Honeywell

Microwave Moisture Measurement

System Manual

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Microwave Moisture Measurement

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Introduction

The purpose of this manual is to provide Honeywell field and factory personnel the information required to install, calibrate, and maintain Honeywell Microwave Moisture Sensors on Experion MX Systems.

Experion MX model numbers covered in this document are Q4270-51 and Q4273-52.

Audience

This manual is intended for use by engineers or process engineers and assumes that the reader has some knowledge of the operation of a paper machine and a basic understanding of mechanical, electrical and computer software concepts.

About This Manual

This manual contains 11 chapters and one appendix.

Chapter 1, **System Overview and Installation**, provides an overview of the system, and installation procedures.

Chapter 2, **Sensor Specifications and Principles of Operation**, describes sensor specifications and operating principles for the system.

Chapter 3, **EDAQ**, describes the principles and operation of the Ethernet Data Acquisition (EDAQ) board.

Chapter 4, **Software**, describes operation of the real-time application environment software on the system.

Chapter 5, **Operation**, describes operation of the system.

Chapter 6, **Static Calibration**, describes procedures for static calibration of the system.

Chapter 7, **Preventive Maintenance**, describes recommended ongoing preventive maintenance tasks.

Chapter 8, **Tasks**, describes procedures for maintenance, diagnostic, and troubleshooting tasks.

Chapter 9, **Troubleshooting**, describes symptoms, alarms, possible causes, and links to associated diagnostic or troubleshooting tasks.

Chapter 10, **Storage, Transportation, and End of Life**, describes methods for storing, transporting, and disposing sensor components.

Chapter 11, **Glossary**, describes the terms and acronyms used in this manual.

Appendix A, **Part Numbers**, lists part numbers for system components.

Related Reading

The following documents contain related reading material.

Honeywell Part Number	Document Title / Description
	Scanpro DS-20/DS-30 manual (shipped with sensor)
6510020375	Experion MX TRIR Fiber Weight and Moisture Measurement system manual
6510020381	Experion MX MSS & EDAQ Data Acquisition system manual

Conventions

The following conventions are used in this manual:

ATTENTION Text may appear in uppercase or lowercase except as specified in these conventions.

`Boldface` Boldface characters in this special type indicate your input.

`Special Type` Characters in this special type that are not boldfaced indicate system prompts, responses, messages, or characters that appear on displays, keypads, or as menu selections.

Italics	In a command line or error message, words and numbers shown in italics represent filenames, words, or numbers that can vary; for example, filename represents any filename. In text, words shown in italics are manual titles, key terms, notes, cautions, or warnings.
Boldface	Boldface characters in this special type indicate button names, button menus, fields on a display, parameters, or commands that must be entered exactly as they appear.
lowercase	In an error message, words in lowercase are filenames or words that can vary. In a command line, words in lowercase indicate variable input.
Type	Type means to type the text on a keypad or keyboard.
Press	Press means to press a key or a button.
[ENTER] or **[RETURN]**	**[ENTER]** is the key you press to enter characters or commands into the system, or to accept a default option. In a command line, square brackets are included; for example: **SXDEF 1 [ENTER]**
[CTRL]	**[CTRL]** is the key you press simultaneously with another key. This key is called different names on different systems; for example, **[CONTROL]**, or **[CTL]**.
[KEY-1]-KEY-2	Connected keys indicate that you must press the keys simultaneously; for example, **[CTRL]-C**.
Click	Click means to position the mouse pointer on an item, then quickly depress and release the mouse button. This action highlights or “selects,” the item clicked.
Double-click	Double-click means to position the mouse pointer on an item, and then click the item twice in rapid succession. This action selects the item “double-clicked.”
Drag X	Drag X means to move the mouse pointer to X, then press the mouse button and hold it down, while keeping the button down, move the mouse pointer.
Press X	Press X means to move the mouse pointer to the X button, then press the mouse button and hold it down.
ATTENTION	The attention icon appears beside a note box containing information that is important.
CAUTION	The caution icon appears beside a note box containing information that cautions you about potential equipment or material damage.
WARNING	The warning icon appears beside a note box containing information that warns you about potential bodily harm or catastrophic equipment damage.

1. System Overview

This manual is intended to be used on Honeywell Q4270-51 (Scanpro DS-20) standard range microwave moisture sensors, and on Q4273-52 (Scanpro DS-30) high range microwave moisture sensors.

Table 1-1 lists model numbers and maximum water weight for each type.

Table 1-1 Model Numbers and Water Weight

Marketing	Hardware	Scanpro	Maximum Water Weight
Q4270-51	094270-51	DS-20	600 g/m^2
Q4273-52	094273-52	DS-30	1500 g/m^2

The Scanpro model number refers to the sensor head unit. This is repackaged by Honeywell to mount into the Experion MX head. The Scanpro Central Unit SA-150 is not used.

1.1. Operating Principles

Honeywell Precision microwave moisture sensors are supplied by Scanpro of Kista, Sweden.

The sensor consists of a resonant cavity with the sheet passing through the middle. The water in the sheet has a high dielectric constant at the measure resonant frequency (1.8 GHz) and thus affects the exact resonant frequency. The measure frequency resonance has an amplitude peak at the sheet position, so the frequency is strongly affected by the sheet dielectric constant. The reference frequency (3 GHz) resonance has low amplitude at the sheet position, so it is not strongly affected by the sheet dielectric constant. It is used to correct for other effects (gap variations, electronic drift, and so on).

The lower head contains only a passive half-cavity (**Figure 1-1**). The half-cavity in the upper head (**Figure 1-2**) has two antennas, and one detector diode in the DS-20; two detector diodes in the DS-30. The antennas are fed by the oscillator board. Note that there is an attenuator on each of the cables where they attach to the cavity.

The microwave oscillator board contains the two oscillators (1.5–1.8 GHz, and 2.5–3 GHz), amplifiers, and mixers. The oscillator starts at a frequency above both resonances, is ramped down until resonance is detected, locks at that frequency for 1 ms while a frequency measurement is made, and is ramped down to the second resonance where another measurement is made. The frequency descends further and then ramps back up, repeating both measurements.

The differentiator board controls the sweep signal that controls the oscillator, receives the detected signal from the detector diode, and converts and sends it to the MS-controller board. It also contains a circuit for adjusting the sensitivity of the measuring head.

The MS-controller board generates the control signals for the sweep generator on the differentiator board, subtracts the measure and reference frequencies, and sends the resulting moisture measurement to the microwave interface board through a serial link.

The microwave interface board provides the -28 V DC power to the measuring head. It also conditions the serial signal which enables communication between the sensor controller board and the Ethernet Data Acquisition (EDAQ) board.

The EDAQ is responsible for converting all analogue and digital signals to and from sensors to Ethernet.

The window or sheet guide side of the sensor is shown in **Figure 1-3**. The window is made of a durable polymer material. The inside of the window is coated with a carbon layer. If taking the window apart, avoid touching the inner side of the window.

CAUTION

> The RF power present in the sensor resonant cavity and especially outside the cavity is very low and do not pose any known risk to human health. The sensor is not interlocked and does not switch off when the heads are split. Be aware of the presence of 28 VDC on the sensor electronic boards and connectors.

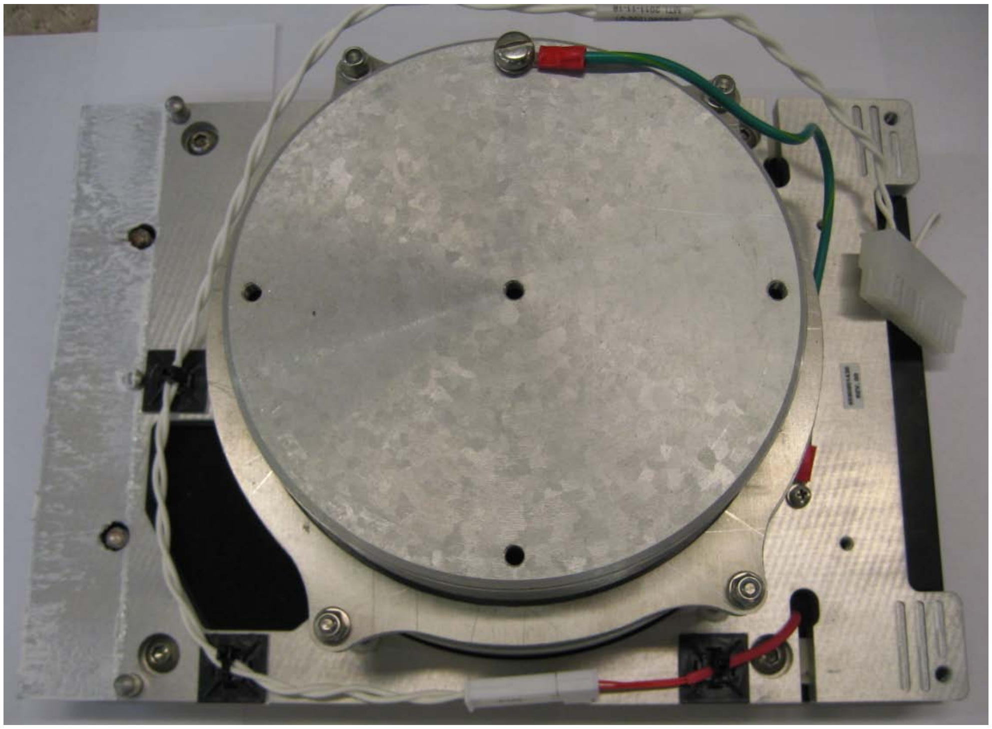

Figure 1-1 Lower microwave head – Passive microwave half cavity

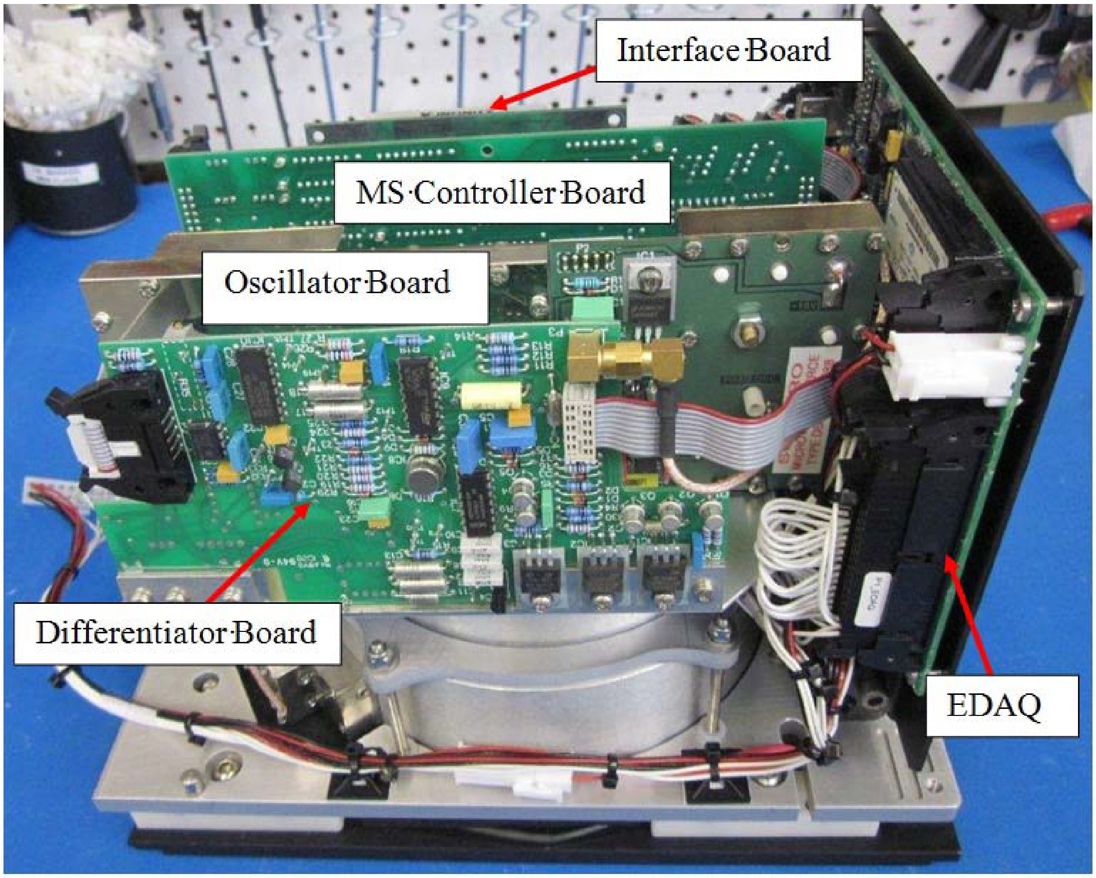

Figure 1-2 Upper microwave head showing electronic boards

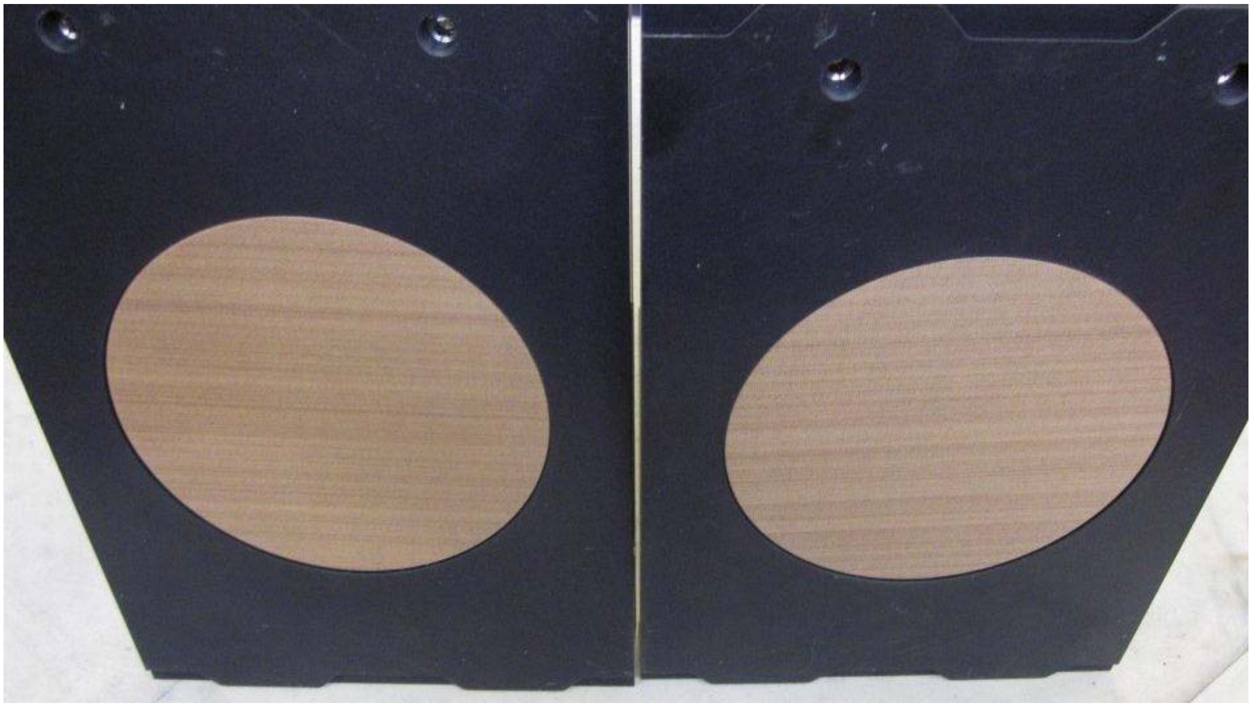

Figure 1-3 Upper and lower microwave head showing window side

1.2. Specifications - Standard Range Sensor

- Part number: Honeywell model Q4270-51, Scanpro DS-20
- water weight range: 6–600 g/m^2; suitable for many dry end and wet end applications
- moisture range: 2–70% moisture
- basis weight range: above 100 g/m^2
- repeatability: equivalent to 0.5 g/m^2 water weight, or 0.1% moisture, whichever is greater
- static accuracy: 2 • Sigma = ± 0.25% for moisture in the range of 4–12%. Above 12%, 2 • Sigma = ± 0.02 • sheet moisture. Table 1-2 lists the accuracies at low basis weight and moisture.

Table 1-2 Low Basis Weight and Moisture Sensor Errors

Percent Moisture	2•Sigma Accuracy for Dry Basis Weight		
	100 g/m^2	200 g/m^2	400 g/m^2
1%	n/a	n/a	0.7%
2%	n/a	0.8%	0.4%
3%	1%	0.5%	0.25%
4%	0.8%	0.4%	0.25%
6%	0.5%	0.25%	0.25%
12%	0.25%	0.25%	0.25%
16%	0.32%	0.32%	0.32%

- response time: 12.5 ms (80 readings per second)
- cross direction resolution: less than 8.7 cm (3.4 in)
- gap: may be 10.2 mm (0.4 in), or 12.7 mm (0.5 in)
- insensitive to passline if kept within 5 mm (0.2 in)
- head temperature: maximum 55 °C (131 °F)
- power requirements: 400 mA at 24 V DC

1.3. Specifications - High Range (wet end) Sensor

- Part number: Honeywell model Q4273-52, Scanpro DS-30
- water weight range: 400–1500 g/m^2; suitable for many wet end applications
- moisture range: 10–70% moisture
- basis weight range: above 570 g/m^2
- repeatability: equivalent to 2 g/m^2 water weight, or 0.3% moisture, whichever is greater
- Static accuracy: 2•Sigma = ± 0.5% for moisture in the range of 10–25%. Above 25%, 2•Sigma = ± 0.02•sheet moisture.
- response time: 12.5 ms (80 readings per second)

- cross direction resolution: 8.7 cm (3.4 in)
- gap: must be 12.7 mm (0.5 in)
- insensitive to passline if kept within 5 mm (0.2 in)
- head temperature: maximum 55 °C (131 °F)
- power requirements: 400 mA at 24 V DC

2. Installation

Read this manual before installing a microwave moisture sensor.

The microwave moisture sensor must be installed in line, that is, in the same CD position, as the Basis Weight sensor. The basis weight measurement is required for the microwave sensor to report moisture in terms of %moisture instead of water weight.

Install the passive half-cavity in the lower head and the active half-cavity in the upper head.

To install the sensor:

1. Check that the jumper settings on both the differentiator board and the oscillator board are for the proper range, standard or high (see Subsection 8.7.2).

2. Install sensor in head and connect sensor harnesses shown in Figure 2-1 and Figure 2-2 to head distribution board.

3. Check in real-time application environment (RAE) under MSS IO point monitor, the voltage (-28 V ± 1) and current (approximately 330 mA) provided to the gauge by the microwave interface board.

4. Check the alignment procedure for the sensor (see Chapter 8), and before aligning (if required), familiarize yourself with the location of the four printed circuit boards in the sensor head, and with the principles of operation (see Chapter 1).

5. Ensure that the head temperatures are within range and stable. Refer to scanner manual if required.

6. Perform a stability test to make sure that the sensor is stable (see Section 8.3)

7. Check that the calibration constants in sensor maintenance for a given code match the constants on the calibration data sheets provided with the system (see Chapter 6).
8. Enable the appropriate correctors, for example, Z-correction, dry end, and profile correction (see Chapter 6).
9. Verify the static calibration (see Chapter 6).
10. Perform dynamic calibration (see Section 5.3).

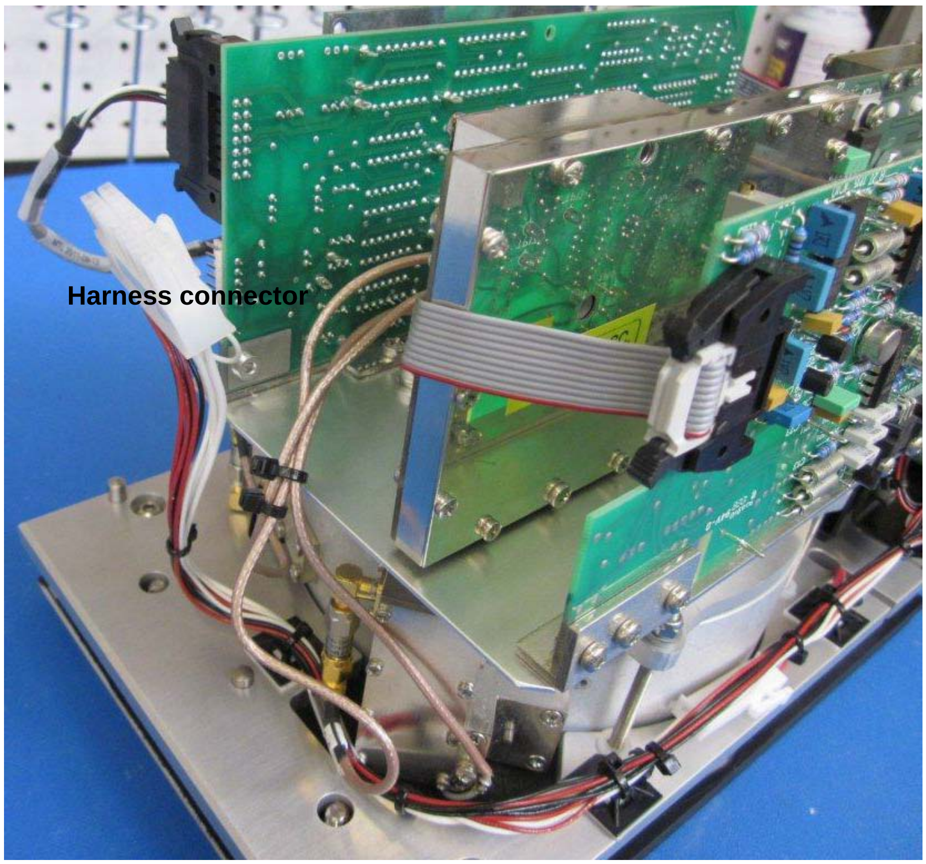

Figure 2-1 Upper microwave sensor showing sensor harness

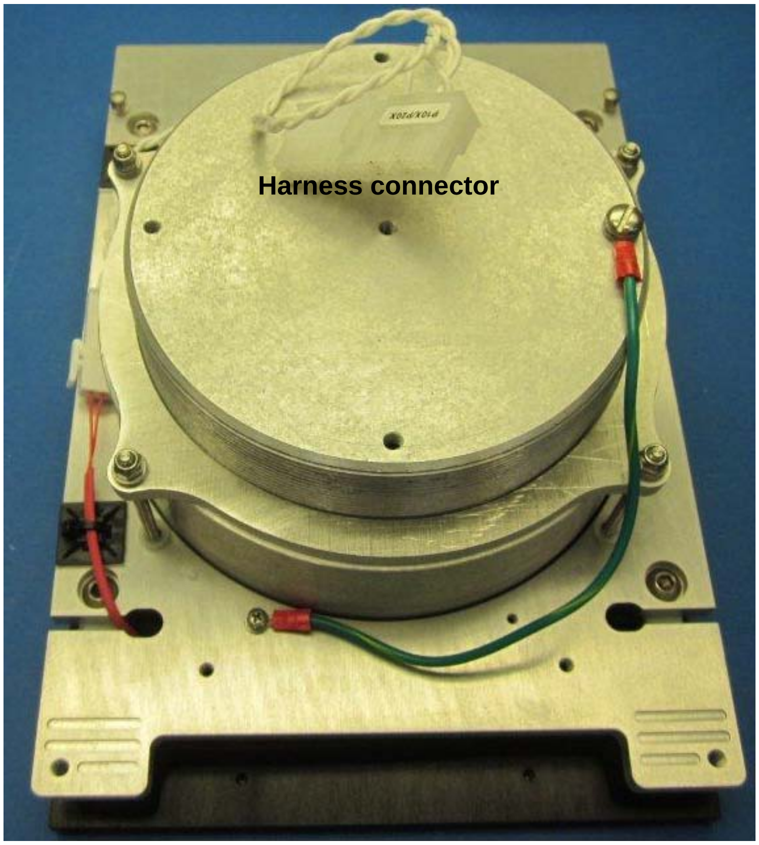

Figure 2-2 Lower microwave sensor showing sensor harness

3. EDAQ

The Ethernet Data Acquisition (EDAQ) board is responsible for converting all analogue and digital signals to and from sensors to Ethernet.

It replaces the functionality of the National Instruments™ cards seen in previous Honeywell scanner systems.

The board is based on an ARM CPU running the Linux operating system and a Field-Programmable Gate Array (FPGA) that controls real-time data acquisition.

The EDAQ contains software licensed under third party licenses including the Gnu Public License (GPL). A copy of that software and its source code can be obtained from *http://www.honeywell.com/ps/thirdpartylicenses* or found on the Experion MX distribution media under *C:\Program Files\Honeywell\Experion MX\MSS\SenLan\Images\GPL*.

The EDAQ board contains a large number of input/output (I/O) systems, including:

- analog inputs (16 inputs of 12 bits @ 4 kHz and 8 inputs of 10 bits @ 1 Hz)
- analog outputs (2 @ 12 bits)
- digital inputs (16 @ 24 V logic)
- digital output (16 @ 24 V logic)
- frequency input (400 Hz to 500 kHz)
- three serial ports
- USB (presently unused)
- Ethernet

Except for a few dedicated signals such as the green light (radiation safety), all sensor signals connect through the EDAQ to the new Experion MX Measurement Sub System (MSS) by Ethernet.

The EDAQ contains sensor-specific code for all sensors. All EDAQs, including the EDAQ performing frame motion control (in the endbell) and the head alley EDAQ, are identical and can be interchanged.

This chapter gives a brief overview of the EDAQ board and some of the diagnostic information. More detail is provided in the *Experion MX MSS & EDAQ Data Acquisition System Manual* (p/n 6510020381).

3.1. Physical Layout

Figure 3-1 and Figure 3-2 show the EDAQ PCBA as it is mounted next to a sensor. To the left are the digital and analog I/Os, which connect directly to a sensor. Below these two large connectors is a 16-pin expansion connector that is only used when the EDAQ is attached to the frame controller (FC) expansion board.

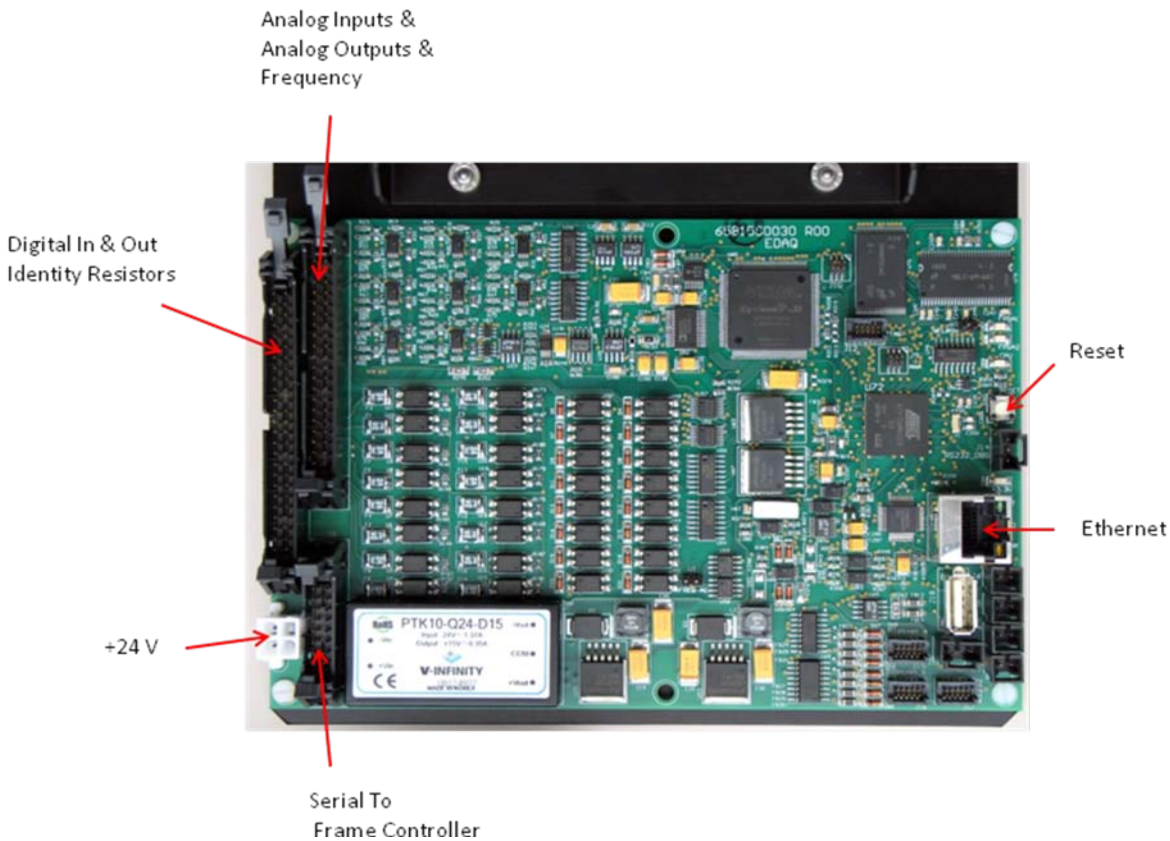

Figure 3-1 EDAQ Board

As shown in Figure 3-2, J1 is the large 50-pin connector on the far left. J2 is the smaller 40-pin connector. J8 on the lower left is used for the FC only. To the right are the Ethernet port, some diagnostic LEDs, serial connections, and temperature inputs. There are no test points for use in the field. A serial debug port is available (115200 kb/s, no flow control, 8N1) that may be connected to any PC running a serial terminal program. For diagnostic purposes, service personal may be asked to connect a serial cable between this debug port and the RS-232 of any neighboring EDAQ.

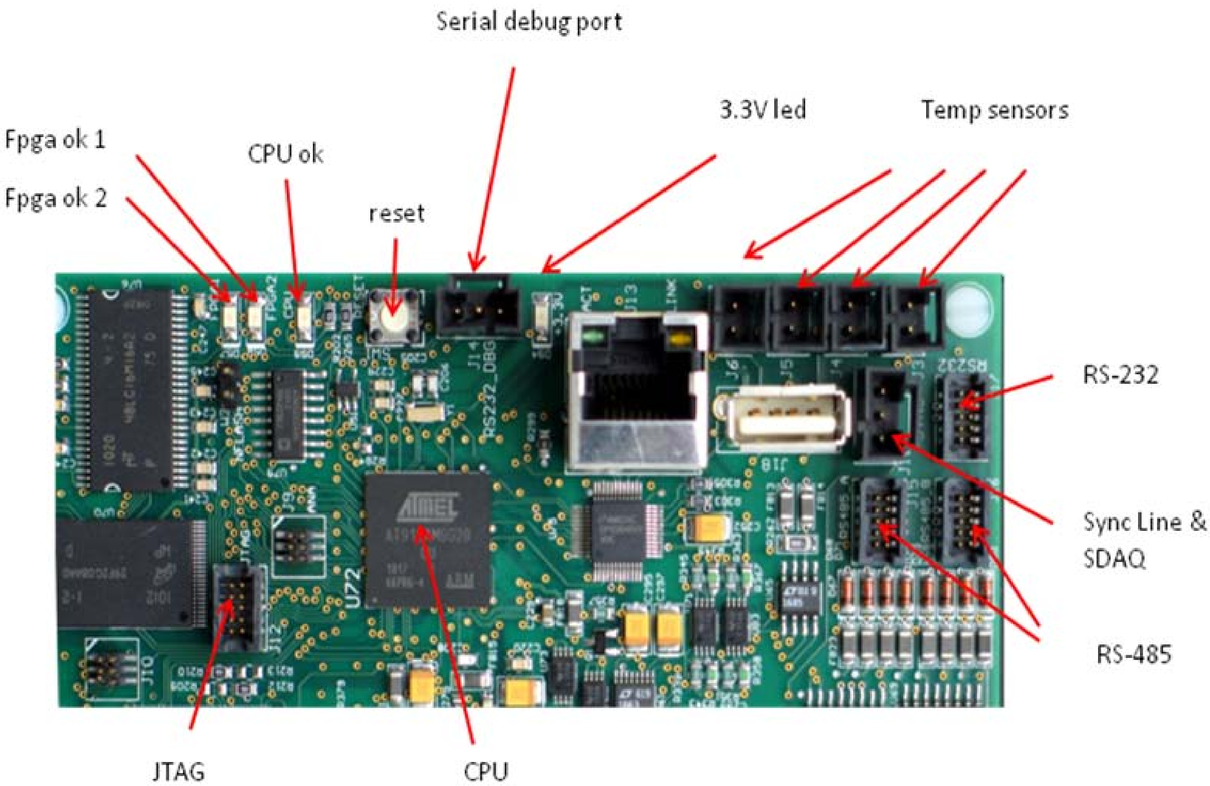

Figure 3-2 EDAQ Board: Ports and Diagnostic LEDs

3.2. Hardware Status Information

There are four diagnostic LEDs on the EDAQ (see Figure 3-2).

- The *3.3 V LED*. When lit, this indicates that all power supplies on the board are functional. The signal is derived from the 3.3 V power supply, which in turn is derived from the 15 V power supply, which is derived from the + 24 V input.

- The *CPU OK LED*. This LED is under control of the central ARM CPU. It will be lit when the main sensor application (edaqapp) is running on the CPU.
- The *Fpga ok 1* (not used at present).
- The *Fpga ok 2*. This LED will blink if the FPGA is loaded and running code.

In addition, the Ethernet connector contains two LEDs: amber indicates a good link to the switch, and green indicates activity on the network.

3.3. EDAQ Reset

A soft reset of the EDAQ may be performed through a Web interface running on the scanner MSS. This interface may be accessed from a QCS Operator station.

A hardware reset can be performed by pressing the white button next to the debug cable. This resets both the CPU and FPGA and is equivalent to a power on/off.

3.4. EDAQ Sensor Identification and IP Addressing

Assuming the firmware (flash code) is the same, all EDAQs are identical. EDAQs can be freely interchanged between sensors and the scanner endbell.

Each EDAQ contains all the code for all supported sensors and loads the appropriate software depending on the identification ID code read at boot time. Two resistors are used to uniquely identify the EDAQ.

For sensor-connected EDAQs, there is a sensor model resistor embedded in the cable harness connecting the sensor to the EDAQ. This resistor determines the function code. Function codes are unique for each sensor model to the extent that the EDAQ needs to differentiate the models (for example, all Source 9 basis weight measurement sensors presently have the same function code, regardless of radioactive isotope).

In addition, the head power distribution board has a resistor for each EDAQ platform connector. This determines the position of the EDAQ in the head. The EDAQ can self-identify both its position and function.

Refer to your scanner system manual to troubleshoot if the EDAQ does not identify itself properly (or to find the correct resistor values).

Every EDAQ has a unique IP address on the scanner network. If the EDAQ can identify its position, it will set its IP address to 192.168.0.*XYZ* (where *XYZ* is the position number in the head). The frame controller (FC) EDAQ always sets itself to IP number 192.168.0.2. The MSS is always 192.168.0.1 on the scanner network, and usually 192.168.10.*n*+100 (where *n* is the number of MSSs on the same MX Experion network) on the Experion MX LAN. The MSS is assigned 192.168.10.101 at the factory, but this can be set to any IP address by using the MSS Web page. Refer to your scanner system manual.

If an EDAQ fails to determine a position, it requests an address of the local DHCP server (which is either running on the FC-EDAQ or the MSS). Any laptop will get an IP address once plugged into any of the scanner Ethernet switches.

3.5. Obtain Status Information

An overall status page is available from a QCS operator station under the **MSS Setup Diagnostics** tab. Select the **MSS Summary** page.

Figure 3-3 shows, on the left, a list of all expected EDAQs with three types of status indicators (from left to right).

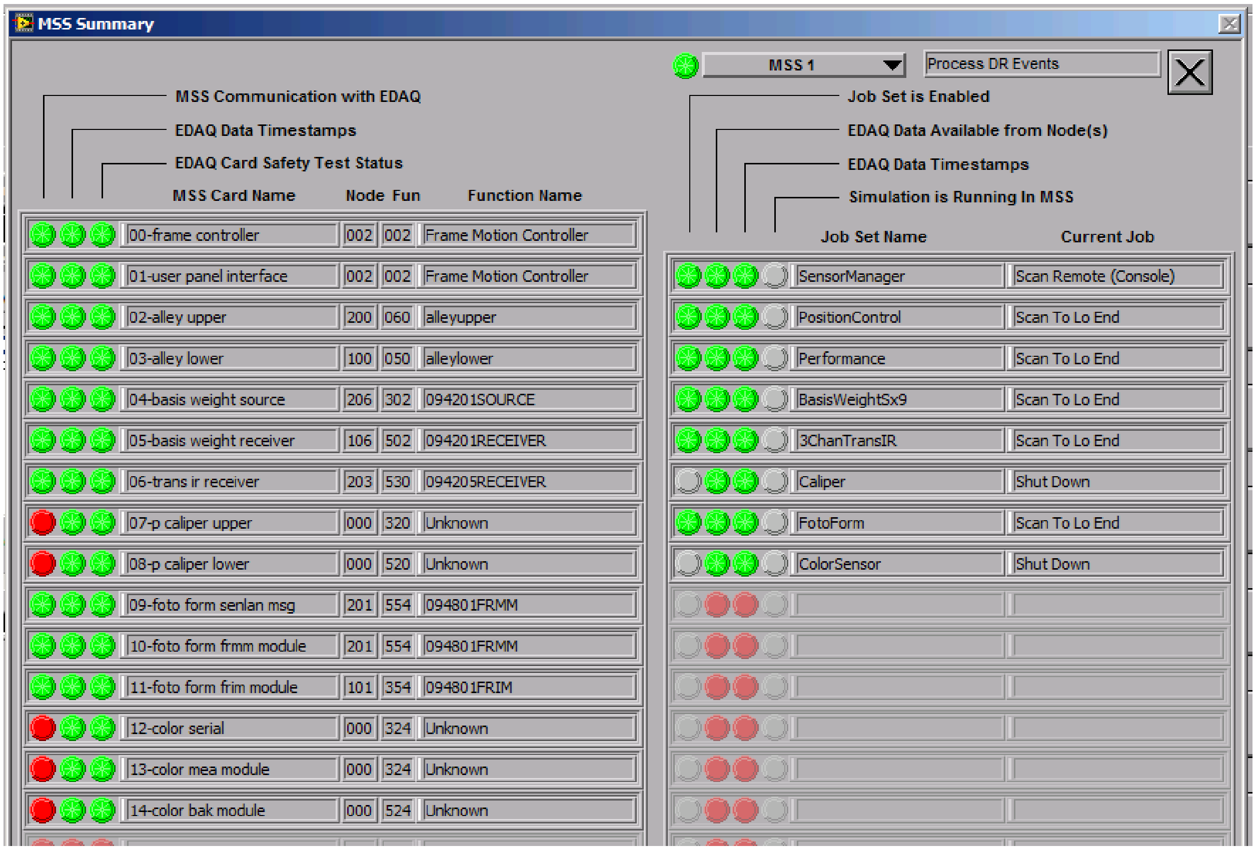

Figure 3-3 MSS Summary

Table 3-1 MSS Summary Display Status Indicators and Descriptions

Column	Description
MSS Communication with EDAQ	EDAQ is communicating (through the EDAL protocol) with the MSS
EDAQ Data Timestamps	Data that the MSS is expecting from that EDAQ is being supplied at the expected rate
EDAQ Card Safety Test Status	EDAQ is not reporting any errors such as interlock or motion control issues

Sensors that are part of the RAE database but are not enabled on the scanner show the left most column indicator as red, for example, *07-caliper upper* in Figure 3-3.

3.6. MSS and EDAQ Web Pages

More detail is available on the MSS and the EDAQs, which all run Web servers and can display server pages containing information on the state of the system. As a general rule, consult the MSS Web pages first. They are accessible in three different ways:

- going to the **MSS Diagnostic** tab, clicking on **MSS Monitor**, choosing the appropriate MSS and clicking on **MSS Web** page
- by opening a browser on any computer connected to the Experion MX level network and using the address *http://192.168.10.101/mss.php* (the first MSS on the LAN), or the address set up for the MSS in the Experion MX system
- by opening a browser on any computer connected to the scanner LAN switch and using the address *http://192.168.0.1/mss.php* or *http://192.168.10.101* (for the first MSS on the system)

Figure 3-4 shows the main MSS Web page (**PHP MSS Page**).

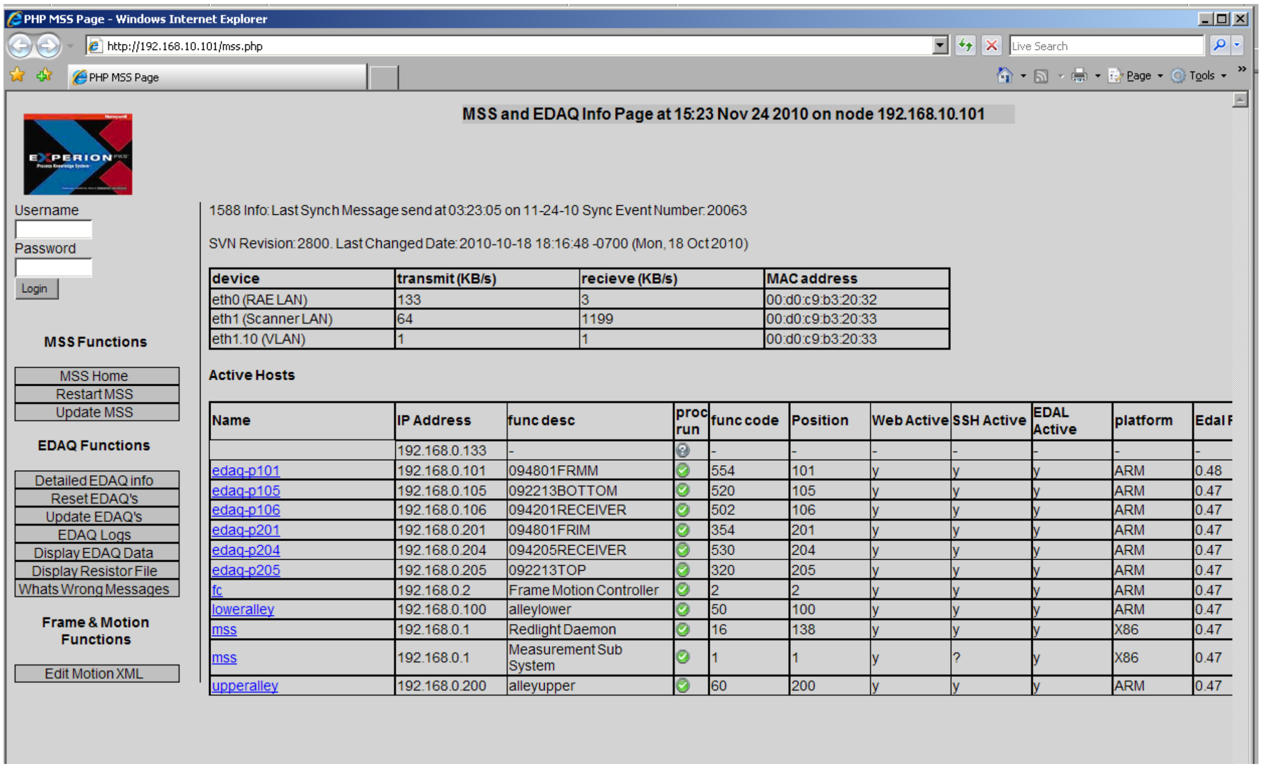

Figure 3-4 PHP MSS Page

The left panel shows a column of options divided into:

- **MSS Functions**
- **EDAQ Functions**
- **Frame and Motion Functions**

Enter the username (**`admin`**) and password (`hmxresult`) for advanced diagnostic options that are not necessary for normal operation and not discussed in this manual.

The main panel shows two tables. The top table contains transmission volume information to and from the MSS. The device labeled **eth1** (scanner LAN) typically shows it receiving a few MBs. The MAC addresses of the MSS are also shown–the **eth0** address is the one required in the setup.

The second table lists all EDAQs discovered on the scanner LAN, their IP numbers, a brief description (related to model number), a program status column, the associated function code and position code, and whether the communication protocols are running (http, ssh, and Edal, the proprietary sensor data transmission protocol).

The EDAQ network name is specified by edaq-p*XYZ* where *XYZ* is both its position and last octet of the IP address. The EDAQs attached to the head power distribution boards are known as *upper* and *lower* alley respectively. The FC-EDAQ is known as *fc*.

The **proc/run** status column is green if all processes known to run on the EDAQ are present. Hovering the cursor over the status indicator calls up a list of running and stopped processes.

More detailed information on each EDAQ can be obtained by clicking **Detailed EDAQ Info** on the left panel.

The resulting table (see Figure 3-5) shows a number of technical details that are not discussed in this document. Important columns include **Process load** (usually less than 0.5), **local time** (matches MSS time clock shown at top) and **Offset From MSS (µs)** (less than 50 µs a few minutes after start up).

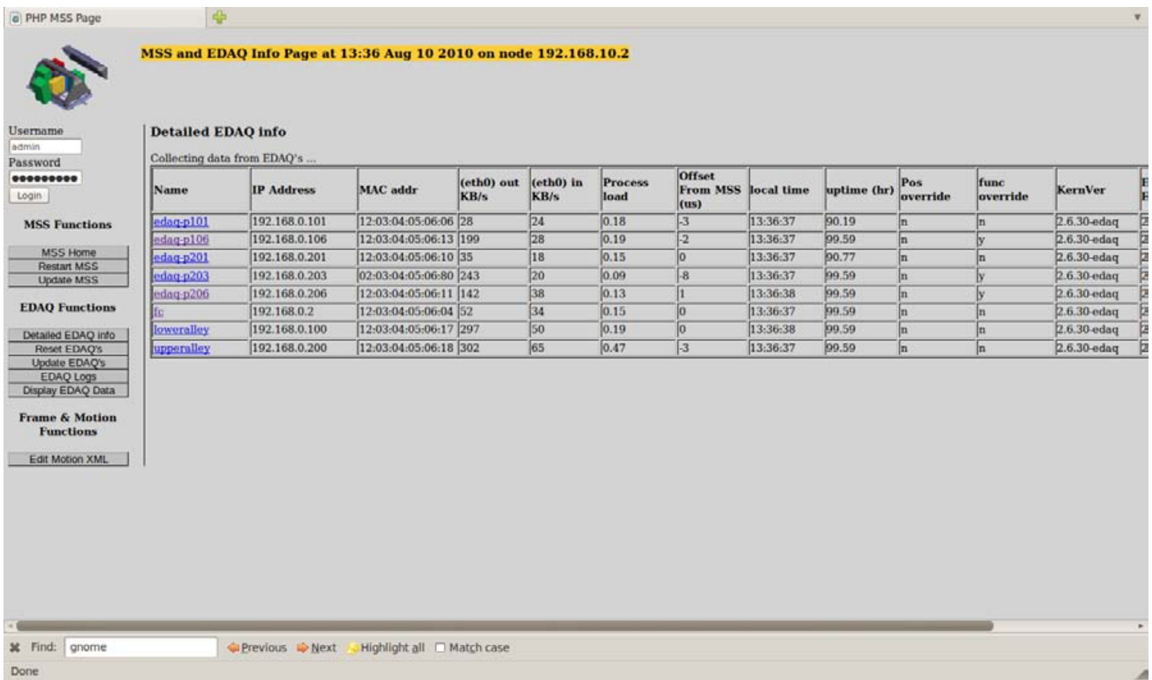

Figure 3-5 Detailed EDAQ Information: Partial Display

4. Sensor algorithm

The microwave moisture sensor uses real-time application environment (RAE) software on an Experion MX System.

This chapter describes the calibration equations and constants for microwave moisture sensors when used in conjunction with RAE system software.

There is a single moisture signal from the sensor. There are no contact inputs or outputs for microwave moisture sensors. There is no *background* function in the sensor software.

4.1. Calibration Equations

4.1.1. Reference and Standardize

During reference or standardize, the system reads the sensor voltage output with an empty gap: *Open Volt*. Two limit checks are performed if enabled:

1. ABS (*Open Volt-T0 Open Volt*)<*Drift limit VoltT0*, where *T0 Open Volt* is the voltage reading at time zero.

2. ABS (*Open Volt – Last Volt*)<*Drift limit Volt*, where *Last Volt* is the voltage reading of the previous standardize.

If the limit checks are passed, *Open Volt* is saved for subsequent subtraction from sample and onsheet readings to correct for any drift of the electronics or buildup of dirt on the sensor windows.

4.1.2. Sample/Onsheet Static Moisture

During the sample function, the voltage readings, *Volt Now*, are read and averaged over the sampling period. When scanning onsheet, the *Volt Now* is likewise read and averaged over the bin.

The *Net Volts* are calculated:

Net Volt = Volt Now – Open Volt

When scanning onsheet, the Z-correction and profile correction are performed if they are enabled. The corrected voltage (*Volt Z*) is:

Volt Z = Net Volt•[1 – NKZ•(ZNOW–ZSTD) + PCOR]

where:

NKZ = Z sensitivity coefficient

ZNOW = Current Z reading in mm

ZSTD = Z Sensor reading at last Standardize

PCOR = Additive profile correction array value

ATTENTION

> Z and PCOR correctors can be performed only during scanning. The profile corrector should be enabled only after building the profile array and pointing the array to the particular code (see Section 8.1).

In sample mode, the software calculates MWR = Net Volt/BW. Onsheet, the software calculates MWR = Volt Z/BW. Here, BW is the basis weight in g/m^2. During sample mode, this is the entered basis weight. Onsheet, it is the current slice value measured by the basis weight sensor.

Two algorithms are available. The dry end algorithm is suitable for moisture ranges with minimum moisture below 10%. The exact form is confidential, but it linearizes the value MWR – MWR0 to give a value MWF that is linear with percent moisture. Here, MWR0 is a calibration constant. It is a grade-grouped static offset obtained by measuring oven-dried samples. The term grade-grouped refers to calibrations constants that apply to a multitude of grades.

The wet end algorithm is suitable for higher moisture levels, and simply sets MWF=MWR.

Finally, the raw or static moisture is calculated using one of these two formulas:

MR = MWD + MWA•MWF

where:

MR = Raw (static) percent moisture

MWA = Grade-grouped static slope

MWD = Grade-grouped static intercept

If the BW Corrector is enabled, the raw or static moisture is calculated as follows:

$$MR = \frac{MWD+MWA*MWF+MWB*BW}{1+MWB*BW}$$

where:

MR = Raw (static) percent moisture

MWA = Grade-grouped static slope

MWD = Grade-grouped static intercept

MWB = Grade grouped basis weight slope

BW = Basis Weight

4.1.3. Onsheet Temperature and Dynamic Correction

Onsheet, the software makes a temperature correction if it is enabled:

DMTP = MR + TMPD•(TNOW–TCAL) + TMPA•(TNOW–TCAL)•MR

where:

DMTP = Percent moisture corrected for sheet temperature

TNOW = Current sheet temperature

TCAL = Temperature at calibration time

TMPA = Slope of temperature correction

TMPD = Intercept of temperature correction

If the temperature corrector is not enabled:

DMTP =MR

Finally, a dynamic correction is made:

MOIS = DYND + DYNA•DMTP

where:

MOIS = Final dynamically corrected percent moisture for slice

DYNA = Slope of dynamic correction

DYND = Intercept of dynamic correction

An order of magnitude for MWR, MWR0, and MWF might be 0.003, 0.0005, and 0.05, respectively. Slope and intercept might be MWA=200 and MWD = -0.5, respectively.

4.2. Calibration Constants

4.2.1. Static Calibration Constants

Table 4-1 lists the static calibration constants that are determined during static sensor calibration. These are the constants that are usually determined in the factory. Enter the values listed in Table 4-1 in the **MWP11 Calibration Table** in the **main code** under the **Recipe Maintenance** frame for permanent storage. Loading the code retrieves these constants. You can also set this in the **Sensor Maintenance** frame for temporary storage.

Table 4-1 Static Calibration

Name	**Default**	**Time-zero/Grade**	**Description**
TCAL	25 ºC	Time-zero	Calibration temperature
T0 Open Volt	0.5 ± 0.1V	Time-zero	Cal Stdz volt
MWR0	0	Grade	Offset (dry end algorithm)
MWA	0	Grade	Static slope
MWD	0	Grade	Static intercept
MWB	0	Grade	Static BW slope

4.2.2. Dynamic Calibration Constants

Table 4-2 lists the dynamic calibration constants. These constants are to be determined in the field, so the default values are set when the system is shipped. When the dynamic calibration constants are determined in the field, enter them in the **MWP11 Calibration Table** in the **main code** under **Recipe Maintenance** frame for permanent storage. You can also set these in the **Sensor Maintenance** frame for temporary storage.

Table 4-2 Dynamic Calibration

Name	Default	Grade/Non-Grade	Description
NKZ	0	Grade	Z-correction constant
TMPA	0	Grade	Temperature correction slope
TMPD	0	Grade	Temperature correction intercept
DYNA	1	Grade	Dynamic correction slope
DYND	0	Grade	Dynamic intercept

4.2.3. Enable/disable limit checks and correctors

The microwave moisture sensor has seven enable and disable functions that can be set in the **MWP11 Configuration Table** in the main code under **Recipe Maintenance**. You can also select each one of them under the recipe-based option in the **Sensor Maintenance** frame.

The functions are:

- Enable/disable drift limit
- Enable/disable T0 drift limit
- Enable/disable Z-correction
- Enable/disable profile corrector
- Enable/disable BW corrector
- Enable/disable temperature correction
- Enable/disable dynamic correction

5. Operation

This chapter describes operation of the microwave measurement sensors.

5.1. Entering Maintenance Mode

1. Open the **Scanner Control** display.
2. Select the appropriate scanner, and press the off-sheet button on the **Scanner Control** display to take the selected heads offsheet.
3. Load a grade code:

   Press **Retrieve/Save Recipes…** on the **Sensor Maintenance** display to call up the **Scanner Modes & Maintenance Recipes** display (see Figure 5-1)

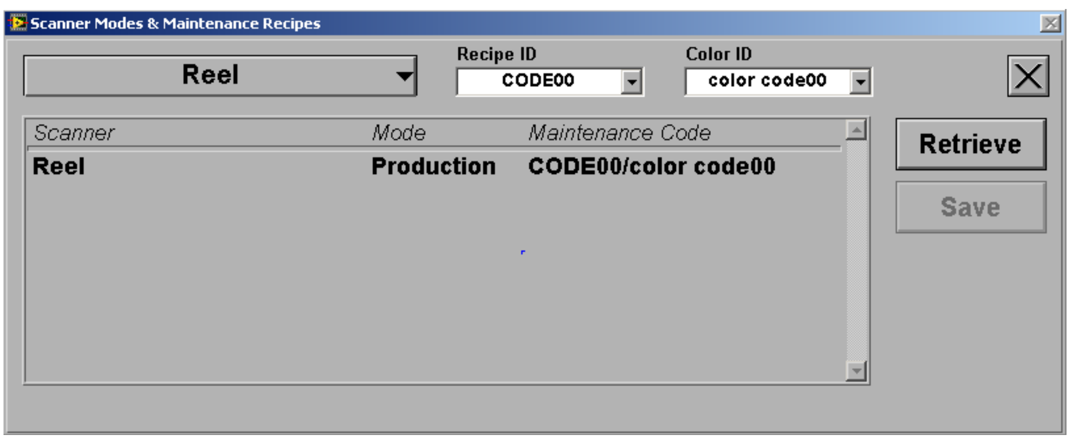

Figure 5-1 Scanner Modes & Maintenance Recipes Display

Select the appropriate scanner.

Under **Recipe ID**, select a grade code.

Press **Retrieve**.

Close the **Scanner Modes & Maintenance Recipes** display.

4. Select **Maintenance Mode** from the drop-down menu on the **Sensor Maintenance** display. Use the same menu to return to production mode.

5.2. Scanner Control

In the **Scanner Control** display, press the scan button to scan the head.

Before the head starts scanning, it takes a background (except for the microwave sensor) and reference reading from all of the sensors (performance, basis weight, moisture, and so on) and stores it.

While it is scanning, you can choose position snapshot by selecting the appropriate option in the **Sensor Maintenance** display. Set the position in bin number. The measurement readings can be monitored. Figure 5-2 shows the position snapshot of the production mode.

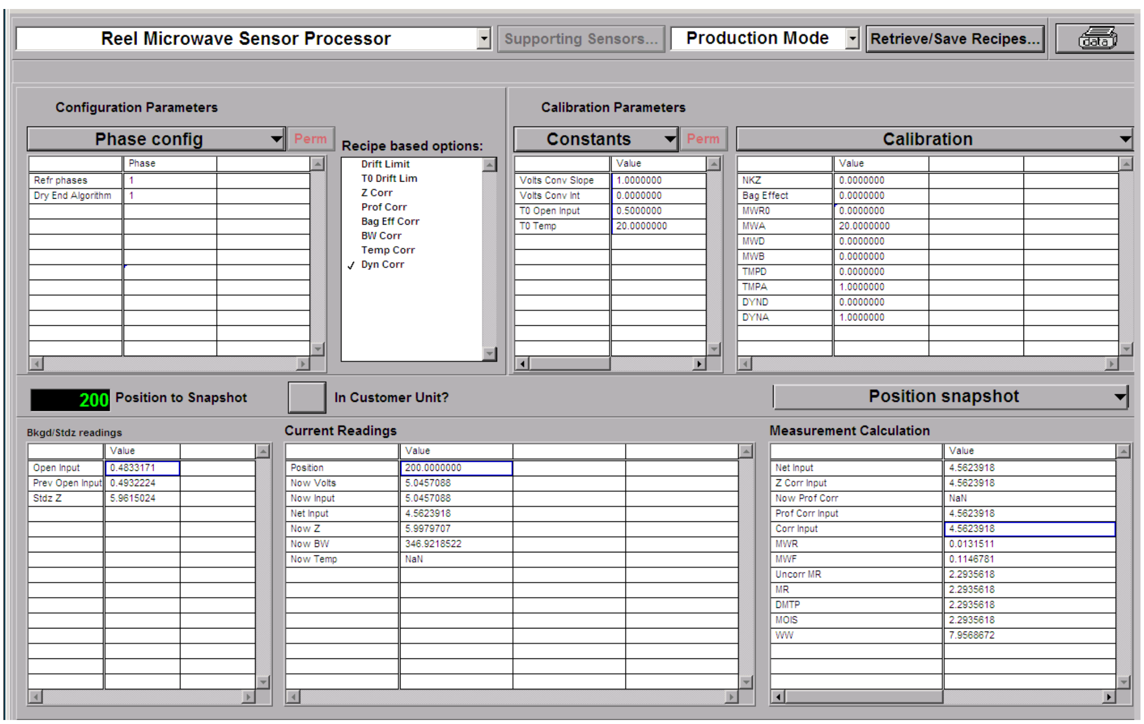

Figure 5-2 Sensor Maintenance Display for Production Mode

Customer unit can be chosen by clicking **In Customer Unit?** Default is set in g/m2, ºC, and a unit length of meters.

Change the units by pressing **System Setup & Debug** and then **Report Units**.

To set the filter factor on the **Measurement Setup** display:

1. Press the **Measurement Setup** button (Figure 5-3).

2. In the **Measurement Setup** display, under the **Select scanner** option, choose the appropriate scanner. Under **Select measurement** option, choose **Moisture** for measurement.

3. Under **Measurement Arrays**, enter the **Trend Filter Factor**.

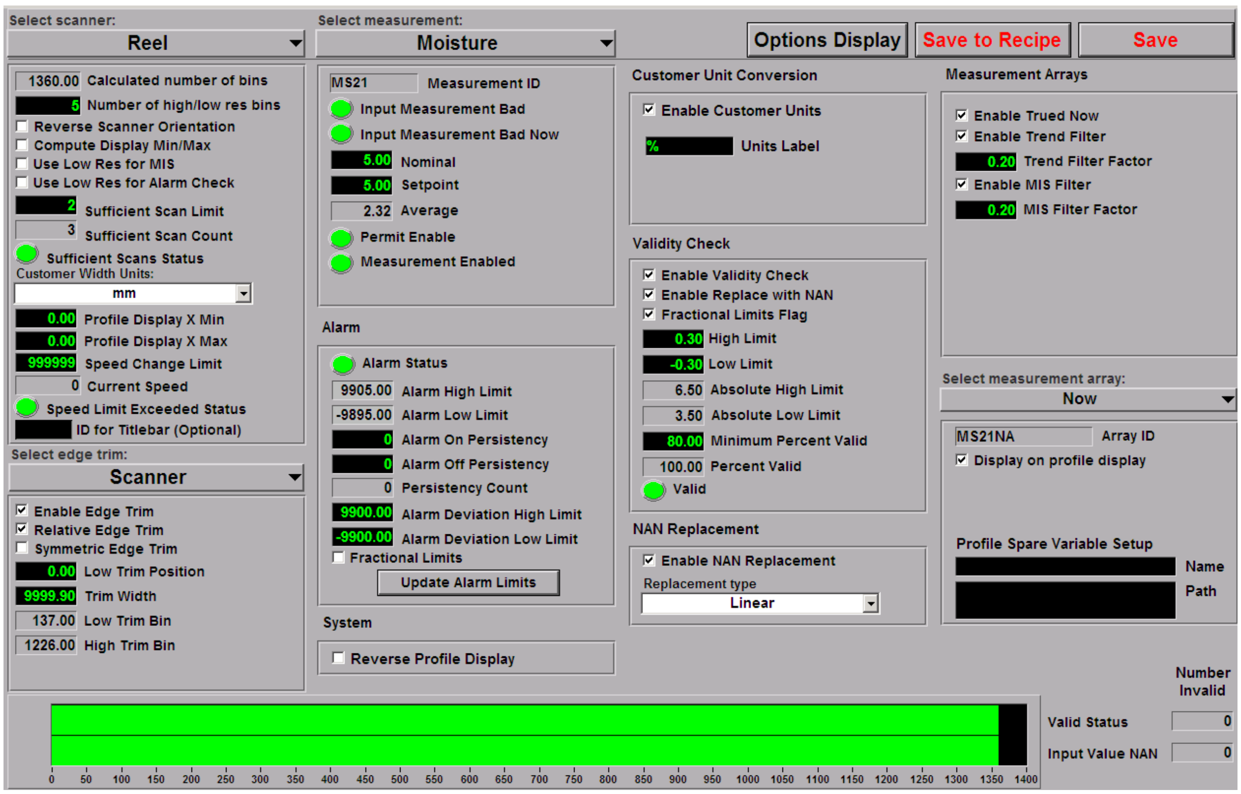

Figure 5-3 Measurement Setup Display

5.2.1. Perform a Sample with the microwave sensor

The microwave moisture sensor takes the input from the performance processor and the nuclear processor for the sheet temperature and the basis weight measurement, respectively. It is necessary to perform a reference on these sensors prior to shooting a sample with the microwave sensor.

To perform references of the supporting sensors:

1. Set up the basis weight units to the appropriate customer units in **System Setup**.

2. Choose the performance processor and perform a background and reference. Figure 5-4 shows the background measurement of the performance sensors.

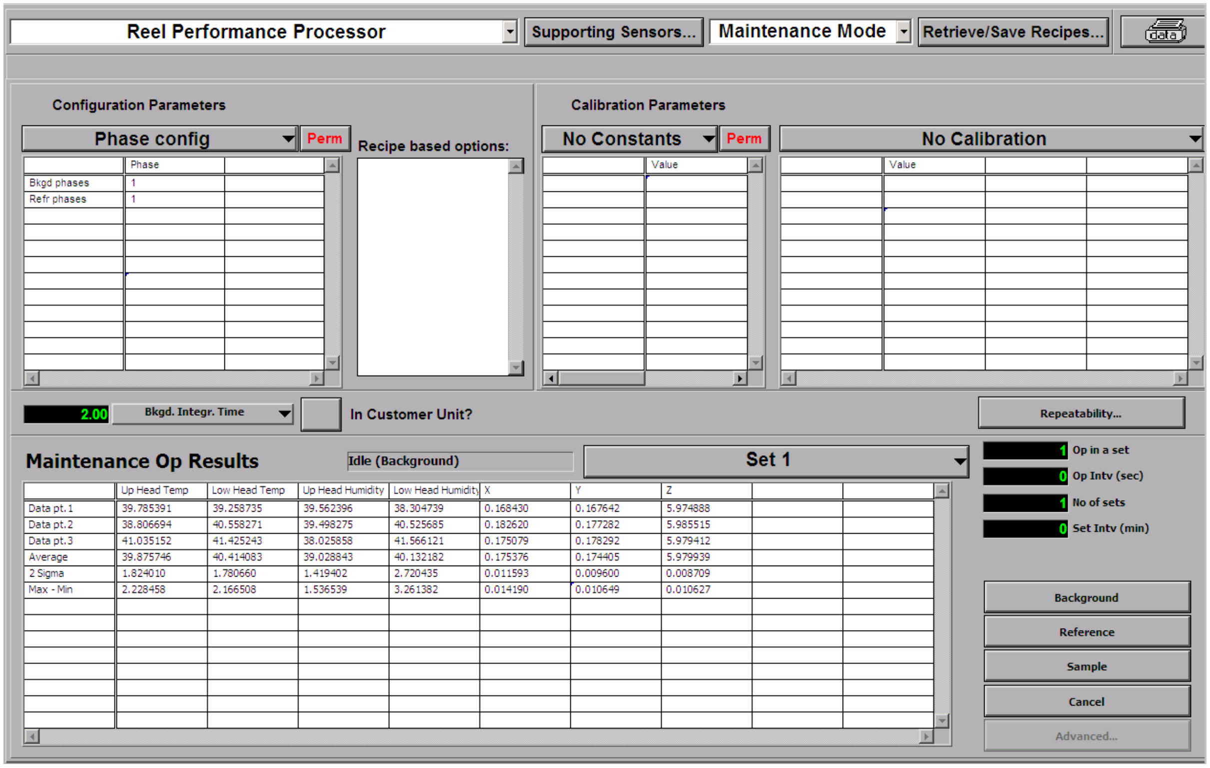

Figure 5-4 Background Measurement of the Performance Sensors

3. Choose the nuclear sensor processor and perform a background and reference. Figure 5-5 shows the reference measurement of the processor.

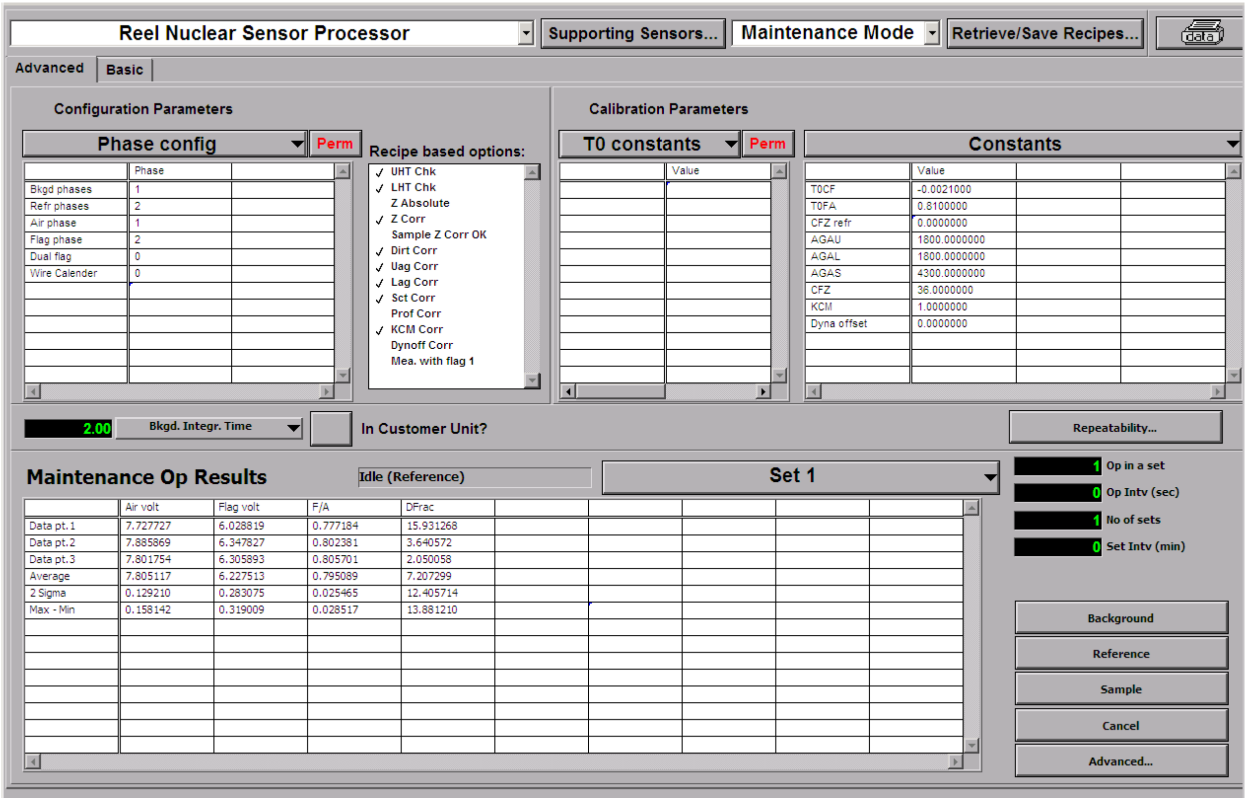

Figure 5-5 Reference Measurement of the Nuclear Processor

4. Put the sample under the basis weight sensor, and perform a sample operation.

The microwave processor is now ready to make measurements. Ensure that you have chosen the proper algorithm under the configuration parameters (dry-end or wet-end algorithm).

5. Place the sample paddle in the gap under the microwave moisture sensor. If shooting bagged samples, insert an empty aclar bag in the sample paddle for the reference step.

6. In the sensor **Maintenance** display, choose the microwave sensor processor and perform a reference. Figure 5-6 shows a reference measurement of the microwave processor.

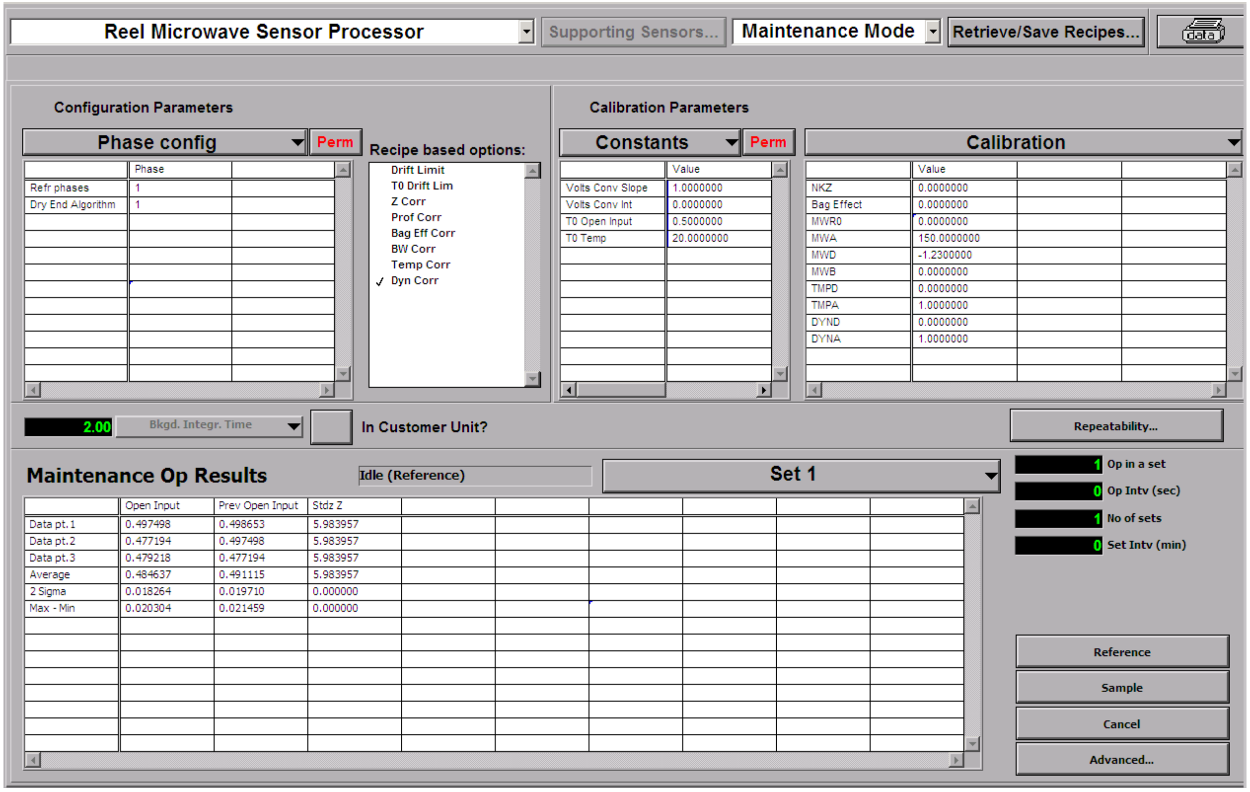

Figure 5-6 Reference Measurement of the Microwave Moisture Sensor

1. Set the integration time to three seconds. Set the operation in a set to be three, and # of sets to be one.

2. Place the sample in the sample paddle. Put the sample in the proper orientation, that is, paper fiber aligned in the MD. Place the paddle in the gap.

3. Perform the sample operation.

5.3. Dynamic Correction

Dynamic correction is used to correct for:

- flashoff of moisture (evaporation from hot sheet) between the scanner and the reel (reel scanners only)
- residual sheet temperature sensitivity in the sensor

- other differences between static calibration readings on bagged samples and onsheet readings

Perform dynamic calibration only after static calibration (See Chapter 6) has been performed and verified. Perform dynamic verification once a week.

Dynamic correction and sheet temperature correction are normally required for all microwave moisture sensors.

To make a dynamic correction:

1. Monitor the *Now* value or trend value of microwave moisture by making an appropriate selection in the **Profile** display. A sample of the profile display is shown in Figure 5-7, showing the profile of **Reel Scanner - Basis Weight (g/m^2) - Now**, and **Reel Scanner - Microwave Moisture (%) - Now**.

Figure 5-7 Profile Report of Basis Weight and Microwave Moisture

ATTENTION

Use profile displays to locate one or more sections of the profiles where the basis weight, sheet temperature, and microwave moisture are relatively flat.

2. After finding the flat region, allow the scanner to complete 15 scans before turn-up.
3. Monitor the average moisture on the **Sensor Maintenance** display until turn-up.
4. As soon as possible after turn-up, locate the bin at which the moisture was monitored and center a template over it.
5. Mark the section corresponding to the chosen bin.
6. Use a knife to cut at least six wraps into the reel using the template marks.
7. Quickly peel off the layers, then insert them into the previously weighed bags and seal them.
8. Mark the bags with the bin number.
9. Take all of the samples to the lab for weighing and drying.
10. For each of the samples, calculate the wet sample and the dry sample weights, and the percent moisture.

5.3.1. Fewer Than Twenty Data Points: Intercept Only

If you have fewer than twenty data points, it is probably best to use only an intercept correction. If there is no dynamic correction:

DYND = - Average[Sensor - Lab]

If there is already dynamic correction, calculate for each point the value of MT (the sensor value without dynamic correction):

MT = (Sensor – DYND)/DYNA

Then use:

DYND = – Average[MT – Lab]

5.3.2. Twenty or More Data Points

When you have 20 or more data points, make a graph of lab percent moisture (vertical axis) against sensor percent moisture. If there is already dynamic correction, use:

MT = (Sensor - DYND)/DYNA

Determine whether the graph looks like a ball or a line.

5.3.2.1. Ball Graph: Intercept Only

If the range of moisture levels is narrow, the points may form a ball shape. In this case, the best you can do is to use a simple intercept correction. Use DYND = – Average [Sensor – Lab] if there is no existing dynamic correction, or DYND = – Average [MT – Lab] if there is already dynamic correction. Ensure that you use DYNA = 1.

5.3.2.2. Line Graph: Slope and Intercept

If the range of values is great enough that a line can be discerned, perform a linear regression on Lab (y) vs. Sensor (x). If there is already dynamic correction, use MT(x). Use DYNA = slope and DYND = intercept.

5.4. Sheet Temperature Correction

Sheet temperature correction is normally required for all microwave moisture sensors where the online sheet temperature is different from the calibration temperature. The dielectric constant of water decreases with temperature; cellulose increases with temperature. Figure 5-8 shows the error in percent moisture in an uncorrected sensor as a function of the measured percent moisture for a 10°C temperature difference between calibration temperature and sheet temperature.

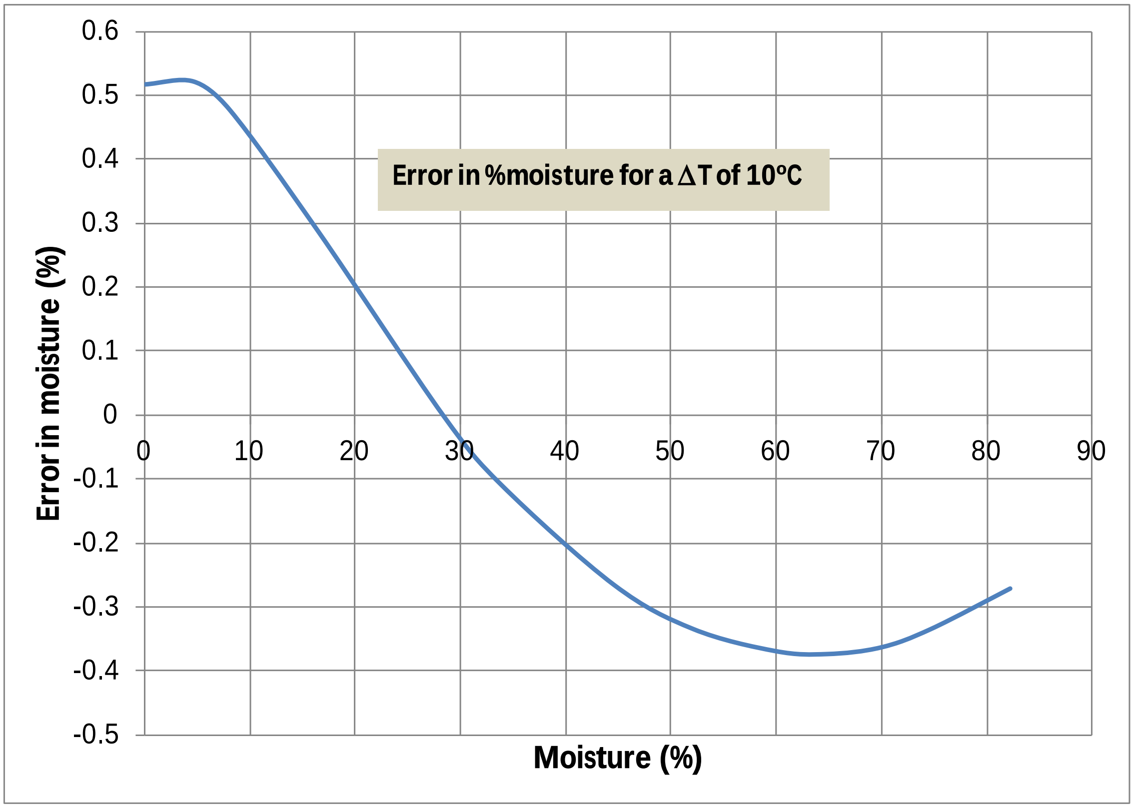

Figure 5-8 Sheet Temperature Dependence of Microwave Moisture Sensors

If the error is fairly constant, or if the moisture range normally encountered is very small (± 2%), you may normally use only a temperature correction intercept. From Figure 5-8, find the moisture error value for your nominal moisture level and a temperature change of ΔT = 10 °C (50 °F). Next, multiply it by -0.1. Use this value for TMPD and use TMPA = 0. For example, in the range from 2–8% moisture, the typical error for ΔT = 10 °C (50 °F) is + 0.5% moisture. Thus, for this typical dry end range, use TMPD = -0.05.

If you have a larger moisture range, use a slope and intercept. From Figure 5-8, pick two points corresponding to the endpoints of your range, then perform a linear regression on the two points. Let TMPA = -0.1*slope and TMPD = -0.1•intercept.

For example, in a wet-end application, the moisture error for ΔT = 10 °C (50 °F) is -0.2% and -0.37% for a sheet moisture of 40% and 60%, respectively. This gives a slope of -0.0085 and an intercept of +0.14. For this wet-end application, TMPA = +0.00085 and TMPD = -0.014.

Note that the sheet temperature sensor measures the surface temperature of the sheet, not the bulk temperature that causes the temperature dependence. It is then possible for the sheet temperature to underestimate, or overestimate (less common), the sheet temperature and thus the correction. If you observe sheet temperature dependence in dynamic verification results, adjust the TMPD or TMPA accordingly.

5.5. Z-Correction

Microwave moisture sensors normally do not require Z-correction. In a case of significant scanner bowing, the appropriate value for NKZ must be entered in the **MWP11 Calibration Table** in the **Recipe Setup**, and the Z-Correction must be enabled.

5.5.1. Standard Range (dry end) Z-Correction

For standard range sensors, the NKZ value depends on the basis weight. Table 5-1 shows typical values:

Table 5-1 Basis Weight Values

Basis Weight g/m^2	100	150	200	> 300
NKZ	0.0156	0.0094	0.008	0.00625

5.5.2. High Range (wet end) Z-Correction

For high range sensors, the NKZ value depends on the water weight. Table 5-2 show typical values:

Table 5-2 Water Weight Values

Water Weight g/m^2	400	500	600	> 700
NKZ	0.0028	0.0018	0.0011	0.001

To obtain the water weight in g/m^2, multiply the basis weight in g/m^2 by the percent moisture and divide by 100:

$$\mathrm{WWgsm} = \frac{\mathrm{BWgsm} \bullet \%\mathrm{MOI}}{100}$$

5.6. Profile Correction

Profile correction can be used to correct for the misalignment of the heads in the X and Y direction during part of the scan. First, determine is a profile correction is needed or not by performing the test described in Subsection 5.6.1. To use the profile correction, a profile array has to be built up and saved in the recipe code. During the profile buildup, the average voltage and deviation from the average voltage are calculated and the deviation is displayed. The deviation array, both in forward and reverse direction, is stored and saved for the given recipe. The details of the profile buildup are explained in the Subsection 5.6.2.

5.6.1. Determine if Profile Correction is needed

Run the following test to determine if any benefit can be obtained by performing the Profile Correction Buildup procedure:

1. With the customer's process shutdown, Insure scanner temperature has stabilized (not heating up or cooling down).
2. Enter Maintenance Mode.
3. Enter grade code for the samples used on the scanning sample plate.
4. Perform a manual standardize.
5. Insert scanning sample plate (Mylar sample for basis weight and glass encapsulated sample for moisture). Note: Basis weight of Mylar sample should be close to the actual basis weight of the moisture sample.
6. Disable standardize.
7. Scan for 20 scans.
8. Check for variation in the trended profiles for basis weight and microwave moisture.
9. Perform profile corrections for basis weight and/or for moisture if the 2-sigma of the trended profiles is a significant proportion (e.g. > ¼) of the 2-sigma observed when scanning on the process.

5.6.2. Profile Correction Buildup

To build the profile array:

1. With the customer's process shutdown, Insure scanner temperature has stabilized (not heating up or cooling down).

2. Select **Maintenance Mode** from the drop-down menu on the **Sensor Maintenance** display (See Subsection 5.1).

3. On the horizontal dispatcher, choose the **Profile Correction** display.

4. The instruction to build the profile array is given in the leftmost side of the **Profile Buildup** display. Figure 5-9 shows the **Profile Buildup** display for the microwave sensor.

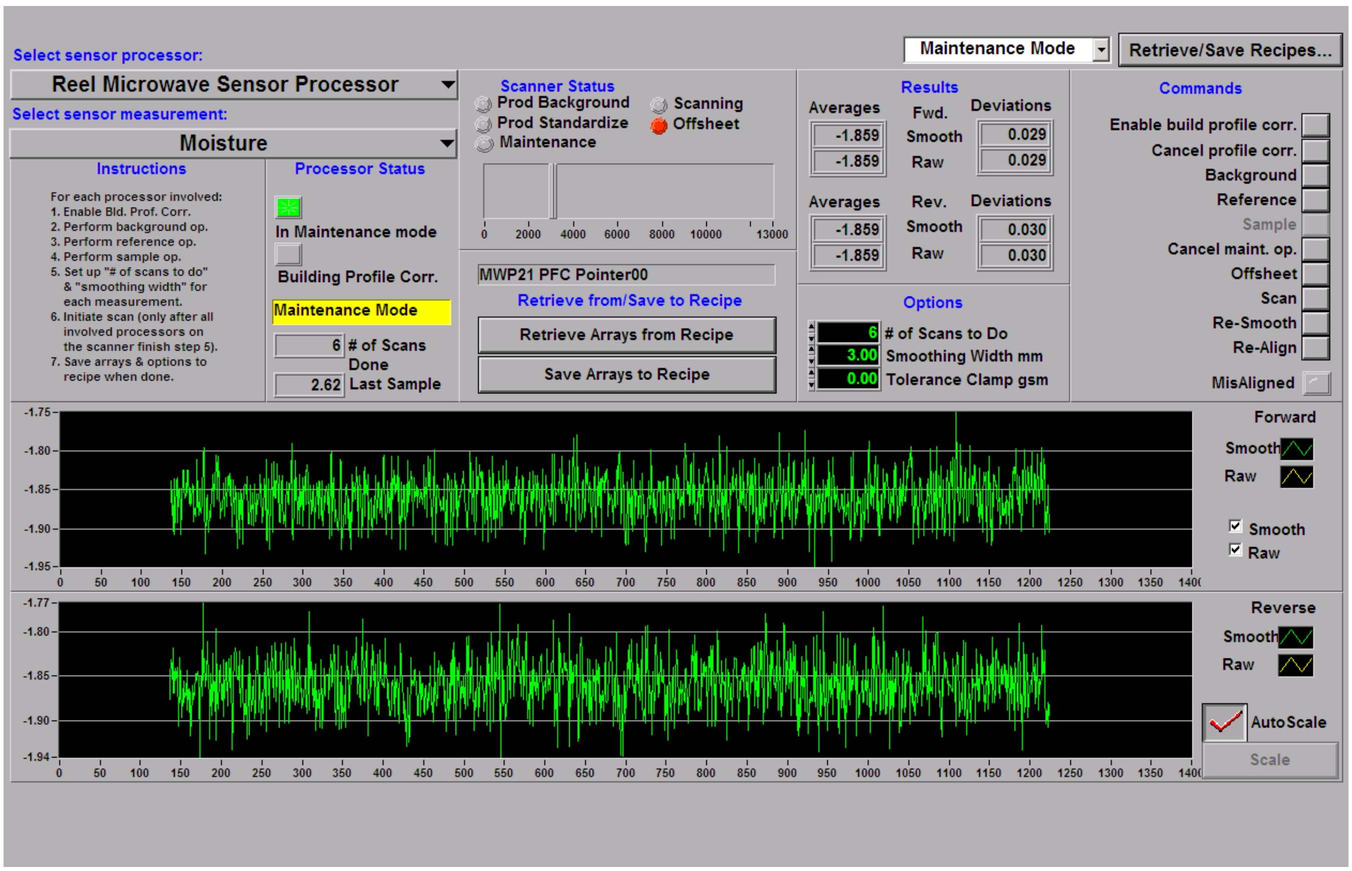

Figure 5-9 Profile Correction Buildup Display

5. Under **Select sensor processor**, choose desired scanner (e.g. **Reel Scanner Nuclear Sensor**) from the drop-down list (see Figure 5-9).

6. Under **Select sensor measurement**, choose **Basis Weight**.

7. Select **Enable build profile correction**. The green button lights up, indicating that build profile correction has been enabled.

8. Perform a background, reference, and sample by pressing the proper buttons as given in the instructions in the **Profile Buildup** display. Before taking a sample, insert scanning sample plate with a Mylar sample for basis weight. Note: Basis weight of Mylar sample should be close to the actual basis weight of the moisture sample.

9. Under **Select sensor processor**, choose the **Reel Scanner Microwave Moisture Sensor** processor.

10. Under **Select sensor measurement**, choose **Microwave Moisture**.

11. Perform a reference and sample by pressing the buttons as given in the instructions in the **Profile Buildup** display. Before taking a sample, insert a glass encapsulated moisture sample in the scanning sample plate.

12. After performing the steps 6-8 for each of the sensor processors, enter the # of scans and smooth width for each processor. Now the scanner is ready to build the profile.

13. Press the **Scan** button to build the profile and plot the voltage profile both in forward and reverse direction (see Figure 5-9).

14. Save this array by pressing the **Save Array to the Recipe** button. The **Select ID and groups to apply** display appears (Figure 5-10). In that display, for example, name the profile array that has been built as *MWP11 PFC Pointer 00*. Choose whether to use a different ID for a different weight, or to apply one to all.

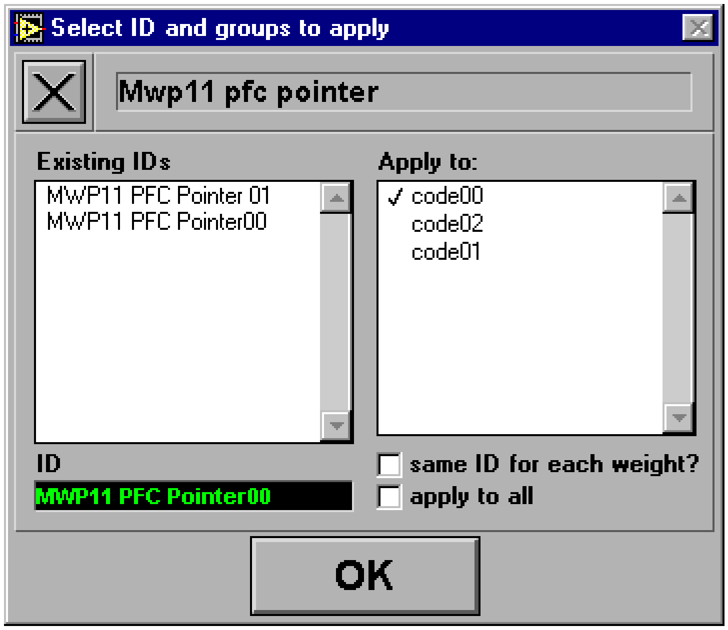

Figure 5-10 Select ID and groups to apply Display

15. To apply this pointer for a particular code, go to the particular code and double-click on it. A check mark appears in front of the code indicating that you have applied the given pointer for that particular code. Press **OK**. For example, Figure 5-10 shows that the pointer array *MWP11 PFC Pointer 00* has been applied to *code 00*.

16. To later set the pointer array to a particular code, go to **Recipe Maintenance**. Go to the pointer array display and choose the particular pointer array, then save it. Figure 5-11 shows the pointer array display.

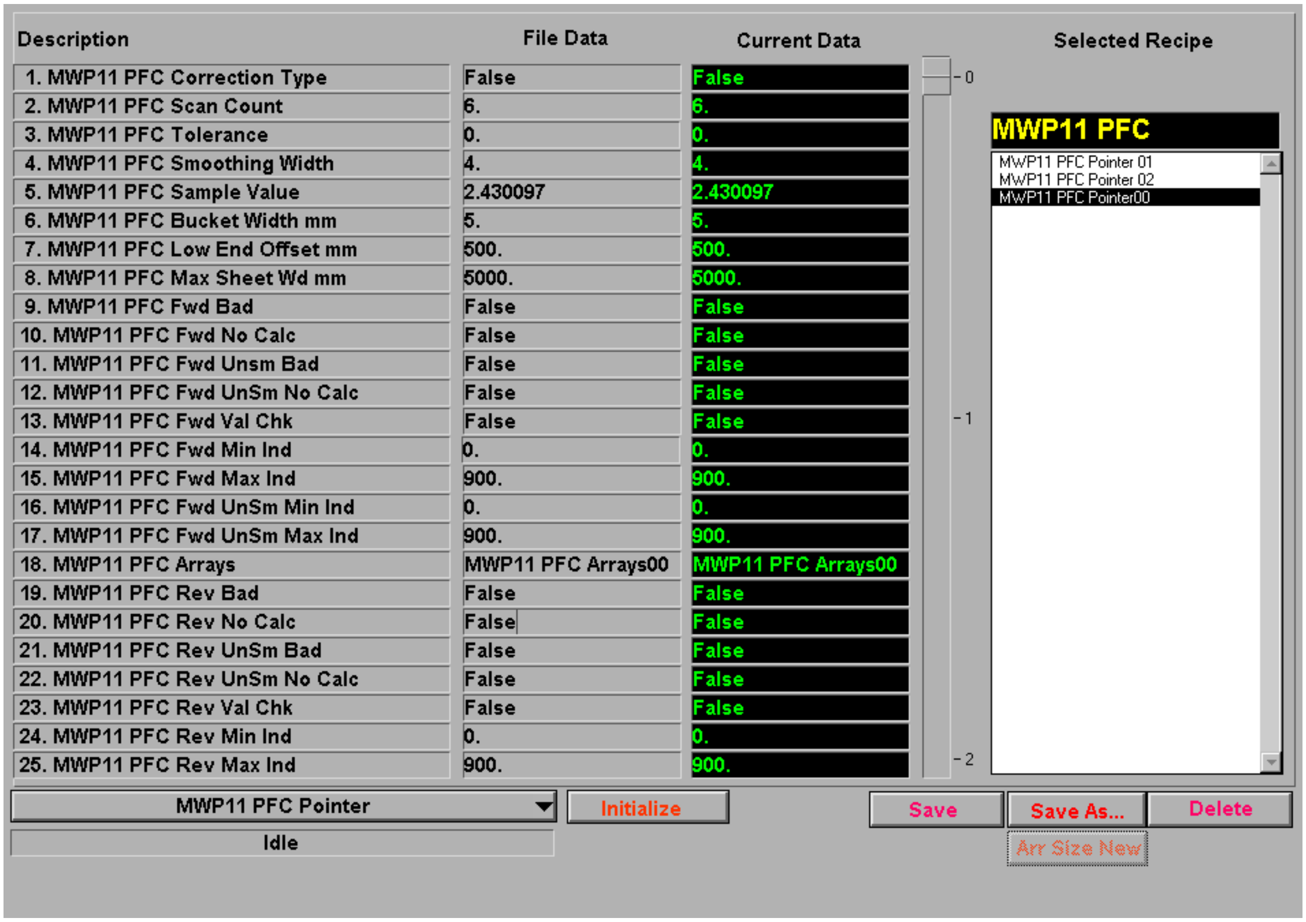

Figure 5-11 The MWP11 PFC Pointer Array Display

17. In the pointer array display (e.g. MWP11 PFC Pointer), choose the particular array and save it. For example, Figure 5-11 shows the selection of the pointer as *MWP11 PFC Pointer00*. Save this, then go to the main code and choose the MWP11 PFC pointer array to the recipe code 00. Save this. When you recall the code, this pointer array is displayed in the **main code** display.

For example, Figure 5-12 shows that the MWP11 PFC Pointer has been pointed to *code00*.

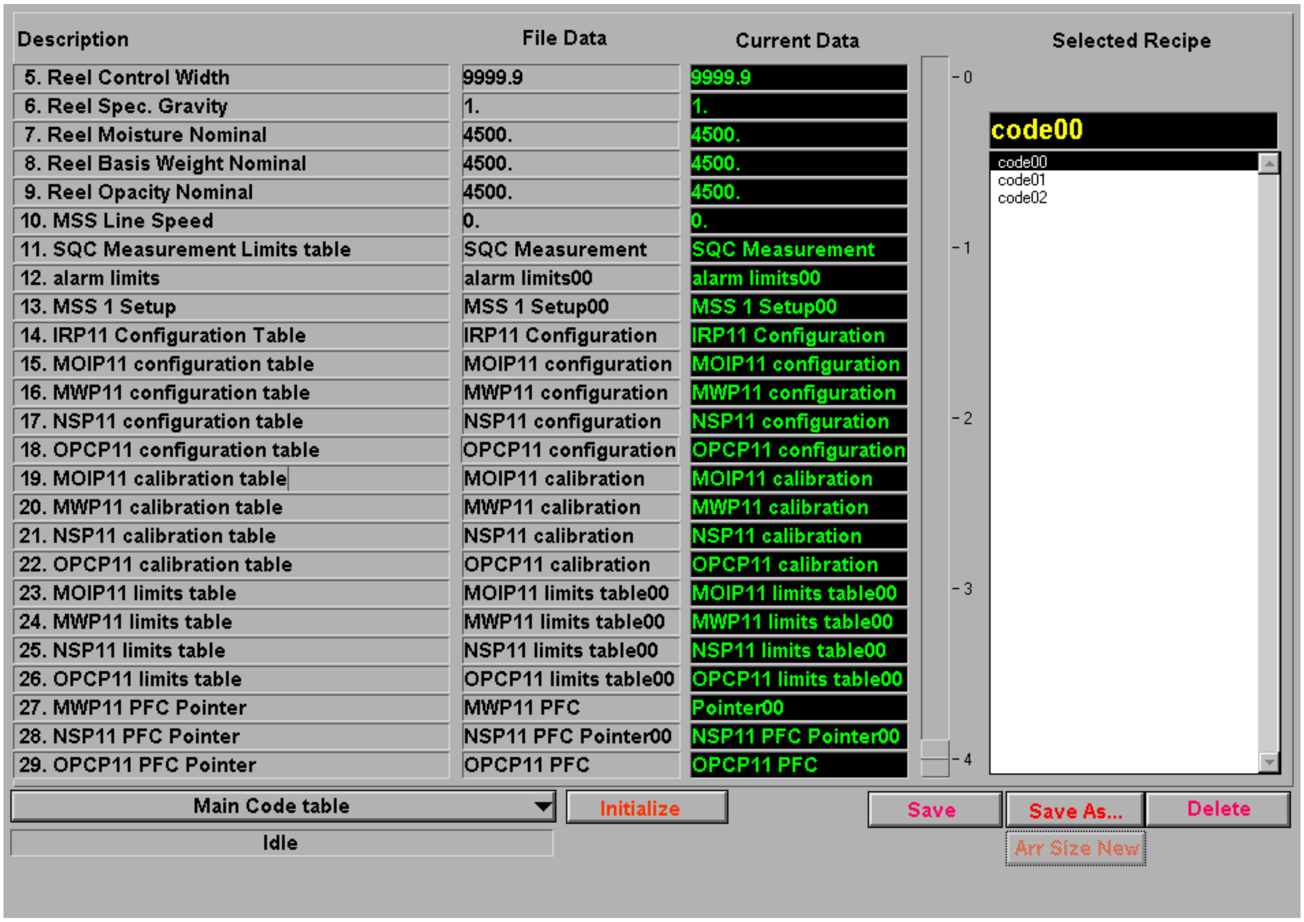

Figure 5-12 Main Code Table: MWP11 PFC Pointer 00 Pointing to code00

Once you point the pointer array to the given code, you can load the code. Now the system is ready to perform the profile correction when you enable it. To check how the profile correction is applied to the given scanning profile:

1. Go to the profile display and select the profile of the particular sensor (for example, **Reel Scanner - Basis Weight (g/m^2) - Now**, and **Reel Scanner - Microwave Moisture (%) - Now** as shown in Figure 5-7).

2. While scanning, watch the moisture profile and freeze it by pressing the **Freeze** button.

3. Enable the profile correction and watch the corrected profile.

6. Static Calibration

This chapter describes the procedures for performing static calibration. Normal installation requires only hardware checks and verification.

6.1. Selecting Samples

6.1.1. Standard Sample Selection

Five moisturized samples of each grade are required for calibration. In addition, a bone dry sample is required for each grade for calibration with the dry end algorithm. The bone dry sample must be bone dry at the time it is measured on the sensor. Therefore, it may be a good idea to delay preparation of this sample until shortly before measurement to avoid having to re-dry it. Select the sheets required to die out the samples, and label them to indicate grade number and, for dry end applications, the top side and machine direction orientation. Select five target moisture values spanning the range needed.

6.1.2. Representative Grade Selection

If there are so many grades that it is impractical to moisturize samples for all of them, select a set of grades that is representative in basis weight and composition. For dry end sensors, it may be helpful to use the method of *Bone dry grade grouping*:

1. For each grade, die out one seven-inch-diameter sample using the die in the sample accessory kit.

2. Label the sample to indicate the grade, top side, and machine direction.

3. Pre-weigh and mark an Aclar® bag for each sample.

4. Bone dry each sample for four hours at 105 ± 0.5 °C (221 ± 0.9 °F), and place it in its Aclar bag.

5. Weigh the bagged sample and subtract the bag weight, recording the bone dry sample weight.

6. Perform a reference on the sensor with an empty bag in the sample paddle in the gap.

7. Measure each sample on the sensor, using the sample paddle.

8. Plot the sensor volts versus bone dry weight, and select the grades to be moisturized using the following criteria:

   Include grades that cover the full basis weight range.

   If the plot shows a definite systematic difference between different product types, include a range of weights for each type.

   Choose grades that represent a large percentage of customer production (if known).

6.2. Preparing Samples

6.2.1. Materials Required

To prepare samples, the following materials are required:

- lab with controlled temperature and humidity of 23 ºC (73 °F) and 50% relative humidity, free from drafts and vibration
- analytical balance accurate to 0.1 mg
- Faraday Cage balance pan to accommodate a seven-inch sample
- forced air drying oven controlled to 105 ± 0.5 °C (221 ± 0.9 °F), with drying racks
- seven-inch Aclar bags and a bag sealer
- seven-inch sample die and a hammer
- aluminum foil for sample protection

- humidity cabinets or beaker of boiling water (covered by a screen), and tweezers

6.2.2. Procedure

1. Using the seven-inch-diameter die, die out five samples for each grade selected. For grades on dry end sensors that have not been previously calibrated (they have no value of MWR0), include a sixth bone dry sample.
2. Before removing the round sample from the sheet, mark the sample ID, and mark the machine direction orientation on both sides of the sample.
3. Bone dry all samples for four hours in the 105 °C (221 °F) oven.
4. Pre-weigh one Aclar bag for each sample.
5. Label each bag with the grade and target moisture level.

ATTENTION

> To conserve the expensive large Aclar bags, use one for both the bone dry and moisturized sample, or use foil bags for the bone dry weighing of samples that are not to be measured bone dry on the sensor.

6. Record the bag weights.
7. Remove each bone dry sample and quickly insert it in its bag.
8. Seal the bag very near the top to allow for re-use.
9. Weigh the bone dry samples and subtract the bag weights to get the dry Sample weight.
10. Calculate a target weight for the wet samples using the formula:

    $T = 100 \cdot Dg/(100-M)$

    where:

    T = Target Sample weight in grams

    M = Target percent moisture

    Dg = Bone dry Sample weight in grams

11. For each sample to be moisturized, carefully cut off the seal on the bone dry sample, remove the sample, and reweigh the empty bag.

12. Bring each sample up to the target moisture level using ambient air, steam, humidity chambers, or a water bath. For very wet samples, it may be necessary to wet the samples with isopropyl or ethyl alcohol followed by a water bath.

13. Seal each sample quickly in its Aclar bag, removing excess air.

14. Weigh the bagged samples, record the weights, and calculate the percent moisture and basis weight for each sample:

$$\%M = \frac{\text{WetSample} + \text{Bag} - \text{WetBag} - \text{Bone - DrySample}}{\text{WetSample} + \text{Bag} - \text{WetBag}}$$

Basis Weight in g/m^2 = (WetSample+Bag – WetBag) • 40.276

To convert to other units, use:

Basis Weight in lbs/1000ft2= Basis Weight in g/m^2 • 0.2048

Wrap each set of Samples in aluminum foil for protection.

6.3. Calibration Using the Advanced Display

Before starting the calibration process, ensure that the sensor is stable (see Section 8.3). To set the time-zero values and to select the proper microwave moisture algorithm to be used by the calibration/verification processor, do the following:

1. Bring the sensor to its equilibrium offsheet temperature with air-gap air and air-gap heating off.

2. Record the time-zero temperature (approximately room temperature) as the time-zero constant, TCAL. This temperature can be found in the Current Readings table of the Sensor Maintenance display as New Temp in currently enabled units (degrees Fahrenheit or degrees Celsius) after a sample measurement has been performed.

3. For dry end sensors, enable the dry end algorithm. Set the dry end algorithm to 1 under **Phase Configuration** in the **Sensor Maintenance** display. If you set the algorithm to zero, you are enabling the wet end sensor algorithm. Figure 6-1 shows the setting up of the dry end algorithm under **Phase config** in the Sensor Maintenance display.

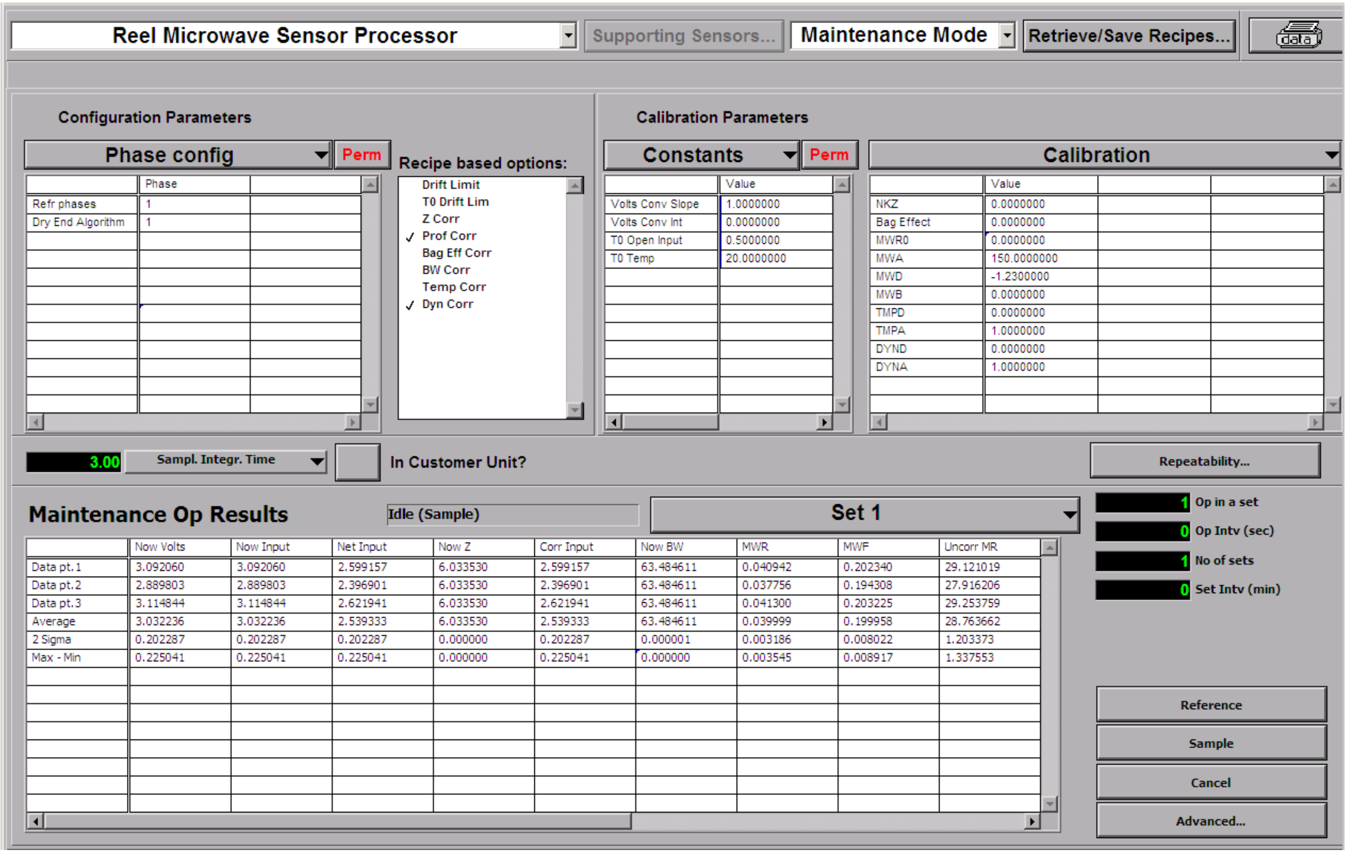

Figure 6-1 Dry End Algorithm

4. On the **Measurement Setup** display, select **Engineering Units** (basis weight units will be g/m^2) or **Customer Units** (make sure the units is set to the correct value for the customer ream size).

5. Perform a reference on an empty gap, and record the value as T0 open input. This value will be used in limit checks.

6. Perform three sample readings on the **Standard Sample** and calculate the average. Subtract from this the average **Reference Volts** to get the average **Net Volts** for the **Standard Sample**. Record this value for future reference.

Advanced maintenance procedures are performed using the **Advanced** display (see Figure 6-2), which is called up by pressing the **Advanced…** button on the **Sensor Maintenance** display while in maintenance mode.

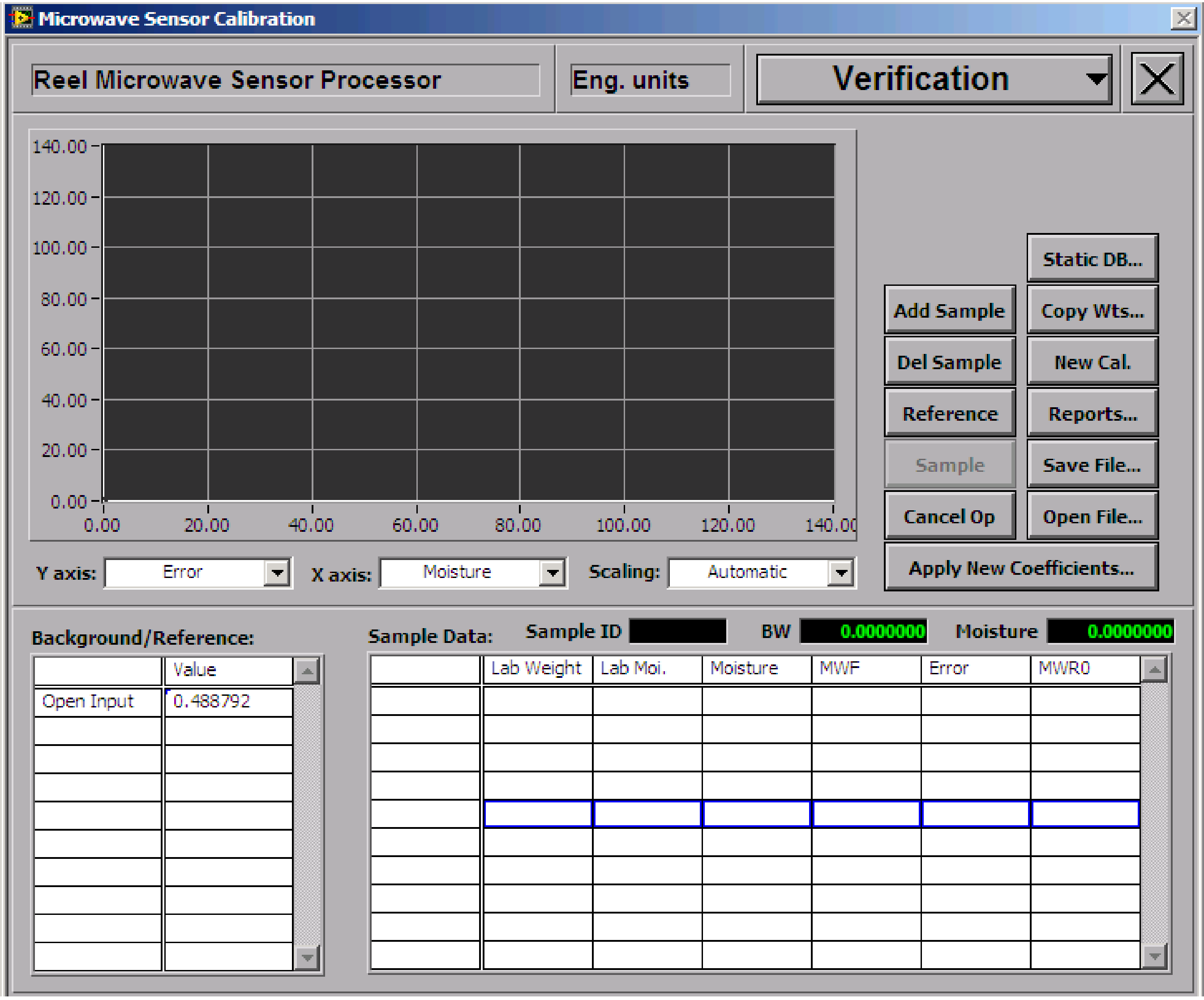

Figure 6-2 Advanced Display

Although maintenance operations are handled on a per scanner basis, only one advanced screen can be brought up at a time.

At the top, the **Advanced** display shows which moisture sensor in the system is under maintenance and which units, either engineering units or customer units, are being used. These two settings are inherited from the **Sensor Maintenance** display and can only be changed from there.

Table 6-1 lists button descriptions for the microwave moisture advanced mode.

Table 6-1 Advanced Mode Button Descriptions

Advanced Mode Button	Description
MWR0/Calibration/Verification	The advanced screen allows calibration and verification of a previously obtained calibration.
Add Sample	If the **Sample Data** table is empty, press this button once to add a sample. This also enables the sample operation. Thereafter, a new sample is added to the sample data immediately after the row in which the cursor is highlighted. By default, the newly added sample has entered basis weight and entered moisture values of zero. To modify, place the cursor on the sample entry row of interest and change the lab values using the basis weight and moisture numeric controls.
Del Sample	To delete a sample from the **Sample Data** table, place the cursor on the row that you want to delete, then press this button to remove the row.
Copy Wts	It is possible to save the effort to re-enter all of the lab values if they turn out to be identical by copying them from a file that was created and saved earlier. To do so, press this button, which prompts you to select a source file. Select the desired source file from which to copy, then acknowledge the choice by pressing **OK**. It is also possible to copy lab values from the **Calibration** page to the **Verification** page. In **Verification**, press **Copy Wts** and select from **Calibration**.
New Cal.	To start a brand new calibration or verification, simply press this button to have a blank working **Sample Data** table.
Save File	At any time during the calibration/verification procedure, you can save the data to a file by pressing this button. The default path for the microwave moisture sensor is: *HMX\Database\Calibration Data\Microwave Moisture*, and it requires that you enter a filename.
Open File	At any time during the calibration/verification procedure, you can open the data to a file by pressing this button. The default path for the microwave moisture sensor is: *HMX\Database\Calibration Data\Microwave Moisture*, and it requires that you enter a filename.
Reports	This button prints out a report of the moisture calibration and/or verification data.
Apply New Coefficients…	Allows you to store calibration constants to the recipe database. Optionally a new table can be created which can be linked to a particular recipe. You will be allowed to select the code (grade) that the new table will be linked to.

6.3.1. Calibrate for MWR0

MWR0 is the average sensor ratio of bone dry samples. It is used as an offset in the dry end algorithm and is not used by the wet end algorithm.

To obtain MWR0:

1. In maintenance mode, click **Advanced…** in the **Sensor Maintenance** display.
2. Select **MWR0** on the pull-down menu.
3. Set up the **Sample Data** table by pressing the **Add Sample** button once for every sample in a grade. For each sample, enter the basis weight (in g/m^2) of the bone dry samples in the **BW** field. Save the entered data to a file as a safety measure.
4. Perform a reference reading on an empty Aclar bag in the sample paddle.
5. Ensure that you place the cursor on the first row in the **Sample Data** table and perform a sample on all the bone dry bagged samples using the sample paddle. When a sample operation is complete, the result is displayed in the **Sample Data** table. The cursor (the highlighted row) automatically moves down to the next entry/sample.
6. Click on **MWR0**.
7. Group together any grades whose bone dry MWR values agree within 3%. The average value of MWR for a group will be used as the MWR0 for that group of grades.
8. Click **Accept** if the MWR values agree to within 3%.
9. Save the data again to include the sensor data as a safety measure.

CAUTION

Take care to ensure that the samples are oriented properly for calibration and verification (the fiber orientation should always be in the machine direction).

If the fiber orientation is at right angles to the normal machine direction, it can introduce an additional moisture error (decrease) of about 1.5%.

6.3.2. Obtaining Calibration Parameters

To obtain calibration parameters:

1. Select **Calibration**.
2. Set up the **Sample Data** table by pressing the **Add Sample** button once for every sample in a grade. For each sample, enter the basis

weight (in g/m^2) in the **BW** field and lab %-moisture in the **Moisture** field. Save the entered data to a file as a safety measure.

3. Click on **Add samples** and enter the basis weight (in g/m^2) and %-moisture of all the wet bagged samples.

4. Perform a reference on an empty bag in the sample paddle.

5. Ensure that you place the cursor on the first row in the **Sample Data** table and perform a sample on each wet bagged sample using the sample paddle. When a sample operation is complete, the result is displayed in the **Sample Data** table. The cursor (the highlighted row) automatically moves down to the next entry/sample.

6. Click on **Curve Fit**. The calibration slope (MWA) and intercept (MWD) are calculated.

7. Select **BW correction!** if the grade group contains grades of different basis weight. The basis weight correction factor (MWB) is calculated. If the calibration error decreases by 20% or more when the basis weight correction is selected, click **Accept**. If not, deselect **BW correction!** and click **Accept**.

8. The calibration results can be graphed with virtually any combination of variables. Select a view that is the most informative in determining the goodness of the calibration (for example, **Error (%)** on the vertical Y-axis versus **Lab Moisture** on the horizontal X-axis). For example, Figure 6-1 shows the plot of Measured Moisture vs. Lab Moisture.

9. Save the data again to include the sensor data as a safety measure.

10. Print a report by pressing **Report**. Give a meaningful heading to the report, select **MWR0** and **Calibration** and click **OK**.

11. Click **Apply new coefficients** to store calibration constants to the recipe database. Optionally, a new table can be created which can be linked to a particular recipe (see step 12). You will be able to select the code (grade) that the new table links to. Otherwise, the data will be stored to the current code table. Select or deselect each coefficient to store. A value without the checkbox selected will not be written to the recipe database. Figure 6-3 shows the display.

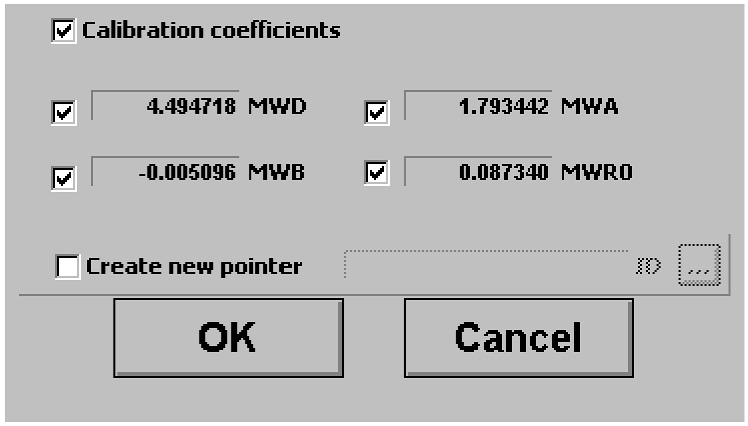

Figure 6-3 Apply new coefficients display

12. Select **Create new pointer** and click the **...** button to store the calibration data in an existing or new table in the recipe database.

13. The browse (**...**) button allows you to browse the recipe database with the popup shown in Figure 6-4.

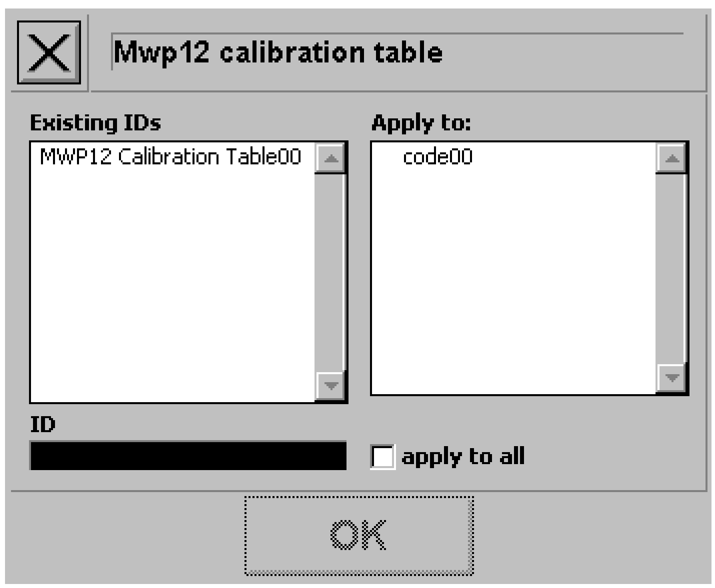

Figure 6-4 Create New Pointer popup window

Selecting the **Calibration Table** and clicking **OK** stores the data in the existing table, or you can modify the name in the **ID** field to create a new table.

ATTENTION

Once a calibration is obtained, it is a good idea to plot the moisture error as a function of the sample moisture in the **Advanced** display. Look for obvious outliers, delete them, and redo the calibration. If more than one sample needs to be omitted per grade, the omitted samples for that grade should be replaced with freshly made samples.

CAUTION

In order for the calibration to not fit noise in the data, it is imperative that a minimum number of samples is used for calibration. A good estimate is that the number of samples used for a calibration be at least two times the number of fitting parameters + 1. Therefore, in the case of a calibration without BW correction, the minimum number of samples is 5 ($2 \times 2 + 1$). It is 7 ($3 \times 2 + 1$) when BW correction is used.

6.4. Verification Using the Advanced Display

CAUTION

Ensure that you load the desired grades and check the calibration constants and correctors before proceeding with the verification process.

CAUTION

Take care to ensure that the samples are oriented properly for calibration and verification (the fiber orientation should always be in the machine direction).

If the fiber orientation is at right angles to the normal machine direction, it can introduce an additional moisture error (decrease) of about 1.5%.

1. If necessary, reweigh the samples and recalculate the moisture and basis weight.
2. Bring the sensor head to thermal equilibrium at the offsheet ambient temperature. Check the stability (see Section 6.3).
3. Load a grade code containing the calibration constants and correctors of the samples to be verified.
4. Check to ensure that the appropriate calibration constants and correctors are properly restored on the **Sensor Maintenance** display to be used by the gauge processor.
5. In maintenance mode, press the **Advanced…** button on the **Sensor Maintenance** display.
6. If the samples have been reweighted:

   Start from a blank working space (**Sample Data** table). It is blank the first time you call up the **Advanced** display; otherwise, press the **New Cal.** button to reset the working space to blank.

Set up the **Sample Data** table by pressing the **Add Sample** button once for every sample in a grade. For each sample, enter the basis weight in the **BW** field and lab %-moisture in the **Moisture** field. Save the entered data to a file as a safety measure.

7. If the samples are the same as the calibration samples:

   Load the calibration file using the **Open File** command.

   In **Verification**, click on **Copy Wts** and select **from calibration**.

8. Perform a reference on an empty Aclar bag in the sample paddle.

9. Place the cursor on the first row in the **Sample Data** table. Perform a sample on each wet bagged sample using the sample paddle. When a sample operation is complete, the result is displayed in the **Sample Data** table. The cursor (the highlighted row) automatically moves down to the next entry/sample.

10. Verify that the **Error (%)** is ≤ the 2•σ accuracy specification. (see Chapter 2). The verification results can be graphed with virtually any combination of variables. Select a view that is the most informative in determining the goodness of the verification (for example, **Error (%)** on the vertical Y-axis versus **Lab Moisture** on the horizontal X-axis).

11. Save the data again to include the sensor data as a safety measure.

12. Print a report by pressing **Report**. Provide a meaningful heading for the report, select **Verification**, and click **OK**.

ATTENTION

> Make note of any samples that measure with an error of greater than the 2•σ accuracy specification. If more than 20 percent of the samples that were not omitted during data reduction fail this criterion, the verification and/or calibration should be repeated until success is achieved.

6.5. Entering Calibration Constants

The most convenient way to record calibration constants and link them to a grade code is to use the **Apply new coefficients** tool in the **Advanced Calibration** display (see Subsection 6.4.2).

You can set up the **MWP11 Calibration Table** and **Configuration Table** for each of the recipes. The appropriate table that has been set up can be selected in the **Main Code Table** for each of the grade recipes. For temporary usage, these calibration constants can also be entered through the **Calibration Constants Table** under **Calibration Parameters** in the **Sensor Maintenance** display.

Similarly, for permanent storage, enable or disable the appropriate correctors in the grade code through the **MWP11 Configuration Table** in the **Recipe Maintenance Display** on the **Setup** menu. The appropriate correctors can be enabled or disabled by setting *True* or *False* in the **MWP11 Configuration Table**. Alternatively, this can also be enabled or disabled through **Recipe-Based Options** under the **Configuration Parameters** in the **Sensor Maintenance** display for temporary usage. To enable the corrector, double-click on the appropriate corrector. A check mark shows in front of it to indicate that it is enabled (to disable a corrector, double-click on it again to remove the check mark).

To set up the calibration constant table for the given code:

1. Go to **Setup** on the horizontal dispatcher and select the **Recipe Maintenance** display.

2. In the **Main Code table**, for example, set up the **MWP11 Calibration Table** and **MWP11 Configuration Table** to 00 for *code00* as shown in Figure 6-5, and click **Save**.

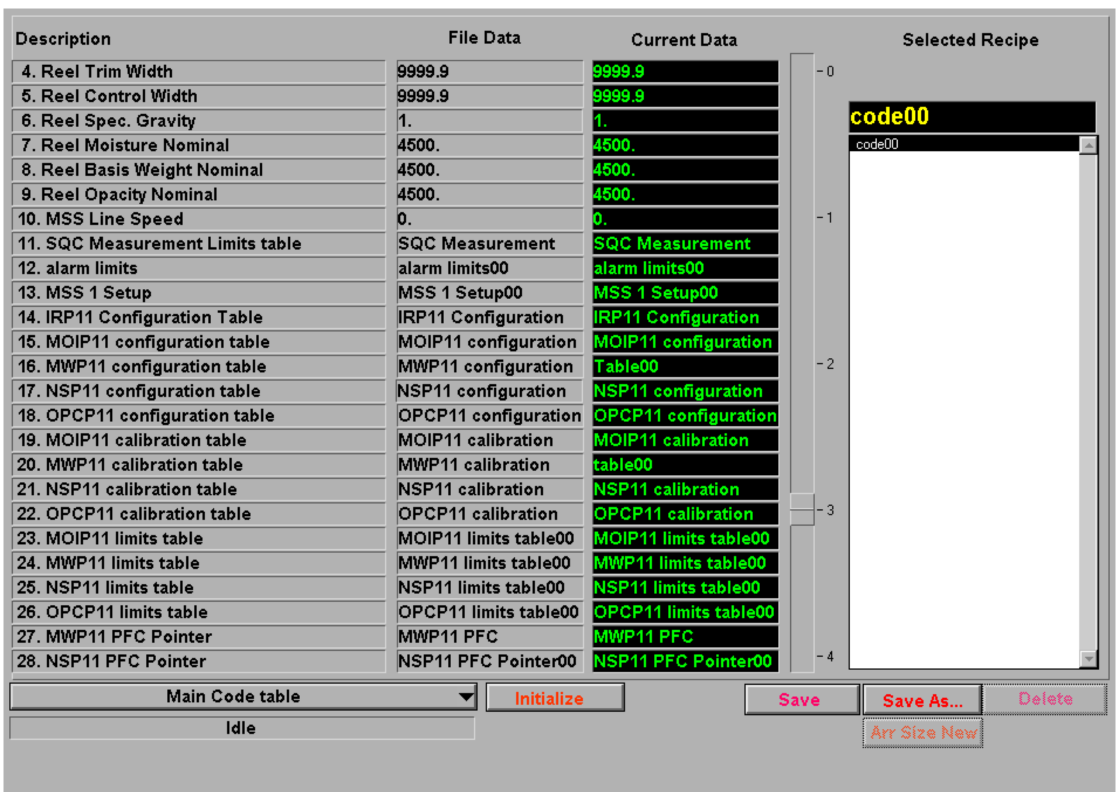

Figure 6-5 Main Code Table

To set up the calibration constants:

3. Press **Main Code table**.

4. Choose the **MWP11 Calibration Table** and press **OK** (see Figure 6-6). This calls up the **MWP11 Calibration Table**.

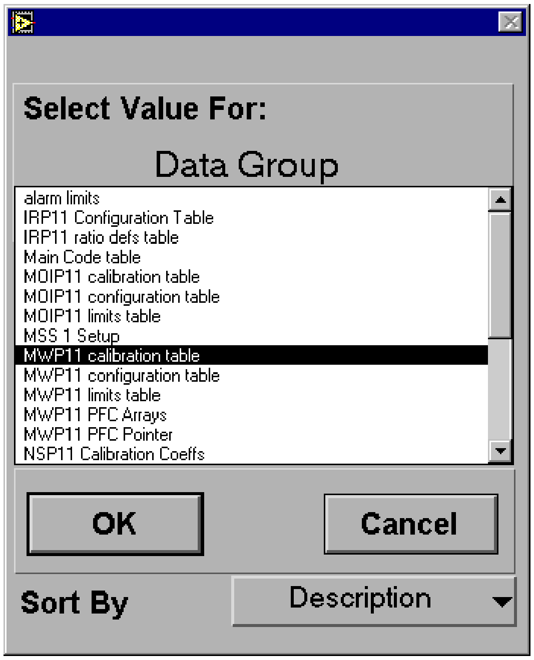

Figure 6-6 Select Value For: Display

5. In the calibration table, enter the calibration constants for a given code and save them as *MWP11 Calibration Table* for the given code. For example, Figure 6-7 shows the setup of **MWP11 Calibration Table** 00 for a given Code 00.

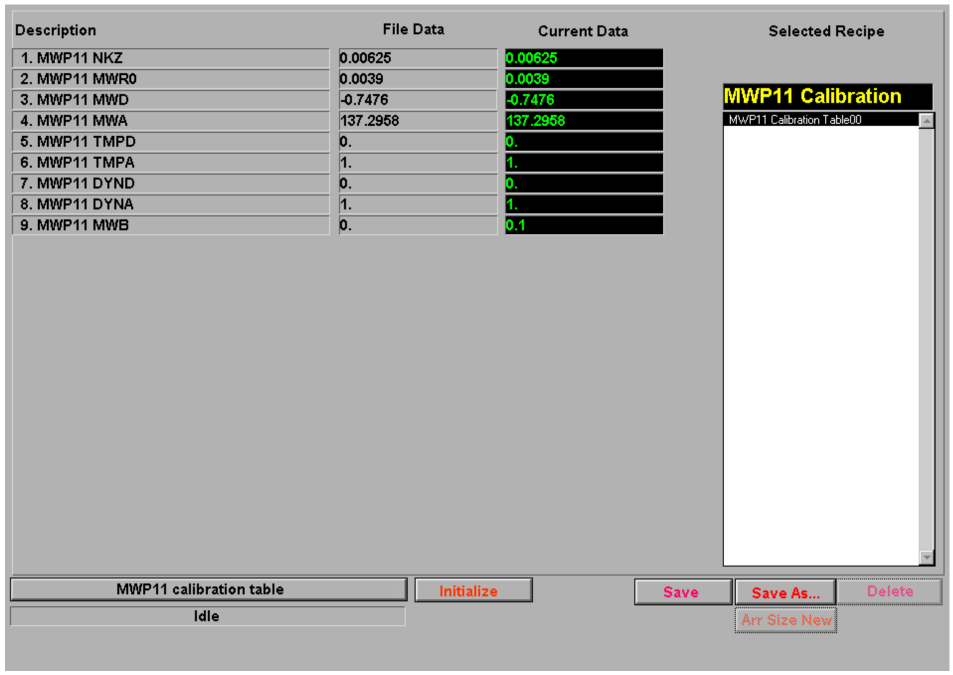

Figure 6-7 MWP11 Calibration Table

6. Open the **MWP11 Configuration Table**.

7. Set the location to *True* for correctors that need to be enabled, and set the others to *False* for correctors that are to be disabled.

8. Save the table in Step 7 as *MWP11 Configuration Table 00*. For example, Figure 6-8 shows the **MWP21 Configuration Table** in which **MWP21 Temp Corr** and **MWP21 Dyn Corr** have been set to *True*.

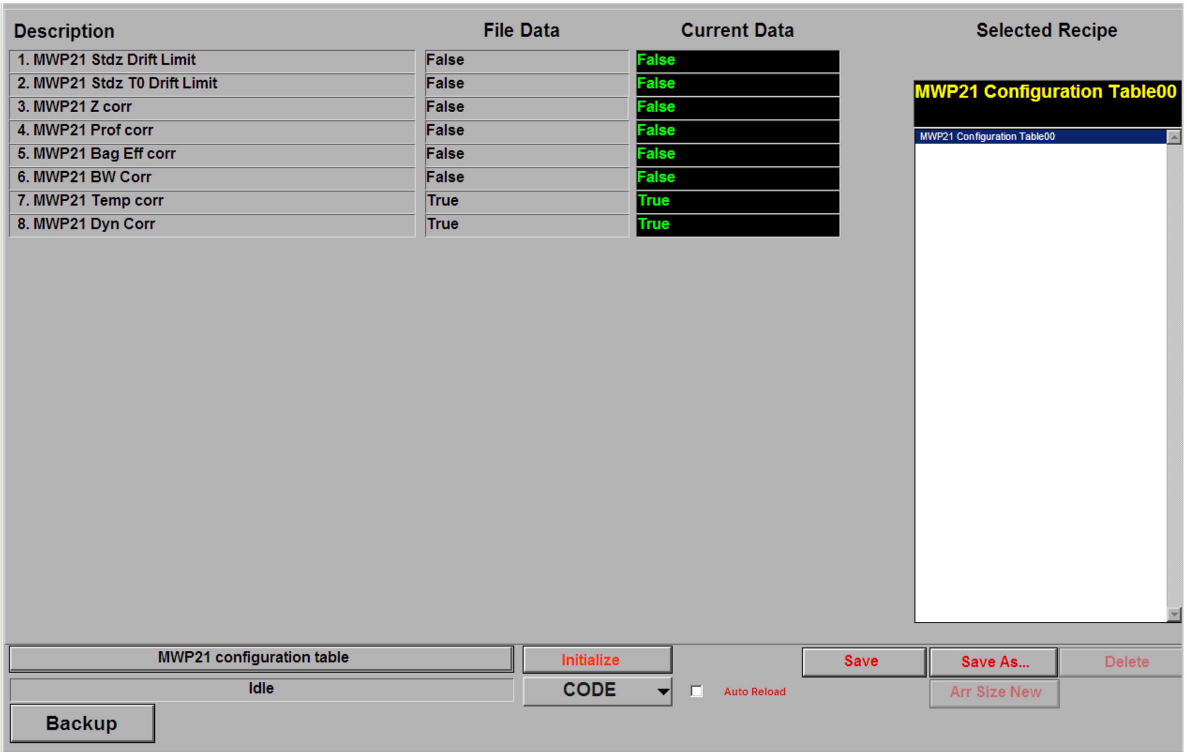

Figure 6-8 MWP21 Configuration Table Showing Temp and Dynamic Correction Enabled

9. In each **Main Code table**, select the appropriate **MWP11 Calibration Table** and **MWP11 Configuration Table**. These grade codes can then be loaded in the maintenance or production mode through the **Modes and Recipe** button on the **Sensor Maintenance** display, which is described in detail in Section 5.1.

7. Preventive Maintenance

7.1. Preventive Maintenance Checklist

The frequency of preventive maintenance procedures is often defined by the operating environment. In Table 7-1, **X** indicates recommended maintenance intervals, and **XX** indicates adjust the interval on an as-needed basis.

Table 7-1 Preventive Maintenance Internal Checklist

Procedure	Daily	Weekly	Months		Years			Procedure Details
			1	6	1	2	5	
General								
Clean sensor windows	XX							Section 8.1
Check and adjust standardize voltage		X						Section 8.2
Check short term stability			X					Section 8.3
Check sensitivity calibration			X					Section 8.4
Check static repeatability			X					Section 8.6
Dynamic verification		X						Section 5.3
Check Z correction and/or profile correction					X			Sections 5.5/ 5.6

8. Tasks

This chapter contains procedures for maintaining optimal microwave moisture sensor function or troubleshooting issues with the microwave moisture sensor.

ATTENTION

Activity numbers that appear in the task tables are for use of the sensor diagnostics display only and do not reflect model numbers for the tasks. To determine whether the task applies to your sensor, check **Applicable Models**.

If a value in the task table is blank, that means it is not applicable to that task.

8.1. Clean Sensor Windows

Clean the sensor windows daily or as appropriate.

Activity Number:	Q4270-51-ACT-001	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Operator
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 day
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	Cloth or paper towels Thin stick methanol or isopropyl alcohol (if necessary)		

Keep the sensor windows clean. Clean with a cloth or paper towels wrapped on a thin stick (dipped in methanol or isopropyl alcohol only if necessary).

8.2. Check Standardize Voltage

Inspect the sensor *Standardize Reports* weekly to check for indications of sensor instability.

Activity Number:	Q4270-51-ACT-002	**Applicable Models:**	All
Type of procedure:	Inspect	**Expertise Level:**	Operator
Priority Level:	Average	**Cautions:**	None
Availability Required:	None	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 week
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:	Clean Sensor Windows	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. In the **Sensor Report** display, select **Microwave Standardize Report** (see Figure 8-1).

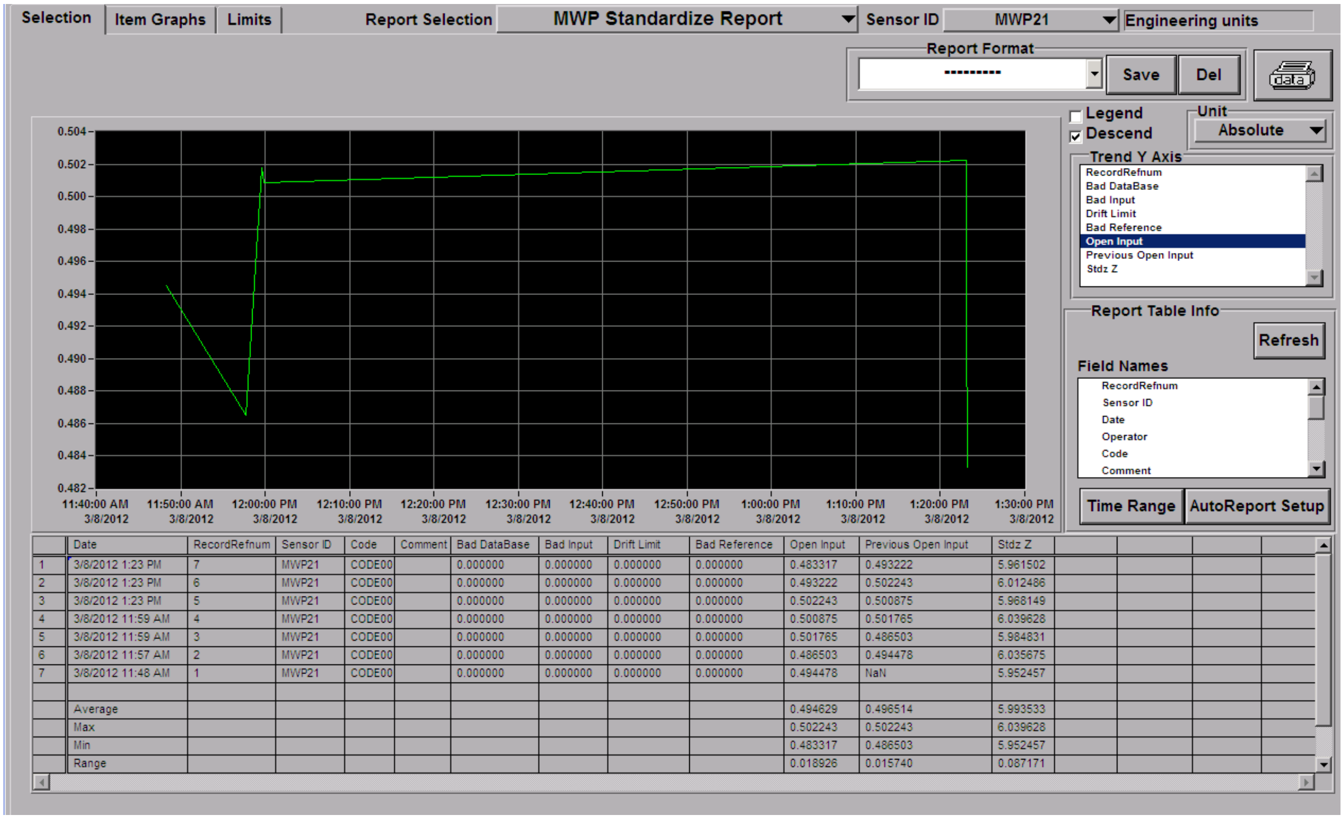

Figure 8-1 Microwave Standardize Report

2. Select the desired parameters (for example, **Open Input**) under the field name by double-clicking. Use the printer button to print them out if desired.

ATTENTION

> The maximum number of records per sensor in the *Sensor Reports* file is 100 for sample and 1000 for reference operations. When the maximum number of records is reached, the newest record replaces the oldest record in the file, so save the sensor report regularly.

3. Standardize volts should be 0.50 ± 0.05V. If it is not, adjust the two or three preset rotary selector switches (ICH1–3) on the MS-controller board (Figure 8-2) in the upper sensor head to obtain this voltage. The three switches allow for a fine, medium and coarse adjustment of the voltage.

   Refer to Chapter 2 of *Experion MX MSS and EDAQ Data Acquisition System Manual* (p/n 6510020381) to learn how to connect a laptop to the scanner network. The sensor output voltage can be monitored on a laptop at the scanner on the MSS I/O monitor display while the rotary switches are adjusted.

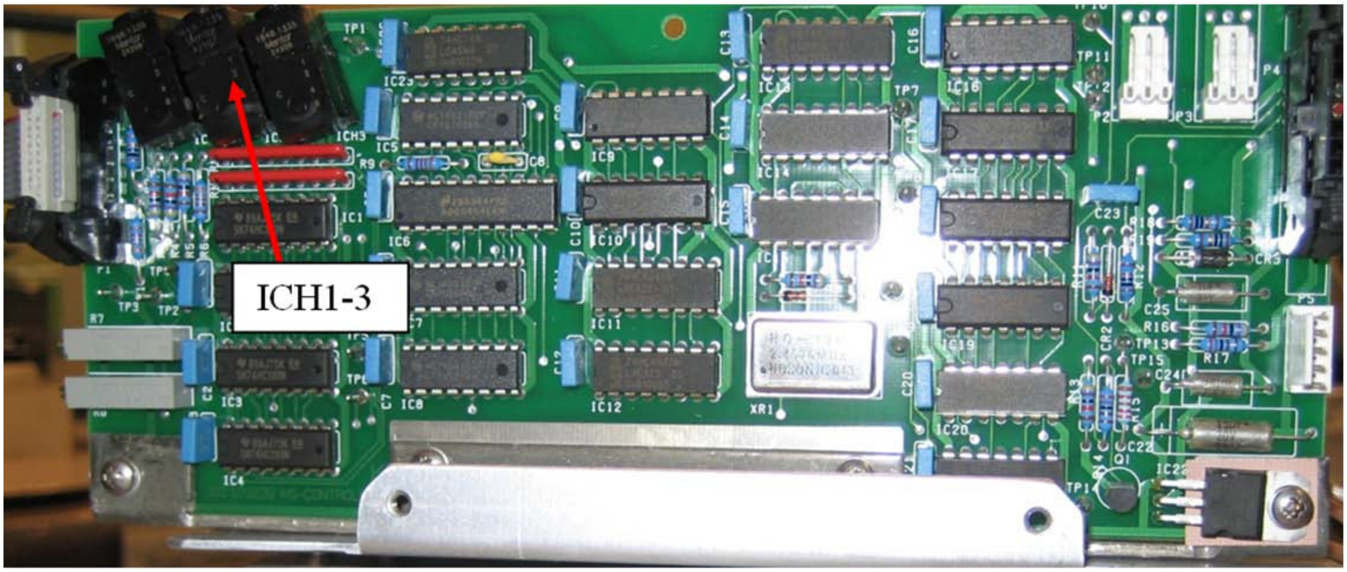

Figure 8-2 MS Controller board

Standardize volts are expected to move up and down slightly with head temperature. Excessive drift may be due to the instability of the head temperature. If the standardize volts are unstable, but the head temperature is stable, see Chapter 9.

If required the standardize drift limits can be adjusted. They are set in the **MWP11 Limit Table** in the main code of the **Recipe Maintenance** display. The default values are:

Drift limit from T0 (volts)	0.2
Drift limit (Volts)	0.05

To set up the limit in the **MWP11 Limit Table**:

1. Select **Setup** on the Horizontal dispatcher.
2. Select **Recipe Maintenance**.
3. Under **Main Code Table**, select **MWP11 Limit Table**.
4. In the **MWP11 Limit Table**, change the value of MWP11 T0 Drift Limit and of MWP11 Drift Limit, then save them. Note that the recipe must be reloaded for the new values to be used.

8.3. Check Short Term Stability

Check the sensor short term stability monthly for indications of sensor noise and instability.

Activity Number:	Q4270-51-ACT-003	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Operator
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:	Clean sensor windows	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	Sample paddle, ScanPro standard sample		
	Part Number	Quantity	Lead Time
Required Tools:			

CAUTION

The high range microwave moisture sensor (Q4273-52) may be affected by contact between the sheetguide and your body or other conducting material. Keep your body and any electrically conducting materials at least 5 cm (2 in) away from the sheetguide during alignment, stability testing, standardization, and sample measurement.

1. Bring the sensor to its equilibrium offsheet temperature. Check that the head temperature is stable (± 1°C). Do not change the sheet guide heater, air wipe flow and air wipe heater settings.

2. Perform a reference with an empty gap.

3. Perform three samples on the standard sample (plastic sample provided by ScanPro) with an integration time of three seconds, and record the average voltage.

4. Set-up a run of 30 references with an empty gap, with an integration time of 3 seconds and with no waiting time between references.

5. When the 30 references are completed, calculate the drift scaled by the standard sample reading:

$$\text{Drift} = \frac{\text{Volts}_{\text{Max}} - \text{Volts}_{\text{Min}}}{\text{Average Volts (Standard Sample)}}$$

   If Drift < 0.01, the sensor is stable.

6. If the sensor is not stable, ensure that the windows are clean and the head cooling is working, then repeat the references.

7. If the sensor is still not stable, see Chapter 9.

8.4. Check Sensitivity Calibration

Check the sensor sensitivity monthly for indications of sensor instability.

Activity Number:	Q4270-51-ACT-004	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:	Clean sensor windows Check standardize report	**Post Procedures:**	Sensitivity calibration
	Part Number	Quantity	Lead Time
Required Parts:	Sample paddle, ScanPro standard sample		
	Part Number	Quantity	Lead Time
Required Tools:			

To determine the net volts reading for the standard sample (plastic sample provided by ScanPro):

1. Perform a reference with an empty sample paddle.

2. Put the standard sample between the paddle pieces, and then insert it into the gap of the sensor.

3. Read the output voltage, and calculate the difference between this value and the reference (or offset) voltage from step 1, or perform a sample on the system and note the net volts printed in the *Sample Report* or in the **Sensor Maintenance** display.

4. The value obtained in step 3, and the value from the factory calibration, should be within 3% of each other.

The reference and the standard sample net volts should be stable over time. Typically, the standard sample net volts should agree with the value obtained at calibration within 3%. If a significant drift has occurred, sensitivity calibration may be required (see Section 8.5).

8.5. Recalibrate Sensor Sensitivity

Recalibrate the sensor sensitivity if the standard sample reading has drifted compared to the value obtained at calibration. If adjustments are made to the electronics and/or boards are replaced, you must check the sensitivity (see Section 8.4), and recalibrate when it is not accurate enough.

Activity Number:	Q4270-51-ACT-005	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	Electric shock
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:	Check Short Term Stability Check Sensitivity Calibration	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	Sample paddle, ScanPro standard sample		
	Part Number	Quantity	Lead Time
Required Tools:	Flat head small screwdriver		

There are two methods to adjust for a change in the sensor sensitivity:

- sensitivity adjustment method

- calibration adjustment method

8.5.1. Sensitivity Adjustment

Use this method to adjust the sensitivity at the sensor head to produce the same output on the standard sample that was found at calibration time. The disadvantage of this method is that you must make the adjustment at the sensor head and measure the output voltage. Refer to Chapter 2 of *Experion MX MSS and EDAQ Data Acquisition System Manual* (p/n 6510020381) to learn how to connect a laptop to the scanner network so the sensor output voltage can be monitored at the scanner.

To adjust the sensitivity at the sensor head:

1. Bring the sensor to its equilibrium offsheet temperature with air-gap air and air-gap heating off.
2. Ensure that the sensor is stable (see Section 8.3).
3. With the empty sample paddle in the gap, note the output voltage with at least three significant digits.
4. Add to this value the standard sample voltage recorded at calibration time.
5. Insert the sample paddle with the standard sample in the gap and measure the voltage.
6. Adjust R35 on the differentiator board (see Figure 8-5) to obtain the calculated value to within 3% of the voltage at calibration time.

8.5.2. Calibration Adjustment

Use this method to adjust the static calibration constants for all grades by a common factor to compensate for the change in sensitivity.

1. Perform a reference with the empty sample paddle in the gap.
2. Insert the sample paddle with the standard sample in the gap and perform a sample.
3. Divide the net volt by those for the standard sample at calibration time (XS) to obtain the ratio RVOLTS = Net Volt/XS.
4. Adjust the static calibration constants as shown in Table 8-1.

Table 8-1 Static Calibration Constants

Dry End Algorithm	Wet End Algorithm
MWA(new) = MWA(old)/√ RVOLTS MWD(new) = MWD(old) MWR0(new) = MWR0(old)•RVOLTS MWB(new) = MWDB(old)	MWA(new) = MWA(old)/RVOLTS MWD(new) = MWD(old) MWB(new) = MWDB(old)

8.6. Check static repeatability

Check the sensor static repeatability monthly for indications of sensor noise and instability.

Activity Number:	Q4270-51-ACT-006	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Operator
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:	Clean sensor windows Check short term stability Check sensitivity calibration	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	Sample paddle, glass encapsulated sample or ScanPro standard sample		
	Part Number	Quantity	Lead Time
Required Tools:			

CAUTION

The high range microwave moisture sensor (Q4273-52) may be affected by contact between the sheetguide and your body or other conducting material. Keep your body and any electrically conducting materials at least 5 cm (2 in) away from the sheetguide during alignment, stability testing, standardization, and sample measurement.

1. Bring the sensor to its equilibrium offsheet temperature. Check that the head temperature is stable (± 1°C). Do not change the sheet guide heater, air wipe flow and air wipe heater settings.

2. Perform a reference with an empty gap.

3. Insert a glass encapsulated sample or a ScanPro plastic standard sample in the gap. Load the appropriate grade code if required.

4. Set-up a run of 30 samples with a three second integration time and no waiting time between samples.

5. When the 30 samples are completed, note the 2-sigma variation of the sensor readings. Compare the result to results obtained previously.

6. If the result is significantly worse than expected, ensure that the windows are clean and the head temperature stability is within ± 1°C, then repeat the samples.

7. If the measurement is still not repeatable, see Chapter 9.

8.7. Adjust Hardware

Hardware adjustment is performed in the ScanPro factory and final adjustments are made in the Honeywell factory. Hardware adjustment may be required in the field if an electronic board such as the oscillator board has been replaced.

Activity Number:	Q4270-51-ACT-007	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	Electric shock
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	2 hours	**# of People Required:**	2
Prerequisite Procedures:		**Post Procedures:**	Check Sensitivity Calibration Check Short Term Stability
	Part Number	Quantity	Lead Time
Required Parts:	Sample paddle, ScanPro standard sample		

	Part Number	Quantity	Lead Time
Required Tools:	Digital voltmeter with two clip leads Oscilloscope with 3 x1 probes		

CAUTION

The high range microwave moisture sensor (p/n Q4273-52) may be affected by contact between the sheetguide and your body or other conducting material. Keep your body and any electrically conducting materials at least 5 cm (2 in) away from the sheetguide during alignment, stability testing, standardization, and sample measurement.

Before adjusting the sensor, familiarize yourself with the location of the four boards in the sensor head and with the principles of operation (see Chapter 2). Make only those adjustments necessary to achieve the described operation.

8.7.1. Microwave Interface Board

The microwave interface board (Figure 8-3) provides the -28 V DC power to the measuring head. It also conditions the serial signal which enables communication between the sensor controller board and the Ethernet Data Acquisition (EDAQ) board.

Figure 8-3 Microwave Interface Board

The microwave interface board does not require any adjustments. Check in the Measurement Sub System (MSS) IO point monitor under the MSS Setup Diagnostics page the voltage (-28 V ± 1) and current (approximately 330 mA) provided to the gauge by the microwave interface board. If the voltage specification is not met, replace the board.

8.7.2. Jumper Settings and Oscillator Board Alignment

Check the jumpers listed in Table 8-2; jumper settings for the standard range sensor and the high range sensor.

Table 8-2 Jumper Settings

Jumper	**Standard Range DS-20 094270-51**	**High Range DS-30 094273-52**
S1/differentiator board	Present	Absent
S1/oscillator board	Pin 3 to pin 6	Pin 1 to pin 4

1. See Figure 8-4 and Figure 8-5 for help in locating the jumpers on the boards. For the locations of the boards, see Chapter 2. The same boards may be used on either the standard range sensor or the high range sensor. Always check the jumpers when replacing these boards.

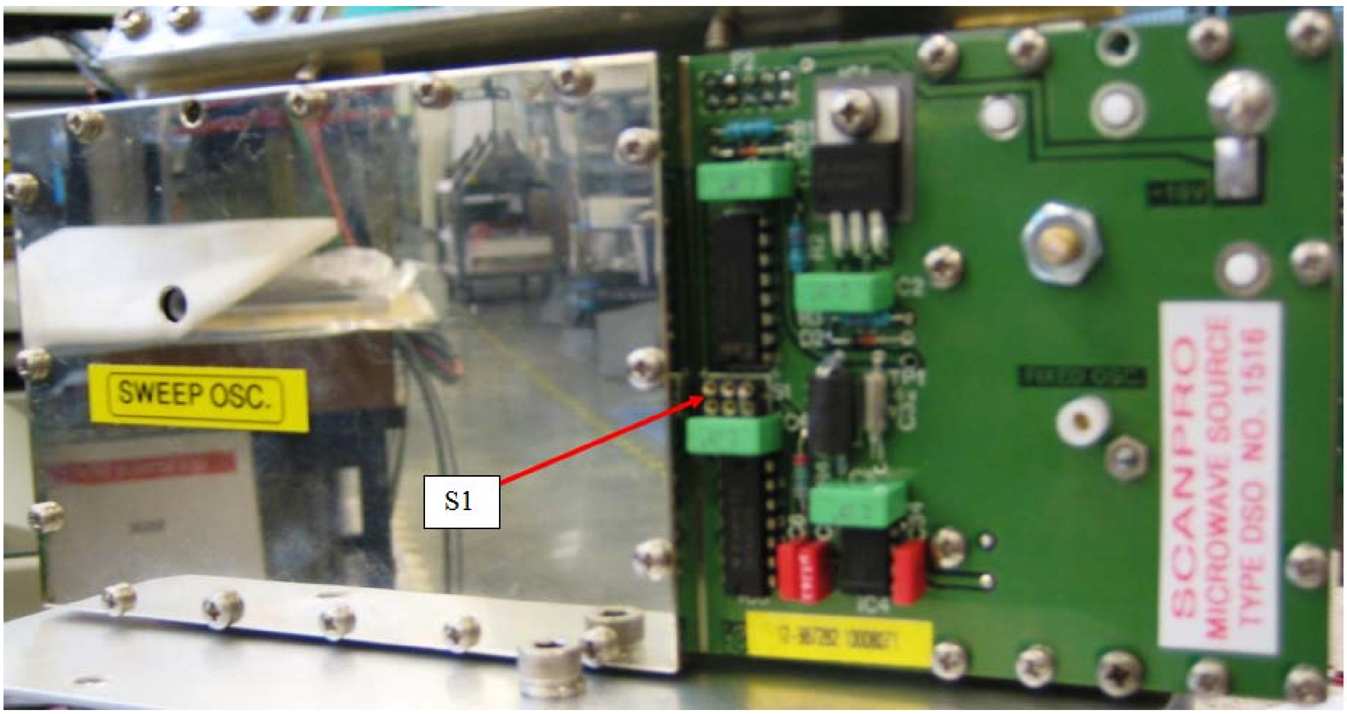

Figure 8-4 Oscillator Board Layout

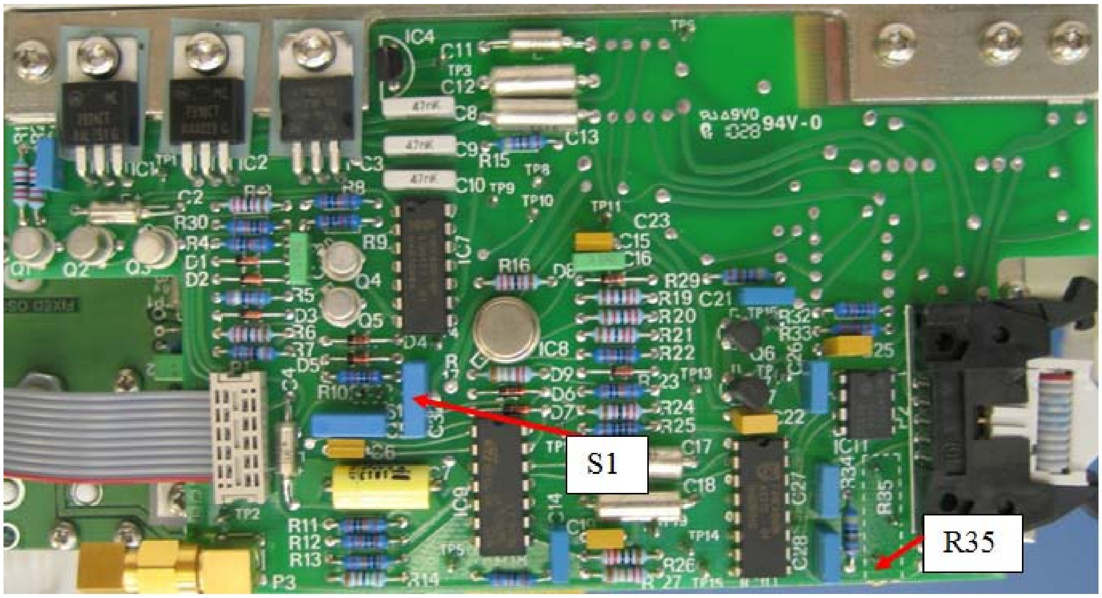

Figure 8-5 Differentiator Board

2. Using three probes (preferably *x1* rather than *x10*), connect an oscilloscope (sweep set at 2 ms) to the differentiator board. Table 8-3 lists the test points for the differentiator board.

Table 8-3 Differentiator Board Test Points

Connection	Signal Name
Ground to TP2	Ground
Trigger to TP1	SS
Channel 1 (0.5 V DC/div.) to TP16	Frequency-to-voltage converter
Channel 2 (0.5 V AC/div.) to TP5	Resonance

3. Check that channel 1 TP16-Frequency-to-Voltage Convertor (FVC) looks like Figure 8-6 (figure courtesy of ScanPro).

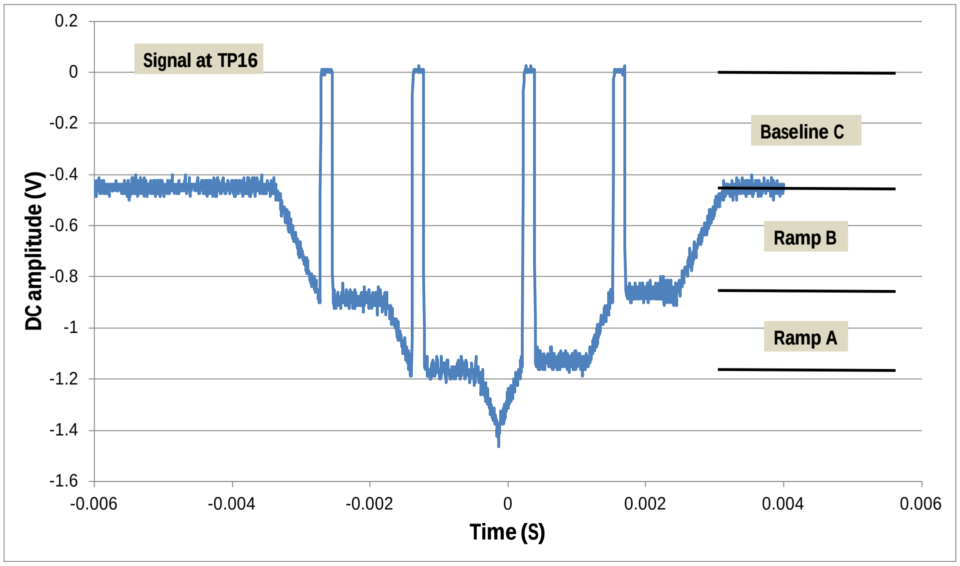

Figure 8-6 Waveform on TP16 (FVC)

Check that channel 2 TP5-Resonance looks like Figure 8-7 (figure courtesy of ScanPro).

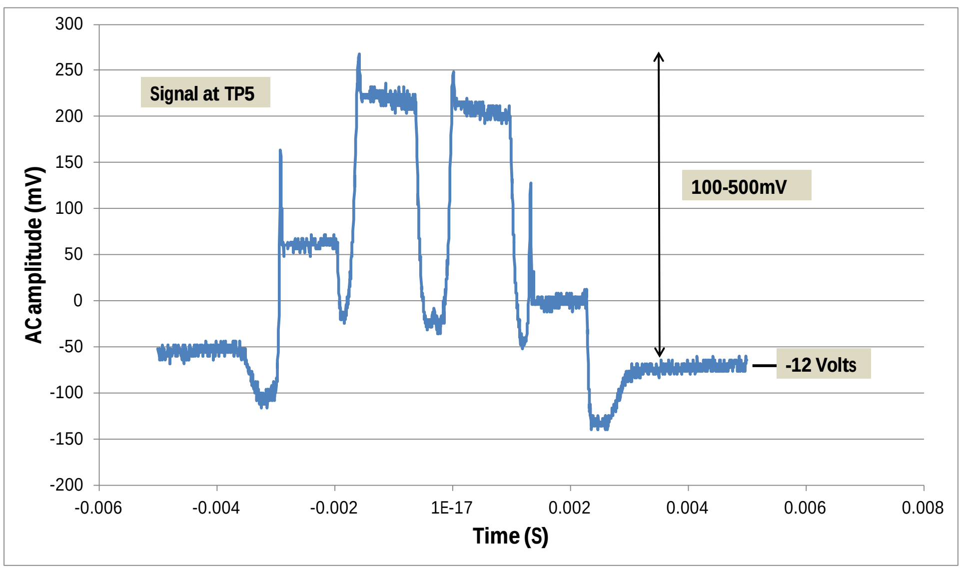

Figure 8-7 Waveform on TP5 (resonance)

The FVC should have ramps A and B and baseline C at approximately the same height. The total amplitude is typically 1–2 V. If this is the case, see Section 8.5. If this is not the case, ScanPro advises replacement of the oscillator board and return of the original board if it is under warranty. This requires ready access to a spare. For cases where this is impossible:

1. Adjust the SWEEP trimmer capacitor on the oscillator board until the oscilloscope trace for channel 1 TP16-FVC looks like that shown in Figure 8-7.

2. Adjust the LO fixed oscillator trimmer capacitor on the oscillator board until the trace for channel 2 TP5-Resonance looks like that shown in Figure 8-8.

3. Readjust the SWEEP trimmer capacitor so that ramps A and B on the channel 1 trace TP16 indicated in Figure 8-7 have approximately the same height. These are typically -0.3V.

4. Readjust the LO trimmer so that baseline C and ramp B (see Figure 8-7) have approximately the same height. The baseline is typically -0.4V, and ramp B is typically -0.3V.

Go to Section 8.5.

Table 8-4 lists a summary of the sensor alignment parameters.

Table 8-4 Sensor Alignment Parameters

Sensor Type	Standard range	High range
Jumper S1 on Differentiator PCB	Present	Absent
Jumper S1 on Oscillator PCB	Pins 3 to 6 (right)	Pins 1 to 4 (left)
Differentiator PCB, TP16	Baseline = -0.4 ± 0.3V Ramp B = -0.3 ± 0.2V Ramp A = -0.3 ± 0.2V	
Output voltage:	Empty gap = 0.5 ± 0.05V Standard sample reading should be within 3% of the value obtained at calibration time	

ATTENTION

Whenever parts of the sensor are replaced, follow the instructions in Chapter 6 to ensure that the static calibration is accurate.

9. Troubleshooting

This chapter is divided into two sections:

- Alarm Based Troubleshooting
- Non-alarm Based Troubleshooting

9.1. Alarm Based Troubleshooting

Depending on your system configuration, your Experion MX system may only display some of these alarms.

9.1.1. -28 V Supply Voltage is Low

Alarm triggers when the supply voltage to the MS-controller board is lower than the lower limit (-29 V)

Symptom	**Possible Cause**	**Solution (tasks)**
-28V supply voltage is low	Microwave interface board is faulty	Replace microwave interface board (See Subsection 8.7.1)

9.1.2. -28 V Supply Voltage is High

Alarm triggers when the supply voltage to the MS-controller board is higher than the higher limit (-27 V).

Symptom	Possible Cause	Solution (Tasks)
-28V supply voltage is high	Possible electrical short on the MS-controller board.	Replace MS-controller board Check and Adjust Standardize Voltage
	Microwave interface board is faulty	Replace microwave interface board (See Subsection 8.7.1)

9.1.3. -28V Supply Current is High

Alarm triggers when the supply current to the MS-controller board is higher than the higher limit (800 mA).

Symptom	Possible Cause	Solution (Tasks)
-28V supply current is high	Possible electrical short on the MS-controller board.	Replace MS-controller board Check and Adjust Standardize Voltage

9.1.4. -28V Supply Current is Low

Alarm triggers when the supply current to the MS-controller board is lower than the lower limit (200 mA).

Symptom	Possible Cause	Solution (Tasks)
-28V supply current is low	Microwave interface board is faulty	If the sensor is not operating properly, replace the microwave interface board (See Subsection 8.7.1)

9.1.5. Bad Input

Alarm triggers when the microwave voltage is outside of the allowed A/D voltage range.

Symptom	Possible Cause	Solution (Tasks)
bad voltage input	Bad communication between the MS-controller board and the EDAQ	Check harness between EDAQ and microwave interface board and between microwave interface board and MS-controller board Replace EDAQ (See Chapter 3) Replace MS-controller board Replace microwave interface board (See Subsection 8.7.1)

9.1.6. Drift from Time-zero

Alarm triggers when the standardize voltage has drifted too far from the time-zero value. By default the standardize voltage should be within 0.2 V of the time-zero value.

Symptom	Possible Cause	Solution (Tasks)
drift from time-zero	Sensor is dirty	Clean Sensor Window
	Sensor was not adjusted in a long time	Check and Adjust Standardize Voltage Check Sensitivity Calibration

9.1.7. Drift from Previous Standardize

Alarm triggers when the standardize voltage has drifted too far from the previous standardize. By default, the standardize voltage should be within 0.05 V of the previous value.

Symptom	Possible Cause	Solution (Tasks)
drift from previous standardize	Head temperature is unstable (not within ± 1ºC)	Check stability of head temperature
	Sensor is dirty	Clean Sensor Window
	Sensor is unstable	Adjust Hardware

9.1.8. Bad Net Converted Volts

Alarm triggers when the voltage read while measuring the product is lower than the voltage read during standardize.

Symptom	Possible Cause	Solution (Tasks)
bad net converted volts	Standardize voltage is not correct	Check and Adjust Standardize Voltage

9.1.9. Bad Z Measurement

Alarm triggers when the measurement required for Z-correction was flagged as invalid.

Symptom	Possible Cause	Solution (Tasks)
bad Z-measurement	The Z-sensor does not exist or is not configured properly	Check by standardizing on performance sensors page in **Sensor Maintenance** display
	The Z-sensor is faulty	Check Z-sensor

9.1.10. Bad Sheet Temperature

Alarm triggers when the measurement required for sheet temperature correction was flagged as invalid.

Symptom	Possible Cause	Solution (Tasks)
bad sheet temperature	The sheet temperature sensor does not exist or is not configured properly	Check by standardizing on performance sensors page in **Sensor Maintenance** display
	The sheet temperature sensor is faulty	Check the sheet temperature sensor

9.1.11. Bad Basis Weight

Alarm triggers when the basis weight measurement required for moisture calculation is flagged as invalid.

Symptom	Possible Cause	Solution (Tasks)
bad basis weight	A sample operation was not performed on the basis weight sensor before performing a sample on the microwave sensor	Perform a standardize and a sample on the basis weight sensor
	Basis weight sensor is not operating properly	Check basis weight sensor

9.2. Non–alarm Based Troubleshooting

Symptom	Possible Cause	Solution (Tasks)
The reference/standardize volt is low or high, for example, not 0.5 V	The voltage has drifted	Check and Adjust Standardize Voltage
The reference/standardize volts are unstable	Sensor window is dirty	Clean Sensor Window
	Head temperature is unstable (not within ± 1ºC)	Check stability of head temperature
	Sensor hardware is misaligned	Adjust Hardware
The sensor reading does not agree with the lab	Sensor needs a dynamic correction	Perform dynamic correction (see Section 5.3)
	Lab dynamic testing procedure not followed	Perform dynamic correction (see Section 5.3)
	Sensor is unstable	Check Short Term Stability
	Bad sheet temperature correction	See Subsection 5.4
	Static calibration not accurate	Verify calibration and recalibrate if necessary (see Chapter 6)
The moisture cross direction profile is not accurate	Scanner has a bad x, y, z profile	Align scanner and/or implement Z-correction (see Section 5.5) Implement profile correction (see Subsection 5.6)
	Bad sheet temperature correction	See Section 5.4

Symptom	**Possible Cause**	**Solution (Tasks)**
The measurement is unstable. Waveforms at TP5 and TP16 on differentiator board do not look like Figure 8-6 and Figure 8-7	Oscillator board needs alignment. Oscillator and/or differentiator board is faulty	Adjust Hardware Replace oscillator board (be sure to note which cable is attached to which antenna. Each cable must have an attenuator. If they are reversed, the signals appear normal with no paper in the gap; however, when paper is introduced, the signals collapse).
The measurement is relatively insensitive to moisture change	Hardware misaligned	Adjust Hardware
	Sensitivity calibration inaccurate	Check Sensitivity Calibration Sensitivity Calibration
	Static calibration not accurate	Verify calibration and recalibrate if necessary (see Chapter 6)
	Hardware faulty (differentiator board, oscillator board and/or detector diode)	If no resonance is seen on TP5 on the differentiator board, and you have tried replacing the oscillator and differentiator boards without success, the detector diode may have failed. Check the diode using a digital DVM in diode check mode or on the 20 kOhm scale. The resistance should be a few hundred ohms in one direction and open circuit in the other.

10. Storage, Transportation, and End of Life

This chapter summarizes Honeywell policy with regards to the storage and disposal of sensors.

10.1. Storage and Transportation Environment

In order to maintain integrity of sensor components, storage and transportation of all equipment must be within the parameters shown in Table 10-1.

Table 10-1 Storage and Transportation Parameters

Duration of Storage	Acceptable Temperature Range	Acceptable Humidity Range
Short term (less than one week)	-20 to 45 °C (-4 to 113 °F)	20–90% non-condensing
Long term	-10 to 40 °C (14 to 104 °F)	20–90% non-condensing

10.2. Disposal

Honeywell supports the environmentally conscious disposal of its products when they reach end of life or when components are replaced.

All equipment should be reused, recycled, or disposed of in accordance with local environmental requirements or guidelines.

This product may be returned to the Honeywell manufacturing location, and it will be disposed of using environmental friendly methods. Contact the factory for further details and instructions.

Guidelines for disposal of equipment by Honeywell or the customer for sensor-specific materials are described in Subsection 10.2.1.

10.2.1. Solid Materials

- remove all non-metallic parts (except plastic) from the sensor and dispose of through the local refuse system
- recycle plastic parts
- wires and cables should be removed and recycled (copper may have value as scrap)
- electrical and electronic components should be recycled or handled as special waste to prevent them from being put in a landfill, because there is potential for lead and other metals leaching into the ground and water
- metals should be recycled (in many cases they have value as scrap)

11. Glossary

Bin (or Measurement Bin)	The smallest measurement zone on the frame. Also called **Bucket** or **Slice**.
CD Spread	Variation in the profile data equal to twice the standard deviation of the measured variable.
Code or Code Name	See Recipe
Cross Direction (CD)	Used to refer to those properties of a process measurement or control device that are determined by its position along a line that runs across the paper machine. The cross direction is transverse to the machine direction that relates to a position along the length of the paper machine.
DYNA	Dynamic correction slope
DYND	Dynamic correction intercept
Experion MX	A Quality Control System (QCS)
Machine direction (MD)	The direction in which paper travels down the paper machine.
Measurement Sub System (MSS)	Computer responsible for binning data before sending to the QCS server.
MWA	Static calibration slope
MWB	Basis weight correction slope
MWD	Static calibration intercept
MWR0	Offset for dry end algorithm
QCS	Quality Control System
RAE	Real-Time Application Environment The system software used by Experion MX QCS to manage data exchange between applications
Recipe	A list of pulp chemicals, additives and dyes blended together to make a particular grade of paper. In Experion MX, the recipe contains all sensor and actuator configuration and calibration parameters associated with a grade

Sensor Processor	A software program that takes one or many inputs from the MSS, converts those measurements to engineering units for measurement or measurement correction, performs automatic diagnostic tests, and reports on any alarm conditions.
Sensor Set	The term used in the Sensor Maintenance displays to describe a set of sensors working together on a scanner to perform one measurement.
Standardize	An automatic periodic measurement of the primary and auxiliary sensors taken offsheet. The standardize measurements are used to adjust the primary sensors' readings to ensure accuracy.
T0 Open Volt	Time-zero standardize volts
Temp CAL	Sheet temperature at calibration time
TMPA	Temperature correction slope
TMPD	Temperature correction intercept
Trend	The display of data over time.

A. Part Numbers

Table A-1 lists Honeywell part numbers.

Table A-1 Part Numbers

Description	Honeywell Part No.
Window, carbon	34000028*
Central unit SA-150	34000042*
Oscillator board	34000043*
Differentiator board	34000044*
MS-controller board	34000045*
Processor board	34000046
Power supply board	34000047
Detector assembly	6581800129*
Fuse, 1A 5x20mm	51000275*
DS-20, unmodified	34000040**
DS-30, unmodified	34000041**
Microwave interface board	6581500035
EDAQ board	6581500030
Standard range sensor	09427051
High range (wet end) sensor	09427352
Seven-inch Aclar® bag	32000269
Bag sealer	42000030

* To prevent lengthy downtimes, it is advisable to stock these items on-site (these are the items available in the spares kit).
** These items should not be ordered for field use; they are given for reference only.

Microwave Moisture Measurement

System Manual

6510020388

Microwave Moisture

May, 2012

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CD Spread	Variation in the profile data equal to twice the standard deviation of the measured variable.
Code or Code Name	See **Recipe**
Cross Direction (CD)	Used to refer to those properties of a process measurement or control device that are determined by its position along a line that runs across the paper machine. The cross direction is transverse to the machine direction that relates to a position along the length of the paper machine.
Drift Limit Volt	Maximum allowable drift of **Open Volt** from the previous standardize
Drift Limit VoltT0	Maximum allowable drift of **Open Volt** from the standardize voltage at time zero (**T0 Open Volt**)
DYNA	Dynamic correction slope
DYND	Dynamic correction intercept
Experion MX	A Quality Control System (**QCS**)
Machine direction (MD)	The direction in which paper travels down the paper machine.
Measurement Sub System (MSS)	Computer responsible for binning data before sending to the **QCS** server.
MWA	Static calibration slope
MWB	Basis weight correction slope
MWD	Static calibration intercept
MWR0	Offset for dry end algorithm
Open Volt	Current standardize volts
QCS	Quality Control System

RAE	Real-Time Application Environment The system software used by **Experion MX QCS** to manage data exchange between applications
Recipe	A list of pulp chemicals, additives and dyes blended together to make a particular grade of paper. In **Experion MX**, the recipe contains all sensor and actuator configuration and calibration parameters associated with a grade
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