$.

After Standardization, all PMT-330's will respond similarly using the same Span and Zero. The Standardization Block may also be used to check measurement stability over time.

Place the PMT-330 Sensor Electrode in the center of the Standardization Block and hold it down firmly (see Figure 6).

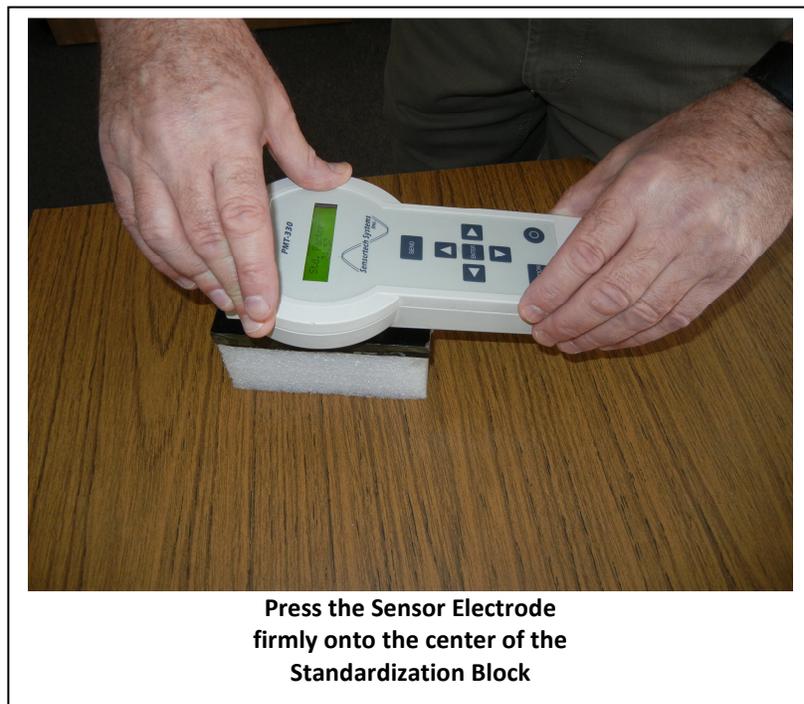


Figure 6. Performing a Standardization

Perform a Standardization calibration before performing a new Product Moisture Calibration and periodically, when significant changes in air humidity, temperature, mechanical and electrical conditions are experienced on a weekly, monthly or quarterly basis.

To perform a Standardization calibration:

1. Complete a Zero/Reference calibration (see previous section).
2. Press the ▲ and ▼ keys simultaneously to Unlock the PMT-330.
3. Press <FUNCTION> until 'Diagnostics' is displayed
4. Press <ENTER> to enter Diagnostics mode.
5. Press <FUNCTION> key until 'Std. Factor' is displayed.
6. Press the PMT-330 Sensor Electrode onto the center of the Standardization Block and hold it down firmly.
7. Press <ENTER> and the number in the lower display will change to the new 'Std. factor'. The typical Std. Factor parameter value should be a positive number between 10 and 50.
8. Press the <SEND> key to save the new Std. Factor value to microprocessor memory.

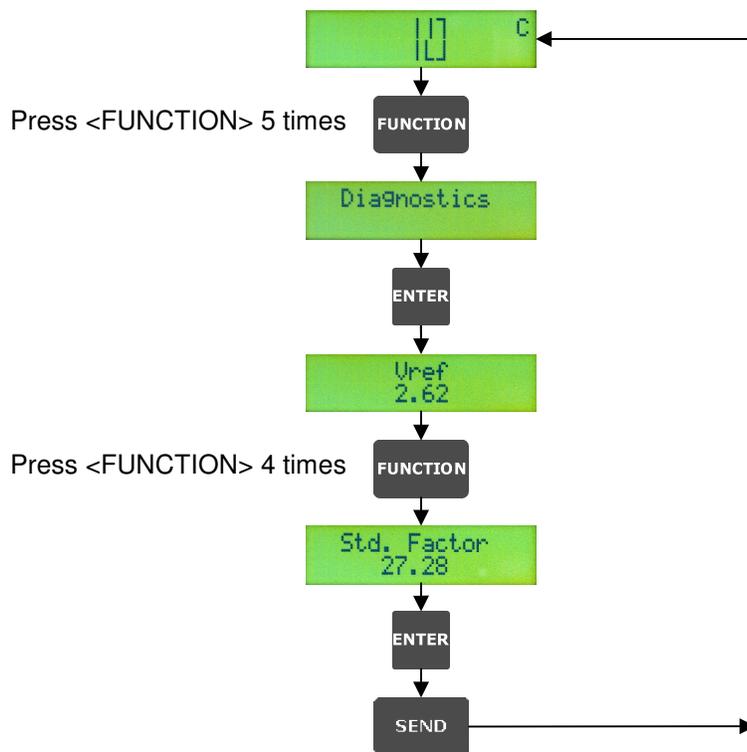


Figure 7. Standardization Calibration Sequence

Product Moisture Calibration

The PMT-330 uses the following equation to calculate moisture:

$$\text{Moisture} = \text{Span} * \text{Std_Factor} * [\text{Raw_Diel.} - \text{Pre-Zero}] + \text{Zero}$$

where:

Span and Zero are the values for the Product Code being measured (user defined).

Std. Factor is the value stored from the Standardization calibration (calculated).

Raw_Diel. is the current measurement dielectric value (measurement value).

Pre-Zero is the value stored from the Zero/Reference calibration (calculated).

The Span and Zero values are determined by the Product Code selected and are pre-set at the factory. The PMT-330 displayed moisture are adjusted by the Span and Zero values. The Zero and Span may be used to match a laboratory calibration moisture range value, to match the IMPS-4400 system or other hand-held moisture measurement. Up to 10 Product Codes may be defined with 10 unique Span and Zero values for measurements that can be set to match a specific product moisture range, product density or product thickness. The Span parameter value should be a positive number. The Zero parameter value may be a negative or positive number.

Product Moisture Calibration Process

The Span and Zero for each Product Code are user defined and may be calculated by regression analysis. Here is a common way to do this.

Collect several product samples with a range of known moisture contents. The more samples used, the more accurate the calibration will be. Five samples are usually enough for reasonable results.

The following example uses veneer calibrated using an oven-dry method. The same procedure is valid for all board products, though gypsum board is typically calibrated using another reference.

When the PMT-330 is received from the factory, it will have default parameters for Span and Zero. The default values have been determined by experimentation and will usually be close enough for immediate use. For improved accuracy, a regression analysis should be run on a number of product samples representing the normal range of moistures found in actual production. Representative samples may be collected using the PMT-330 before Product Calibration to provide a range of values. From a stack of veneer look for the highest value reading and the lowest value reading and 2 – 4 mid-value readings. This will provide the necessary sample moisture range. Cut out 6" x 6" samples from each of the veneer sheets and seal samples in zip-lock bags. Recently dried samples should be double bagged and allowed to equilibrate for 2 – 5 days.

Immediately prior to measurement, the PMT-330 should be calibrated by performing a Zero/Reference and Standardization using the Standardization block. It is preferable to use the factory default Span and Zero values to begin the analysis.

Flip the Standardization block over so that foam is uppermost. Place a sample on the foam and gently press PMT-330 down on the sample. The PMT-330 measures approximately a 2-inch diameter circle allowing measurements to be taken from each quarter of the sample (4 measurements). An average reading may be calculated and entered in the table as a single value or, if using a spreadsheet, each separate reading may be entered.

After obtaining the 4 readings, weigh the sample and record the weight in the table as wet weight. The sample should then be analyzed in the laboratory by oven drying at 180°F (80°C) for 12 hours or until no further weight loss. The dry sample should now be weighed and the result entered in the dry weight column.

Make a table as shown below.

Table 1. Example measurement data table

Sample #	Dry Weight (DW)	Wet Weight (WW)	Actual Moisture (%) 100*(WW-DW)/WW	PMT-330 Reading
1				
2				
3				
4				

Moisture is determined as $M = 100 \times (WW - DW) / WW$

Enter the calculated value in the actual moisture column. If PMT-330 values have been individually entered resulting in 4 PMT-330 readings per sample, the weight and moisture results should be duplicated for all 4 measurements.

An Excel spreadsheet was used for the following example:

Table 2. Example spreadsheet after data entered

Sample #	Dry Weight (DW)	Wet Weight (WW)	Actual Moisture 100*(WW-DW)/WW	Measured Moisture	Normalized PMT-330	Calibrated PMT-330
1	46.26	47.25	2.1	3.1	4.03	2.17
1	46.26	47.25	2.1	2.8	3.93	1.76
1	46.26	47.25	2.1	3	4.00	2.03
1	46.26	47.25	2.1	2.9	3.97	1.90
2	56.07	59.94	6.46	6.2	5.07	6.35
2	56.07	59.94	6.46	6.2	5.07	6.35
2	56.07	59.94	6.46	6.1	5.03	6.21
2	56.07	59.94	6.46	6	5.00	6.08
3	56.34	59.76	5.72	6	5.00	6.08
3	56.34	59.76	5.72	5.9	4.97	5.94
3	56.34	59.76	5.72	5.8	4.93	5.81
3	56.34	59.76	5.72	5.9	4.97	5.94
4	53.82	60.12	10.48	9.8	6.27	11.20
4	53.82	60.12	10.48	9.6	6.20	10.93
4	53.82	60.12	10.48	9.5	6.17	10.80
4	53.82	60.12	10.48	9.7	6.23	11.06
5	43.2	50.58	14.59	12.1	7.03	14.30
5	43.2	50.58	14.59	12.3	7.10	14.57
5	43.2	50.58	14.59	11.8	6.93	13.90
5	43.2	50.58	14.59	11.9	6.97	14.03

Many regression packages are available including Microsoft Excel. Plot an x-y graph with the laboratory values on Y-axis and the PMT-330 readings on the X-axis. A sample graph is shown below. If you are using Excel, position the cursor over any data point, and right-click the mouse. Select 'add trend-line', and choose 'linear fit'. Also, choose the show equation option to display the equation on the graph.

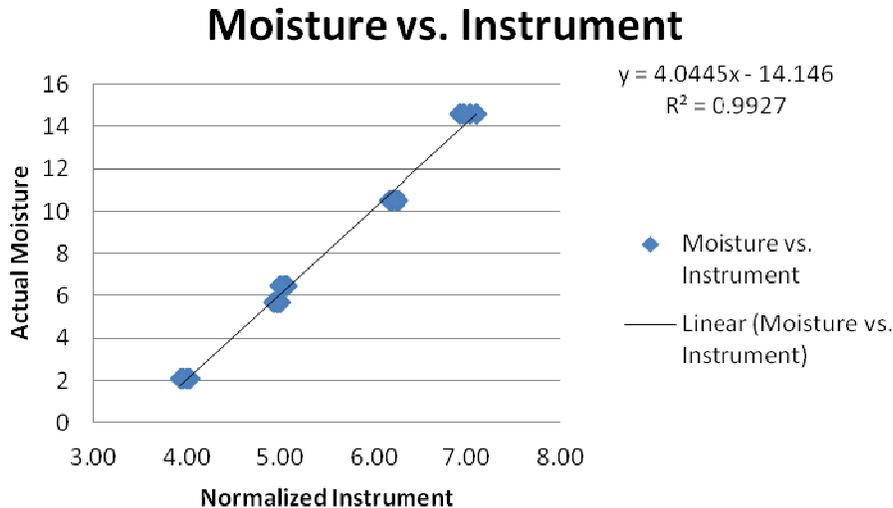


Figure 8. Normalized PMT-330 value = (displayed value – Zero)/Span

If default Span and Zero settings are used (Span = 1; Zero = 0) then the new Span and Zero are simply the calculated slope and intercept values.

New Span = Slope

New Zero = Intercept

If non-default Span and Zero values were used, then the PMT-330 values must be normalized prior to regression. Normalized PMT-330 value = (displayed value – Zero)/Span

The graph should be plotted using normalized PMT-330 on x-axis and actual moisture on y-axis. In the example shown, original Span = 3 and original Zero = -3. The linear trend line results in a new slope of 4.04 and intercept of -14.15 (rounded to 2 decimal place).

To enter the calibration coefficients into the PMT-330, first select the product code to be edited.

- Press <FUNCTION> one time, 'Product Code' is displayed.
- Simultaneously press ▲ and ▼ keys to Unlock the PMT-330.
- Select the desired Product Code using ▲ and ▼ keys.
- Press <FUNCTION> until 'Span' is displayed. The lower display shows the Span value with one digit highlighted with a flashing cursor. The cursor may be positioned under any digit using the ◀ and ▶ keys. Select the digit you wish to change and, press ▲ and ▼ keys to set the desired value. Move the cursor and repeat the operation until the complete number is entered.
- Press <FUNCTION> until 'Zero' is displayed. The lower display shows the Zero value. Adjust the Zero value in the same way as for the Span value.



Figure 9. PMT-330 with Accessories:

1. PMT-330 Portable Moisture Tester
2. Charger Cradle and International Plug Adaptors
3. Standardization Block