Honeywell

HPIR Moisture Measurement

System Manual

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HPIR

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Introduction

The purpose of this document is to enable Honeywell personnel to install, calibrate, and maintain the High Power InfraRed (HPIR) Moisture Measurement sensor.

The model covered in this manual is Q4287-57 for Experion MX.

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 these chapters and two appendixes.

Chapter 1, **Sensor Overview**, describes operating principles and system specifications.

Chapter 2, **System Components,** describes HPIR Moisture Measurement System components.

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

Chapter 4, **Installation,** describes the installation and set up tasks for the sensor.

Chapter 5, **Software Configuration Parameters,** describes the configuration parameters related to the HPIR Moisture measurement system.

Chapter 6, **Operations** describes operations such reference displays, typical sampling, and dynamic calibration for the HPIR Moisture measurement system.

Chapter 7, **Static Calibration,** describes the static calibration process for the HPIR Moisture measurement system.

Chapter 8, **Preventive Maintenance,** describes a schedule for recommended ongoing maintenance tasks.

Chapter 9, **Tasks,** describes procedures for maintenance, diagnostic, and troubleshooting tasks.

Chapter 10, **Troubleshooting,** describes symptoms, alarms, possible causes, and links to associated diagnostic or troubleshooting tasks.

Chapter 11, **Transportation, Storage, and End of Life,** describes methods for storing, transporting and disposing of sensor components.

Chapter 12, **Glossary,** describes terms and acronyms used in this manual.

Appendix A, **Part Numbers**, lists current part numbers for parts and spares.

Appendix B, **Moisture Samples Worksheet**, contains a linked version of the worksheet needed for making calibration samples.

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 covers the High-Power InfraRed (HPIR) Moisture Measurement sensor. Table 1-1 shows the model number and head gap measurement.

Table 1-1 Model Number and Head Gap Measurement

Marketing Model No.	Hardware Model No.	Source Power	Head Gap Inch	Head Gap mm
Q4287-57	092235-57	High	0.4	10

HPIR Moisture sensors use the strong and very specific absorption by water of infrared radiation at a wavelength of 1.9 microns to provide a measurement of the amount of water in paper or other materials.

HPIR Moisture sensors are three-channel transmission sensors that measure the water weight and percent moisture when operated in conjunction with a nuclear Basis Weight Measurement sensor. The source and receiver hardware are mounted on 10-inch-by-7-inch baseplates for assembly into Experion MX heads.

1.1. High Power Source

The high-power source uses a 150 W halogen lamp, a low-frequency (170 Hz) chopper wheel powered by a motor, and Motor Controller board. The light modulation phase is monitored by a Single-Sided Detector board and the Sync Generator/Lamp Modulator board.

The lamp may be powered at full power by the 24 VDC directly, or at reduced power by the Sync Generator/Lamp Modulator board. An elliptical reflector focuses the light through the chopper wheel aperture onto the sensor window. A low-wavelength blocking filter blocks the visible light to minimize heating of the sheet.

1.2. INFRAND Optics

The sensor uses two flat quartz-Teflon diffusing reflector plates with a single aperture for both the source and the receiver plates. The apertures are offset from each other by two inches in the machine direction (See Figure 9-5).

Light that is scattered by the sheet makes multiple passes through the sheet and enters the receiver optics through the offset aperture. For very light sheets, the average number of passes may be as high as 10; for very heavy sheets, the average number of passes is slightly more than one.

This increased sensitivity to light sheets compensates for the strong scattering of light from fibers that increase the path length inside heavy sheets and thus increases sensitivity in heavy sheets. This offset optics is called INFRAND for INfinite RANDom scattering optics.

The sensor employs quartz-Teflon diffusing reflector plates specially constructed for high signal transmission and independence of sheet pass line and flutter. These plates minimize the dynamic offset.

1.3. Receiver Optics

The light that reaches the offset aperture in the receiver window passes to a light pipe, is collected by a lens mounted in the lower body optics block, and is collimated into a parallel beam. The beamsplitter mounted in the upper body transmits about 60% to the MES channel filter and detector, reflecting about 30% to the REF channel filter and detector. Because the filters reflect the wavelengths they do not transmit, the 3RD channel (opposite to the REF channel) filter and detector receive nearly as much signal as the REF channel.

The high power IR sensor includes a flag. The flag is inserted by a single-contact output. It is used to attenuate the light during Background and Standardize, and for onsheet and sample measurement on lighter paper grades. Without the flag in these situations, the light would be too intense and the electronics would saturate.

1.4. Receiver Electronics

The IR for each channel is detected by a PbS photoconductive detector and amplified in the Fast PbS Detector Assembly. Each channel is further amplified by a Fastcard PCBA and demodulated using the phase signal from the source, resulting in a 0–10 VDC signal for reading.

The PbS detector contains a thermistor and a Peltier cooler that, along with the Temperature Control PCBA, maintain the detector temperature at a few degrees above freezing. This increases sensitivity, reduces noise, and decreases sensitivity to temperature, while the accurate temperature control (±0.005°C) maintains accurate sensitivity to the IR signal.

All of these elements are supported by the Type II Unigauge Backplane, which passes the various signals and voltages to the other components and houses the DC-DC converters (±15V, 8V, and 250V) used to power the electronics.

1.5. Filter Selection

The three IR bandpass filters for the three channels are chosen according to the application. See Table 1-2 for the approximate wavelengths and functions.

Table 1-2 Wavelengths and Functions

Channel	Wavelength	Function
REF	1.8 microns	Correction for effect of basis weight, dirt, drift, etc.
MES	1.9 microns	Measurement of absorption by water
3RD	1.7 microns	Correction for sheet temperature

Sheet temperature influences all IR moisture sensors to some degree because the absorption spectrum of water shifts with temperature. The shift results from the fact that water molecules tend to group together, and the number of molecules in a group influences the absorption spectrum of the molecules.

At higher temperatures, fewer molecules group together, causing the absorption to shift to lower wavelengths. The sheet temperature effect is minimized by carefully balancing the REF and MES filters. If required, the 3RD channel can provide an additional compensation for sheet temperature effect. The 3RD channel compensation is calibrated using glass-encased paper samples measured both at room temperature (about 22°C) and at 60°C.

1.6. Specifications

Model number

The high-power sensor marketing model number is Q4287-57. The hardware model number is 092235-57.

Basis Weight Range

The sensor may be used for basis weight up to 1000 gsm for clean furnish. For furnish containing elemental carbon from recycle or as a pigment, or iron oxide as a pigment, the basis weight range may be reduced.

Moisture Range

The standard ranges are 2 to 10% or 12% moisture. Higher ranges are special and will further restrict the basis weight range and degrade the accuracy.

Repeatability

2•Sigma = ±0.1% moisture on stirred bagged samples (if heated, moisture in a sample may redistribute, thereby degrading repeatability).

Static Accuracy

2•Sigma = ±0.25% for well-made bagged calibration samples with moisture content ranging from 2% to 10%. When elemental carbon or iron oxide is present, accuracy may be degraded to 2•Sigma ≤ ±0.50%. Above 12% moisture, accuracy is also degraded to 2•Sigma = ±0.02•Sheet Moisture, or in the presence of carbon, 2•Sigma = ±0.04•Sheet Moisture.

This accuracy includes not only sensor error, but also calibration, sampling, and lab errors.

Dynamic Accuracy

Dynamic accuracy is the same as static accuracy or 2•Sigma ≤ ±0.50%, whichever is higher.

This accuracy includes not only sensor error, but also calibration, sampling, and lab errors.

Flutter Sensitivity

Normally negligible for the heavy grades measured with the HPIR sensor.

Sensitivity to Basis Weight

Sensitivity to Basis Weight is negligible for variations within a grade. Between grades, it is also usually negligible. Basis weight sensitivity is normally removed in the calibration by the SingleCal correction.

Sensitivity to Coatings, Additives, and Furnish

Sensitivity to coatings, additives, and furnish is negligible for variations within a grade. Between grades, it is also usually negligible (rarely more than ±0.30%).

Carbon Effect

When used on paper containing elemental carbon (from recycle or added as a pigment), or on paper containing iron oxide as a pigment, the sensor may read substantially low if not corrected by Carbon Correction. Calibration of Carbon Correction is normally performed with papers made with different levels of carbon or iron oxide.

Streak Sensitivity

70% of response is from 2.5 cm (1 inch) width in cross direction.

Sample Averaging

70% of response is from 5 cm (2 inches) in machine direction.

Stratification Sensitivity

Less than ±0.25% moisture.

Response Time

The response time is 5 ms and cutoff frequency is 70 Hz for the high power sensor.

Sensor Temperature Sensitivity

<0.1% moisture/10°F

Sheet Temperature Sensitivity

Sheet temperature dependence is less than ±0.003% moisture/°C.

Dynamic Moisture Loss

The flashoff (evaporation with accompanying heat loss) between the reel scanner and take-up reel is normally corrected in the software with Dynamic Correction.

A temperature loss of 23°F (12.8°C) is typically accompanied by a loss of 1% moisture due to flashoff. Typical moisture loss for board is 0.25% to 0.5% moisture.

Sensor Window Cleanliness

The software contains the provision for correcting the effect of dirt buildup on the windows. However, the dirt effect is negligible for most HPIR applications.

Gap (Z) Sensitivity

To correct for normal scanner gap variations, the software contains the provision for correcting the moisture sensor reading using the Z-Sensor. However, the effect is usually negligible for most HPIR applications.

Edge-of-Sheet

The sensor reads slightly low at the edge due to some light going around the sheet. Typically, a sensor reads low by no more than 0.50% up to 1.5 inch (3.75 cm) from the edge for board and pulp sheet.

Power Requirements

Both heads require 24 VDC. The source dissipates about 150W; the receiver also dissipates about 20W.

2. Sensor Components

2.1. Hardware description

2.1.1. High Power Source Assembly

Figure 2-1 through Figure 2-6 show the High Power Source Assembly.

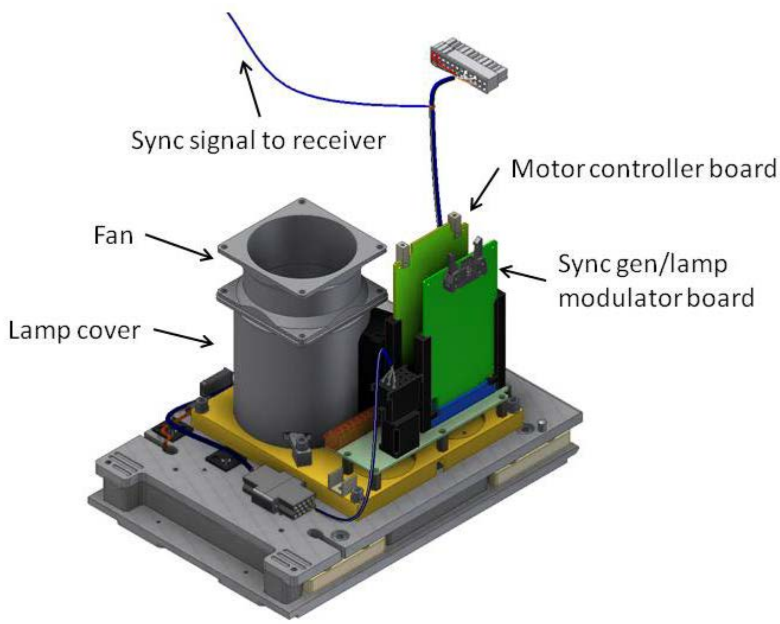


Figure 2-1 High Power Source Assembly

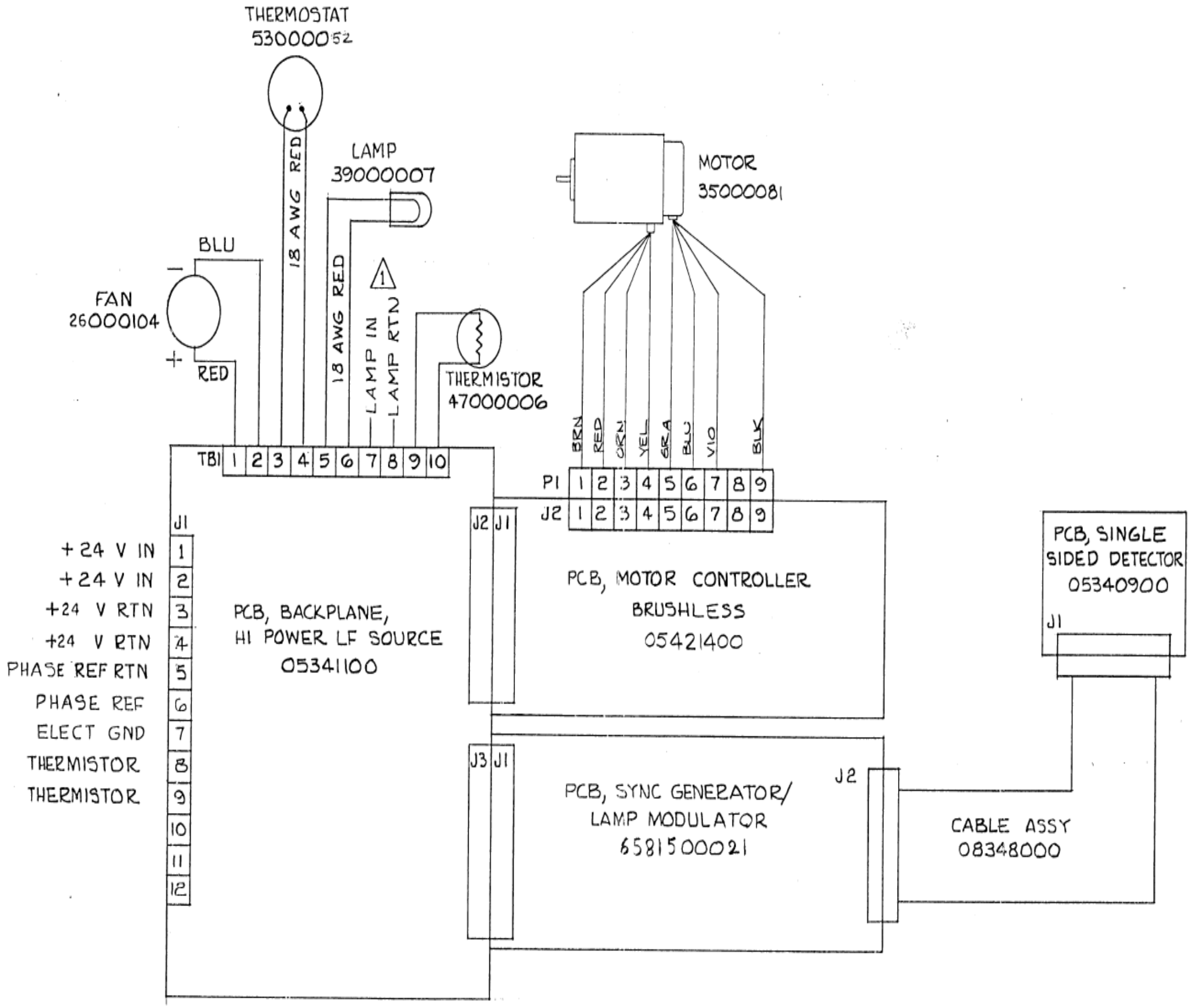


Figure 2-2 High Power Source Assembly Schematic

2.1.1.1. High Power Source Backplane board

See Figure 2-3 for a photograph of the High Power Source Backplane board.

The source backplane board provides power to the lamp, the motor controller board and the sync gen and modulator board. Check for 24 ± 0.5V at TB1-1 (+24) and TB1-2 (RTN) on the Backplane.

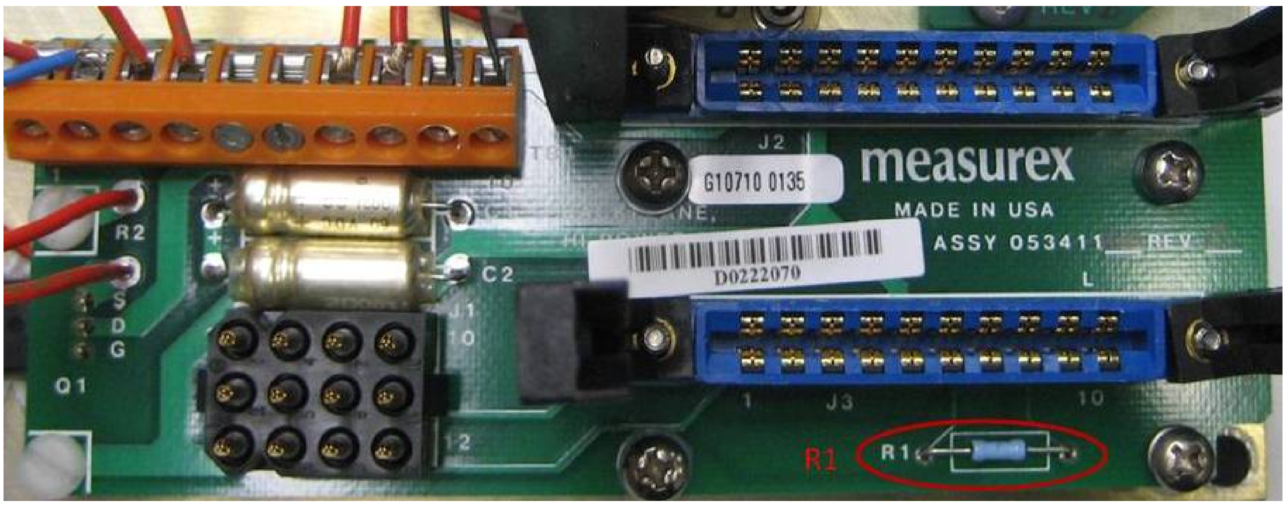


Figure 2-3 High Power Source Backplane Board

2.1.1.2. Sync Generator/Lamp Modulator Board

See Figure 2-4 for a photograph of the Sync Gen/Lamp Modulator board. To check the board operation, connect oscilloscope probes to TP3 and TP4 with TP5 as ground. TP3 should give a clean square wave, which indicates clear detection of the chopper wheel position by the Single-Sided Detector. See Figure 2-5 for a photograph of the Single-Sided Detector board.

TP4 should give narrow clock pulses generated from the small holes in the wheel. Amplitudes should be about 9V. If the signals are not clean or of adequate magnitude, adjust the three spring-loaded mounting screws on the Single-Sided Detector to correct the signals (Figure 2-5).

TP2 should give a clean square wave of 10V amplitude. The frequency is 170 Hz (period 5.88 ms) +/- 25 Hz. If necessary, the frequency can be adjusted using the pot on top of the Motor Controller board (R2). See Figure 2-6 for a photograph of the Motor Controller board.

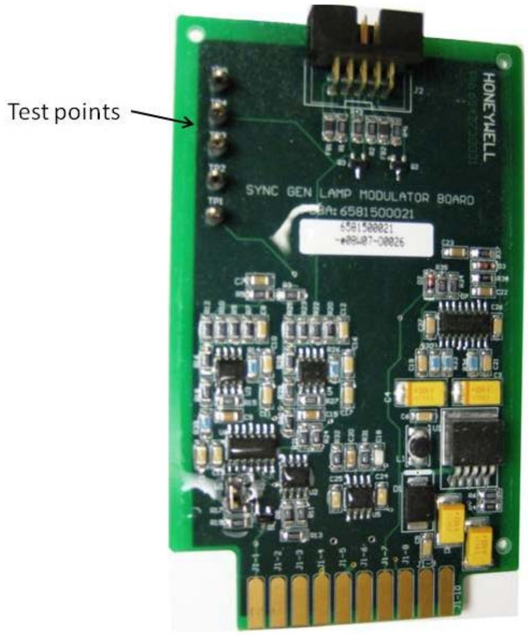


Figure 2-4 Sync Gen/Lamp Modulator Board

2.1.1.3. Alternate Lamp Power

For most applications, the lamp is powered directly by the 24 VDC power supply (HPIR Source Backplane TB1-5 and -6).

In applications where less lamp power is desirable, the lamp may be powered with pulse-width-modulated 24 Volts. In this case, the lamp connects to TB1-7 and TB1-8. Power is supplied by the Sync Generator/Lamp Modulator PCB, which uses resistor R1 located on the source backplane to determine the power delivered to the lamp (Figure 2-3). Make a note if your lamp is powered in this way and make a note of the value of R1.

The standard value is 3.9 KOhms, which powers the lamp at 80%. An R1 value of 10 KOhms powers the lamp at 40% of normal power.

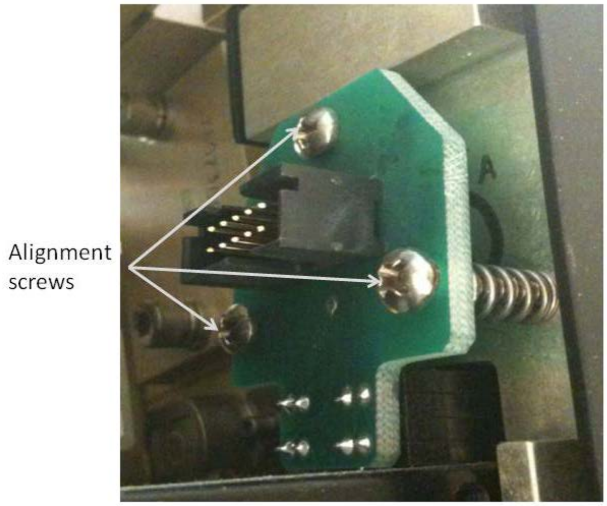


Figure 2-5 Single-Sided Detector Board (harness removed)

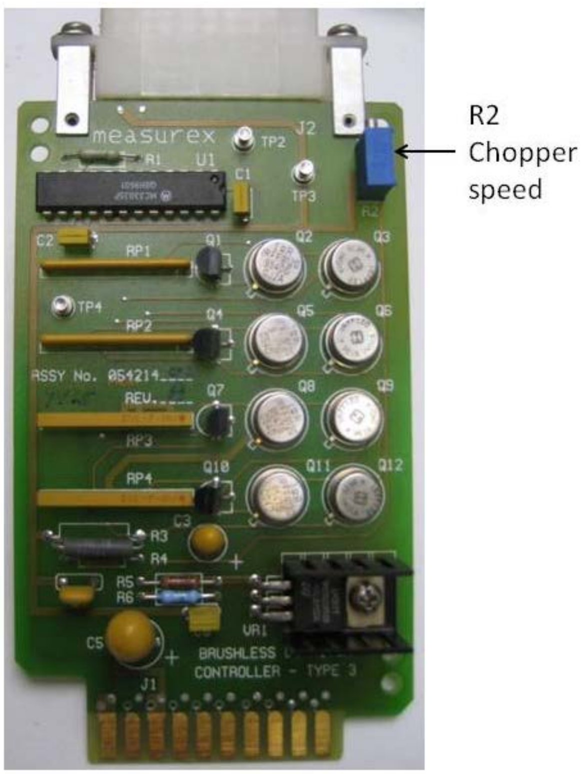


Figure 2-6 Motor Controller Board

2.1.2. Receiver Assembly

Figure 2-7 through Figure 2-10 show the Receiver Assembly. Figure 2-7 is the assembly schematic. Figure 2-9 summarizes the test points.

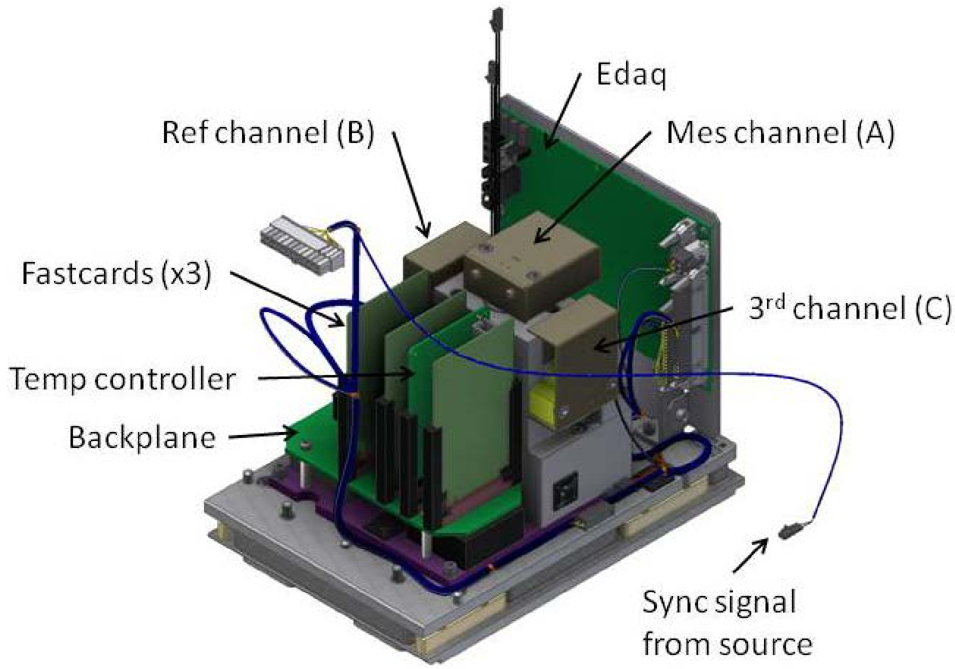


Figure 2-7 IR Receiver Assembly

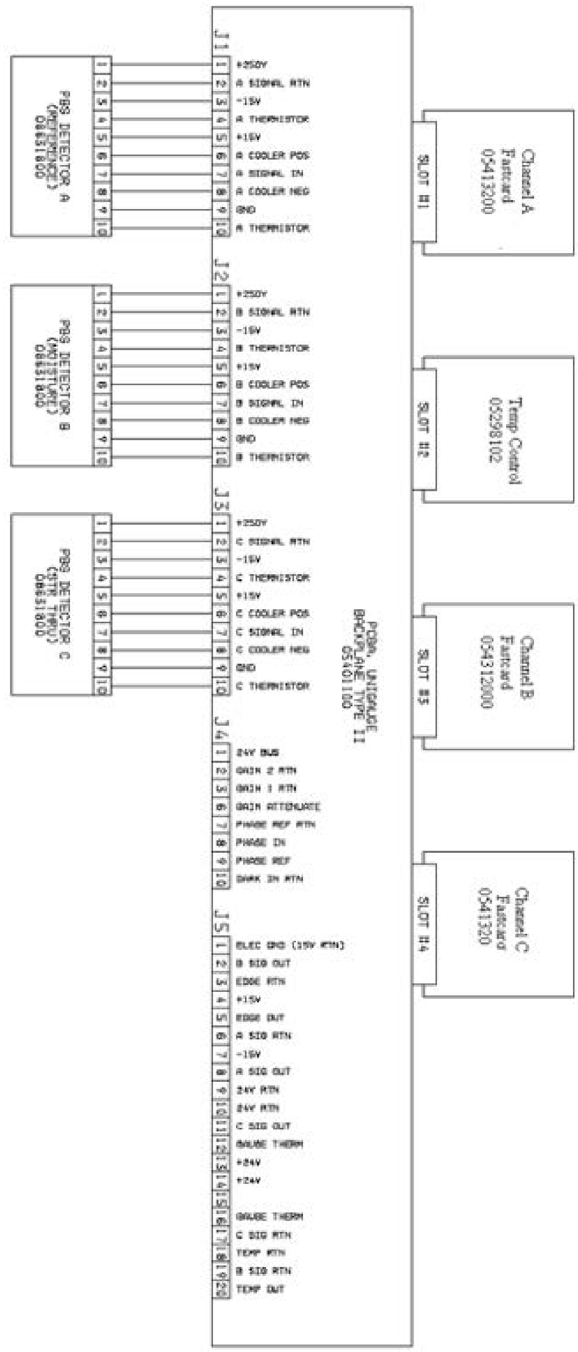
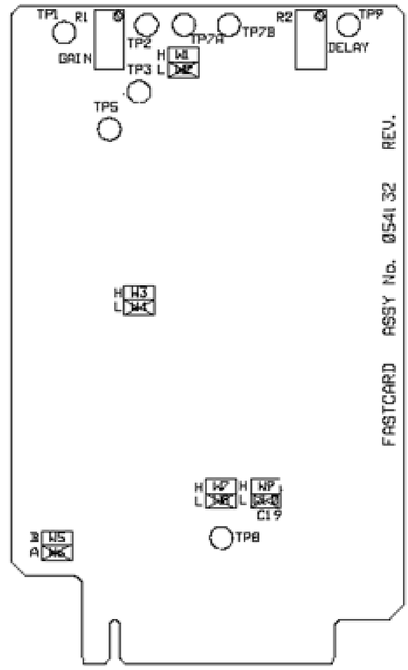


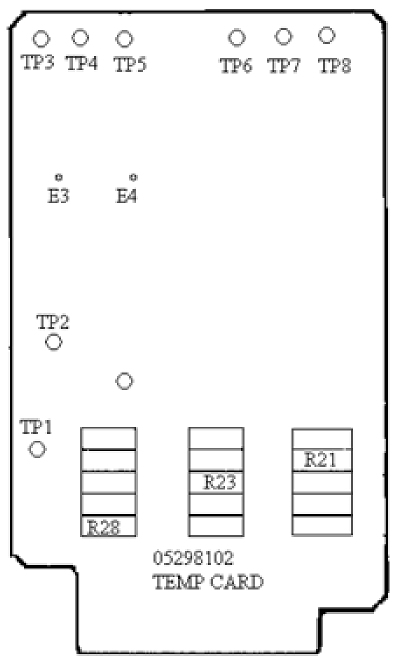
Figure 2-8 IR Receiver Assembly Schematics

Fastcard Board



TP1 GND
TP2 Preamp Signal
TP3 Amplified Signal
TP7A-TP7B Phase Signal
TP8 Added Phase Signal
TP9 Output
W1/W2, W3/W4, W7/W8, W9/W10
High/Low (Standard) Power
W5/W6 Phase A/B

Temperature Control Board



TP1 GND
TP2 Sensor Temperature =15V
TP3-TP4 Cooler A, 0.4 to 0.8 VDC
TP4-TP5 A Control, >0.8 VDC
TP5-TP6 Cooler C, 0.4 to 0.8 VDC
TP6-TP7 C Control, >0.8 VDC
TP7-TP8 Cooler B, 0.4 to 0.8 VDC
TP8-Gnd B Control, >0.8 VDC

Figure 2-9 Receiver Test Points

2.1.2.1. Backplane Assembly, Type II

See Figure 2-10 for the Backplane Assembly, Type II.

To confirm that the backplane is generating the proper voltages:

1. Check the input voltage at the two pins of the DC-DC converter at the front of the Backplane. It should read 24 ± 0.5 VDC.
2. Check the voltage between TP3 on the Temperature Control board and ground TP1 on the Backplane. It should read 8.0 ± 0.5 VDC.
3. Check that there is 250 ± 5 VDC between TP8 (the protected red test point) and TP1.
4. Check the ±15 VDC by removing the Temperature control board and the first two Fastcard boards (A and B), and testing the +15 ± 0.5 VDC and -15 ± 0.5 VDC indicated outputs from the middle DC-DC converter, using TP1 as ground. Replace the boards in their appropriate slots.

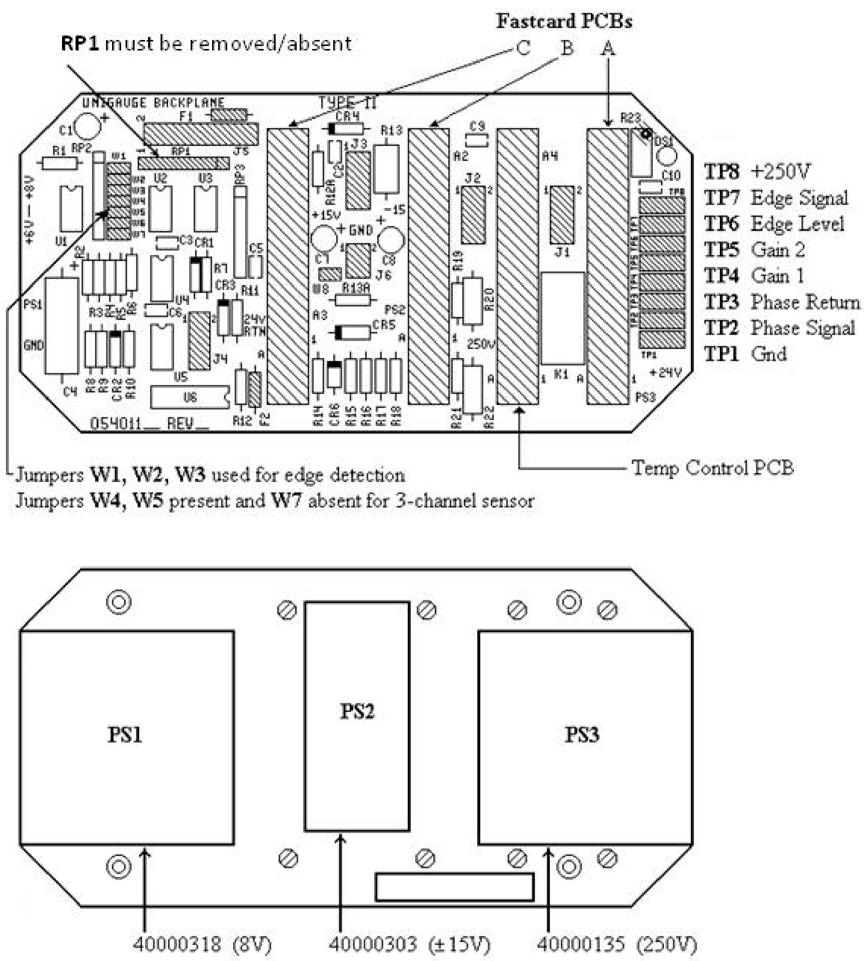


Figure 2-10 Unigauge Backplane Board, Type II

2.1.2.2. Temperature Control Board

This board controls the temperature of the PbS chips to a few degrees above freezing. With this board and all three Detector Preamps plugged in, check the voltages supplied to the three Peltier coolers. The test points are on the temperature control board (See Figure 2-9).

They should be between 0.4 and 0.8 VDC:

- Cooler A (REF) channel, TP3(+) to TP4
- Cooler B (MES) channel, TP7(+) to TP8
- Cooler C (3RD) channel, TP5(+) to TP6

2.1.2.3. Fastcard board

The Fastcard board demodulates the AC signal from the PbS detector module and produces a DC signal which is sent to the EDAQ for digitization. The layout of the Fastcard board is shown in Figure 2-9. The sensor uses a PbS detector assembly and an associated Fastcard for each channel. See Section 9.10 for the Fastcard board alignment procedure.

2.1.2.4. Edge detection

In a few systems, the IR sensor is used for detecting the edge of the sheet during scanning. In such cases, a jumper on the Unigauge Backplane, Type II, is placed into either W1, W2 (default), or W3 to select the channel (REF, MES, or 3RD, respectively) from which the edge detect is taken.

To adjust the edge detection:

1. Bring a sheet of the paper (for example, the lightest grade) into the gap so that its edge is at the cross-direction midpoint of the source spot on the sensor window.
2. Connect a voltmeter between TP7 (+) and TP1 (Gnd) of the Unigauge Backplane.
3. Adjust R23 so that TP7 is high (13 to 15 VDC) when the sheet is out of the beam, and goes low (0 to 1 VDC) when the sheet passes the middle of the beam.

2.1.2.5. Detector and filter locations

See Figure 2-7 for the standard locations of the PbS Detector Assemblies for the three channels. During installation, be sure to check the configuration you have and note it on the figure for future reference.

2.2. Software description

The HPIR Moisture Measurement sensor uses Real-Time Application Environment (RAE) software on an Experion MX System.

2.2.1. Inputs and outputs

There are three analog voltage outputs, corresponding to the three channels: REF, MES, and 3RD.

There are five contact inputs (24 VDC relay or solenoid): DARK, GAIN1, GAIN2, GAIN ATTENUATE, and FLAG.

- DARK zeroes the inputs from the three detectors to allow the software to read the offset due to the electronics for subtraction from all subsequent readings.
- GAIN1 provides an analog gain of about 2.85 to the 3 input signals.
- GAIN2 provides an analog gain of about 9.8 to the 3 input signals. These gains are used to increase the signal levels for heavier grades of paper.
- GAIN ATTENUATE reduces the voltage on the PbS detectors and thus reduces the signals by about a factor of 10 to 20. GAIN ATTENUATE is used to assist in measurement of the precise gains of the GAIN1 and GAIN2 functions during Background.
- FLAG inserts a strongly attenuating flag into the Receiver beam during Background, Standardize, and Offsheet, and for some grades while measuring in Sample, Onsheet, and Single Point modes.

2.2.2. Background

Background is scheduled periodically (typically every 8 to 24 hours) to measure the dark offsets and analog gain factors for subsequent correction of the readings. There are 4 phases to background, as shown in Table 2-1.

Table 2-1 Background Phases

Phase		Contact Output Set	REF Reading in Volts	MES Reading in Volts	3^{RD} Reading in Volts
1	Read, Store dark offsets	DARK GAIN ATTEN FLAG	Dark volt	Dark volt	Dark volt
2	Read Gain0 Phase	GAIN ATTEN FLAG	$Gain0_{REF}$	$Gain0_{MES}$	$Gain0_{3RD}$
3	Read Gain1 Phase	GAIN ATTEN GAIN1 FLAG	$Gain1_{REF}$	$Gain1_{MES}$	$Gain1_{3RD}$
4	Read Gain2 Phase	GAIN ATTEN GAIN2 FLAG	$Gain2_{REF}$	$Gain2_{MES}$	$Gain2_{3RD}$

The results from phases 2, 3, and 4 are combined to calculate the analog gains for GAIN0, GAIN1, GAIN2, and GAIN3, respectively. These are typically 1, 2.85, 9.8, and about 28:

$$\mathrm{GAIN0} = 1$$

$$\mathrm{GAIN1} = \mathrm{Gain1} / \mathrm{Gain0}$$

$$\mathrm{GAIN2} = \mathrm{Gain2} / \mathrm{Gain0}$$

$$\mathrm{GAIN3} = (\mathrm{GAIN1}) \bullet (\mathrm{GAIN2})$$

After dark offset correction the analog Gains for the respective phases are calculated and stored for subsequent corrections like gain-compensated channel ratios.

These results are displayed on the scanner diagnostics display and in the sensor report of the Experion MX System when the background report is selected.

$$\mathrm{GAIN0}_{\mathrm{REF}} = \mathrm{Gain0}_{\mathrm{REF}} \quad \mathrm{GAIN0}_{\mathrm{MES}} = \mathrm{Gain0}_{\mathrm{MES}} \quad \mathrm{GAIN0}_{\mathrm{3RD}} = \mathrm{Gain0}_{\mathrm{3RD}}$$

$$\mathrm{GAIN1}_{\mathrm{REF}} = \frac{\mathrm{Gain1}_{\mathrm{REF}}}{\mathrm{Gain0}_{\mathrm{REF}}} \quad \mathrm{GAIN1}_{\mathrm{MES}} = \frac{\mathrm{Gain1}_{\mathrm{MES}}}{\mathrm{Gain0}_{\mathrm{MES}}} \quad \mathrm{GAIN1}_{\mathrm{3RD}} = \frac{\mathrm{Gain1}_{\mathrm{3RD}}}{\mathrm{Gain0}_{\mathrm{3RD}}}$$

$$GAIN2_{REF} = \frac{Gain2_{REF}}{Gain0_{REF}} \quad GAIN2_{MES} = \frac{Gain2_{MES}}{Gain0_{MES}} \quad GAIN2_{3RD} = \frac{Gain2_{3RD}}{Gain0_{3RD}}$$

$$GAIN3_{REF} = (GAIN1_{REF}) \bullet (GAIN2_{REF})$$

$$GAIN3_{MES} = (GAIN1_{MES}) \bullet (GAIN2_{MES})$$

and

$$GAIN3_{3RD} = (GAIN1_{3RD}) \bullet (GAIN2_{3RD})$$

These values are multiplied by GFLAG for grades for which the flag is selected to be out during onsheet measurements.

Table 2-2 Gain Factors

GAIN	REF	MES	3RD
0	1	1	1
1	$GAIN1_{REF}$	$GAIN1_{MES}$	$GAIN1_{3RD}$
2	$GAIN2_{REF}$	$GAIN2_{MES}$	$GAIN2_{3RD}$
3	$GAIN3_{REF}$	$GAIN3_{MES}$	$GAIN3_{3RD}$

The typical values of these gains are 1, 2.85, 9.8, and 28, respectively.

These Gain factors are stored and used in calculating the Gain Compensated channel ratio of the REF, MES, and 3RD. The raw ratio values, RN and RN2, are explained in detail in Section 2.3 and Section 2.4.

2.2.3. Gain and Flag contact output patterns

The sensor analog Gain and Flag contact outputs are grade-dependent. The gain and flag settings are used to ensure that the signals onsheet are not too low and not too high.

Signals that are too high may saturate the electronics and have a dramatic effect on the measurement accuracy. Set the gain settings so the channel voltages on-sheet read 8 Volts or less.

Low voltages are typically less of a concern as signals are digitized right at the sensor by the Sensor EDAQ.

2.3. Reference/Standardize

A Reference or a Standardize are identical operations. The term Reference is used when it is manually requested in Maintenance mode, while a Standardize is scheduled periodically during sensor scanning in Production mode. These functions consist of: taking a reading on an empty gap to correct Sample and Onsheet readings for dirt buildup on the sensor windows, electronic drift, lamp brightness changes, and so on. The flag in the receiver assembly is inserted to prevent saturation of the electronics.

The reference (or standardize) measurement gives the net open volts (Dark volt subtracted measurements) for the three channels. These net open volts are stored and used in determining the gain-compensated channel ratios of REF, MES, and 3RD, which are explained in Section 2.4.

Standardize ratios are also calculated from the net open volts:

$$\mathrm{RS} = \frac{\mathrm{REF}}{\mathrm{MES}} \qquad \mathrm{RS2} = \frac{\mathrm{REF}}{\mathrm{3RD}}$$

According to the gain and Flag selection, the analog REF gain factor (REFGR) is calculated.

$$\mathrm{REFGR} = \mathrm{GAIN}_{\mathrm{REF}} \bullet \mathrm{GFLAG}$$

The Gain value is multiplied by GFLAG for grades for which the FLAG is selected to be out during Sample/Onsheet measurement. Here GFLAG is a calibration constant and is equal to the attenuation factor of the flag.

The REFGR value is subsequently used in carbon correction and dirt correction.

The value DIRTY is calculated for subsequent use in Dirt correction. The DIRTY calculations are defined as Ratios of time-zero REF to now REF, time-zero MES to now MES, and time-zero 3RD to now 3RD, respectively.

In the next equation, T0 REF is a time-zero constant, which is the REF channel measurement at the calibration time.

$$\mathrm{DIRTY} = \frac{\mathrm{T0\ REF}}{\mathrm{REF}} - 1$$

The sensor report displays the Dark volts, the net open volts of the three channels, and the ratios of the three channels to their time-zero calibration values respectively when a reference report is requested. This ratio is stored for subsequent use in Dirt correction. It also displays the standardize ratios: RS and RS2.

The values of RS and RS2 are compared with their time-zero calibration values: RS0 and RS20. If the absolute value of the difference between the now and time-zero values drift by more than the allowed limits (default .05), an alarm is generated.

2.4. Sample/Onsheet

The Sample and Onsheet readings involve several optional correctors.

For temporary usage, these correctors can be enabled or disabled by choosing them in the recipe-based options in the **Sensor Maintenance** display.

For permanent storage, these have to be set up in the grade codes through the MOIP configuration table in the **Recipe Maintenance** display.

A sample operation request displays the measurement of the REF, MES, and 3RD channels in net volts. These measurements are used to determine the channel ratios of the RES, MES, and 3RD.

The channel ratios of the REF, MES, and 3RD are defined as:

$$\text{Channel Ratio REF} = \frac{\text{REF}_{\text{Standardize}}}{\text{REF}_{\text{Sample}}}$$

$$\text{Channel Ratio MES} = \frac{\text{MES}_{\text{Standardize}}}{\text{MES}_{\text{Sample}}}$$

$$\text{Channel Ratio 3RD} = \frac{\text{3RD}_{\text{Standardize}}}{\text{3RD}_{\text{Sample}}}$$

Based on the GAIN selection, Gain-compensated channel ratios are further computed as:

$$\text{Gain Compensated Channel Ratio REF} = (\text{Channel Ratio REF}) \bullet (\text{GAIN}_{\text{REF}})$$

$$\text{Gain Compensated Channel Ratio MES} = (\text{Channel Ratio MES}) \bullet (\text{GAIN}_{\text{MES}})$$

$$\text{Gain Compensated Channel Ratio 3RD} = (\text{Channel Ratio 3RD}) \bullet (\text{GAIN}_{\text{3RD}})$$

The raw ratios are defined as:

$$\text{RN} = \frac{\text{Gain Compensated Channel Ratio MES}}{\text{Gain Compensated Channel Ratio REF}} \bullet \text{GFLAG2}$$

$$\text{RN2} = \frac{\text{Gain Compensated Channel Ratio 3RD}}{\text{Gain Compensated Channel Ratio REF}} \bullet \text{GFLAG3}$$

GFLAG 2 and GFLAG3 are corrections made to the raw ratios for grades for which the flag is selected to be out during Sample, Onsheet, and Single Point measurement to correct for its effect. GFLAG2 and GFLAG3 are calibration constants (see Section 2.5).

$$\text{REFA} = \frac{\text{REF}_{\text{Sample}}}{\text{REF}_{\text{Standardize}} \bullet \text{REFGR}} = \frac{\text{REF}_{\text{Sample}}}{\text{REF}_{\text{Standardize}} \bullet \text{GAIN}_{\text{REF}} \bullet \text{GFLAG}}$$

The principal measurement comes from the ratio RN-1, which is proportional to the water weight. To make the measurement more accurate under a wide variety of conditions, correctors are applied sequentially. At each stage, a corrected Ratio minus one is calculated and displayed on the **Sensor Maintenance** display. The final corrected value is called RCOR-1; and it is used to calculate the water weight. The calculations for moisture are defined in the next sections.

2.4.1. Gap (Z) correction

The formula for Z-Correction is:

RZ-1 = (RN-1) • [1+ZCR1 • (ZCR2+REFA) • (Zmm/ZmmST-1)]

RZ2-1 = (RN2-1) • [1+ZCR3 • (ZCR4+REFA) • (Zmm/ZmmST-1)],

where ZCR1, ZCR2, ZCR3 and ZCR4 are calibration constants, Zmm and ZmmST are the Z values now and at standardize, respectively.

2.4.2. Dirt correction

The formula for Dirt Correction is:

RD-1 = (RZ-1) • (1+KDTY • DIRTY • REFA)

RD2-1 = (RZ2-1) • (1+KDT2 • DIRTY •REFA),

where KDTY and KDT2 are calibration constants.

2.4.3. Sheet temperature correction

The algorithm for Sheet Temperature Compensation is Honeywell confidential. It uses the ratios RD and RD2, the calibration constants TCR1, TCR2, TCR3, and TCR4, and produces the ratio RT.

2.4.4. HiCurve correction

$$RH - 1 = \left[\frac{RT}{(1 + CURV \bullet RT)} \right] - 1,$$

where CURV is a calibration constant.

2.4.5. SingleCal (Basis Weight) correction

The algorithm for SingleCal Correction is Honeywell confidential. It uses the ratio RH, the basis weight in gsm, the calibration constants BBB and CCC, and produces the ratio RS-1. The calibration constants FFF and BWMIN are no longer used for SingleCal.

2.4.6. Low Curve correction

The Low Curve (Breakpoint) correction is used in a few low moisture applications. If RS<RBRAK (the breakpoint), then:

$$RL - 1 = RS - \frac{DDD \bullet (RBRAK - RS)}{AAA \bullet (RBRAK - 1)} - 1,$$

where AAA and DDD are calibration constants.

2.4.7. Carbon correction

The algorithm for Carbon Correction is Honeywell confidential. It uses the ratios RL-1 and REFA, the basis weight in gsm, the calibration constants C2, C3, and GGG, and produces the ratio RK-1. The final corrected ratio is:

RCOR-1 = RK-1

2.4.8. Water weight

The water weight in gsm is calculated as:

$$\mathrm{WW} = \mathrm{DDD} + \mathrm{AAA} \bullet (\mathrm{RCOR\ \text{-}1})$$

2.4.9. Static percent moisture

The static percent moisture is calculated as:

MSTAT = 100 • WW/BW,

where BW is the basis weight in gsm.

During Sample mode, this is the entered basis weight target; onsheet, it is the current slice value. MSTAT is the percent moisture value reported in the Sample mode.

2.4.10. Dynamic percent moisture

Onsheet there is also the Dynamic Correction for flashoff (evaporation) from the sheet between the scanner and the reel:

$$\mathrm{MDYN} = \mathrm{MSTAT} \bullet [\mathrm{DMAE} - \mathrm{KAYE} \bullet (\mathrm{TEESH} - \mathrm{TOSH})] - \mathrm{DMBE},$$

where TEESH is the temperature value from the Sheet Temperature sensor or from the Air Gap Temperature sensor and DMAE, KAYE, TOSH and DMBE are calibration parameters.

2.5. Calibration constants

2.5.1. Time-Zero (Calibration Time) Constants

Table 2-3 shows the time-zero moisture calibration constants determined in the factory from empty-gap Standardize or Reference. These are typical values for the Standardize measurements.

Check and re-determine these measurements in the field at installation or when the sensor is aligned or repaired.

Table 2-3 Time-Zero Moisture Calibration Constants

Name	Typical value	Description
T0 REF	7.0 to 8.0V	REF net volts at time zero
T0 MES	7.0 to 8.0V	MES net volts at time zero
T0 3RD	7.0 to 8.0V	3RD net volts at time zero
RS0	1.00 ± 0.07	Standardize ratio of REF/MES at time zero
RS20	1.00 ± 0.07	Standardize ratio of REF/3RD at time zero
GFLAG	100 ± 5	FLAG Attenuation
GFLAG2	1.00 ± 0.1	FLAG Corrector
GFLAG3	1.00 ± 0.1	FLAG Corrector

2.5.2. Static Moisture Calibration Constants

Table 2-4 shows the static moisture calibration constants determined in the factory calibration. Normally, only AAA and DDD should be re-determined in the field.

Table 2-4 Static Moisture Calibration Constants

Name	Range	Description
AAA	0.5 to 20	Water weight slope
DDD	±10	Water weight intercept
BBB	±0.01	SingleCal primary corrector

Name	Range	Description
CCC	±100	SingleCal secondary corrector
CURV	±0.3	HiCurve Correction
TCR1	±10	Temperature correction primary corrector
TCR2	0.5 to 1.1	Temperature correction R2 offset
TCR3	±1	Temperature correction secondary corrector
TCR4	±1	Temperature correction secondary corrector
C3	20 to 200	Carbon Correction scale factor
C2	-1000 to 200	Carbon Correction basis weight offset
GGG	0 to 1.25	Carbon Correction primary corrector

C2 must be outside of the basis weight range in gsm (that is, either negative or less than the minimum basis weight, or greater than the maximum basis weight).

2.5.3. Correctors Determined On-Site

Table 2-5 shows the calibration constants normally determined or entered on site.

Table 2-5 Calibration Constants Entered On-Site

Name	Default	Description
DMBE	0	Dynamic intercept corrector
DMAE	1	Dynamic slope corrector
KAYE	0	Dynamic temperature corrector
T0SH	38ºC	Temperature at static cal (Dynamic temp)
ZCR1	0.5	Z-correction for RN
ZCR2	0.6	Z-correction for RN
ZCR3	-0.5	Z-correction for RN2
ZCR4	0.6	Z-correction for RN2
KDTY	0.3	Dirt correction for RN
KDT2	0.3	Dirt correction for RN2

For the recommended values for dynamic correctors, see Subsection 6.3.3.

For the recommended values for Z Correction, see Subsection 6.3.4.1.

For the recommended values for Dirt Correction, see Subsection 6.3.4.2.

3. EDAQ

The 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 MSS by Ethernet.

The EDAQ contains sensor-specific code for all sensors. All EDAQs, including the frame controller (FC) EDAQ (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 FC expansion board.

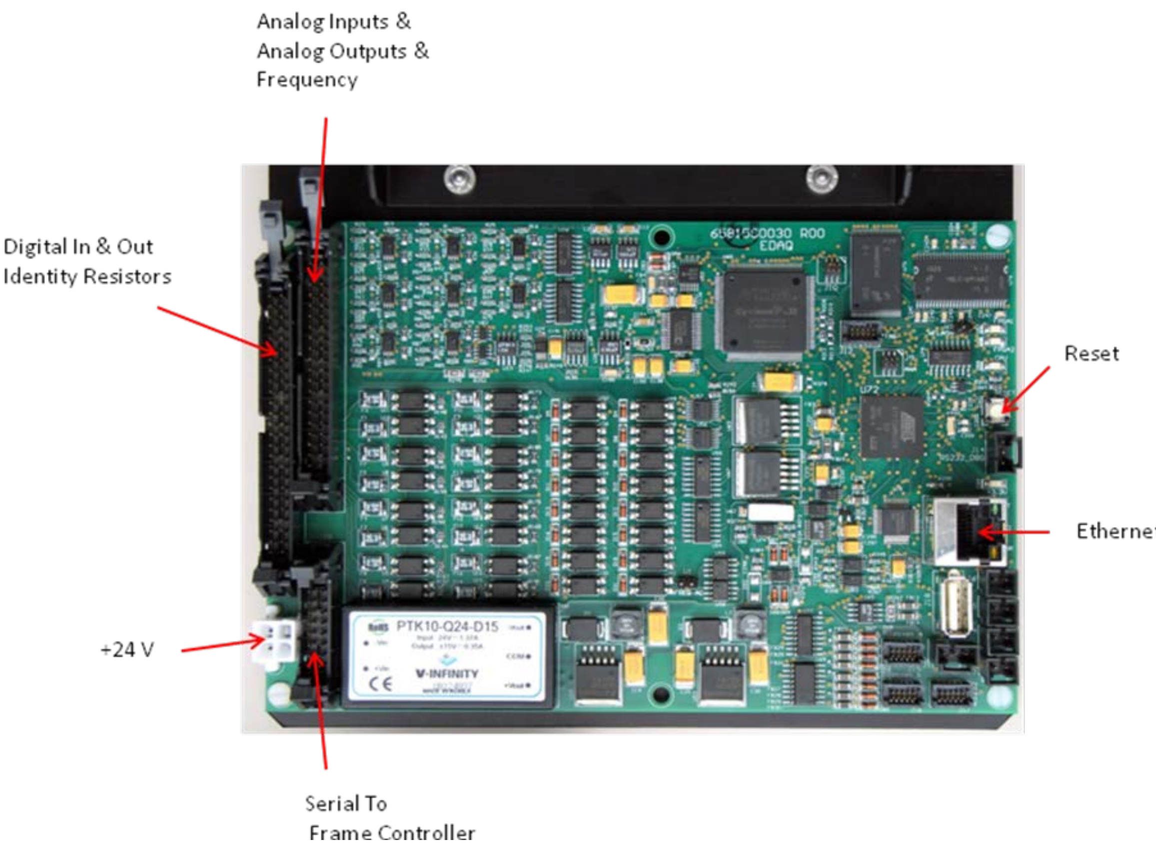


Figure 3-1 EDAQ Board

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 the debug port and the RS-232 of any neighboring EDAQ.

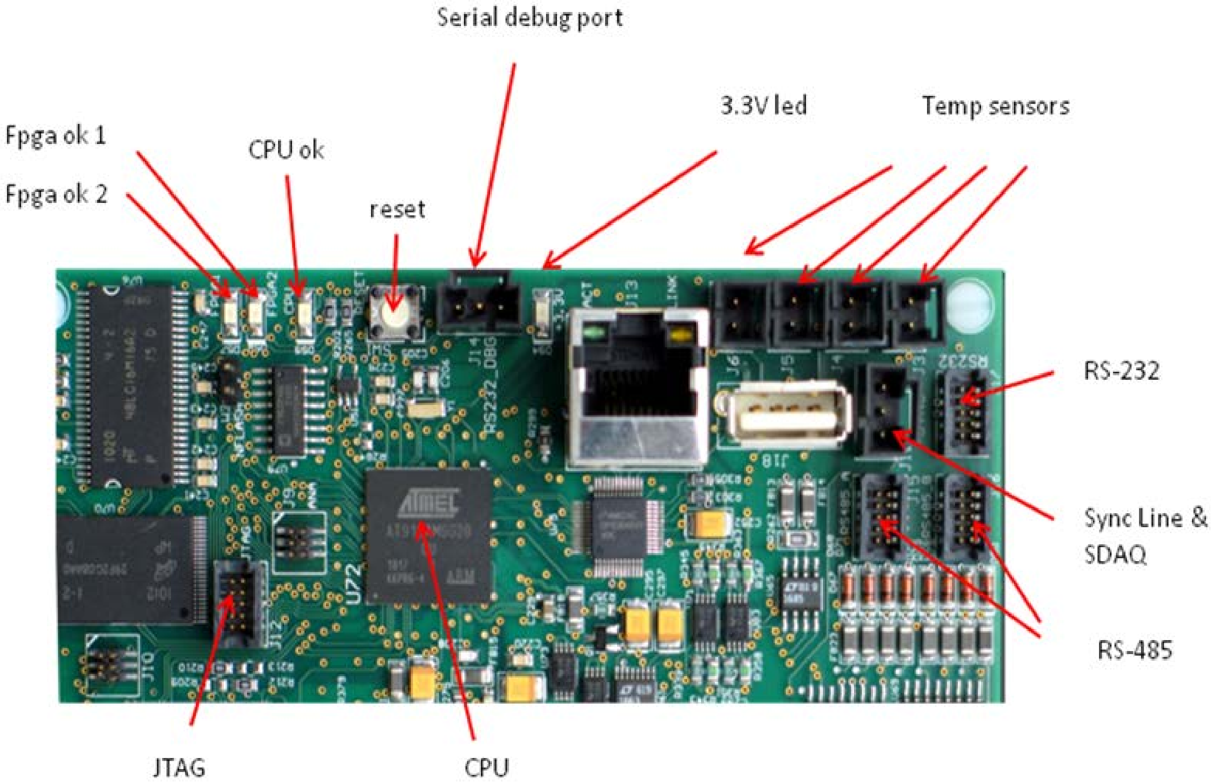


Figure 3-2 EDAQ Board: Ports and Diagnostic LEDs

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.

The Ethernet connector contains two LEDs:

- amber indicating a good link to the switch
- green indicating 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 the EDAQ if it 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 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 when 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** display).

On the left side of the **MSS Summary** display, as shown in Figure 3-3, is the list of expected EDAQs with three types of status indicators (from left to right).

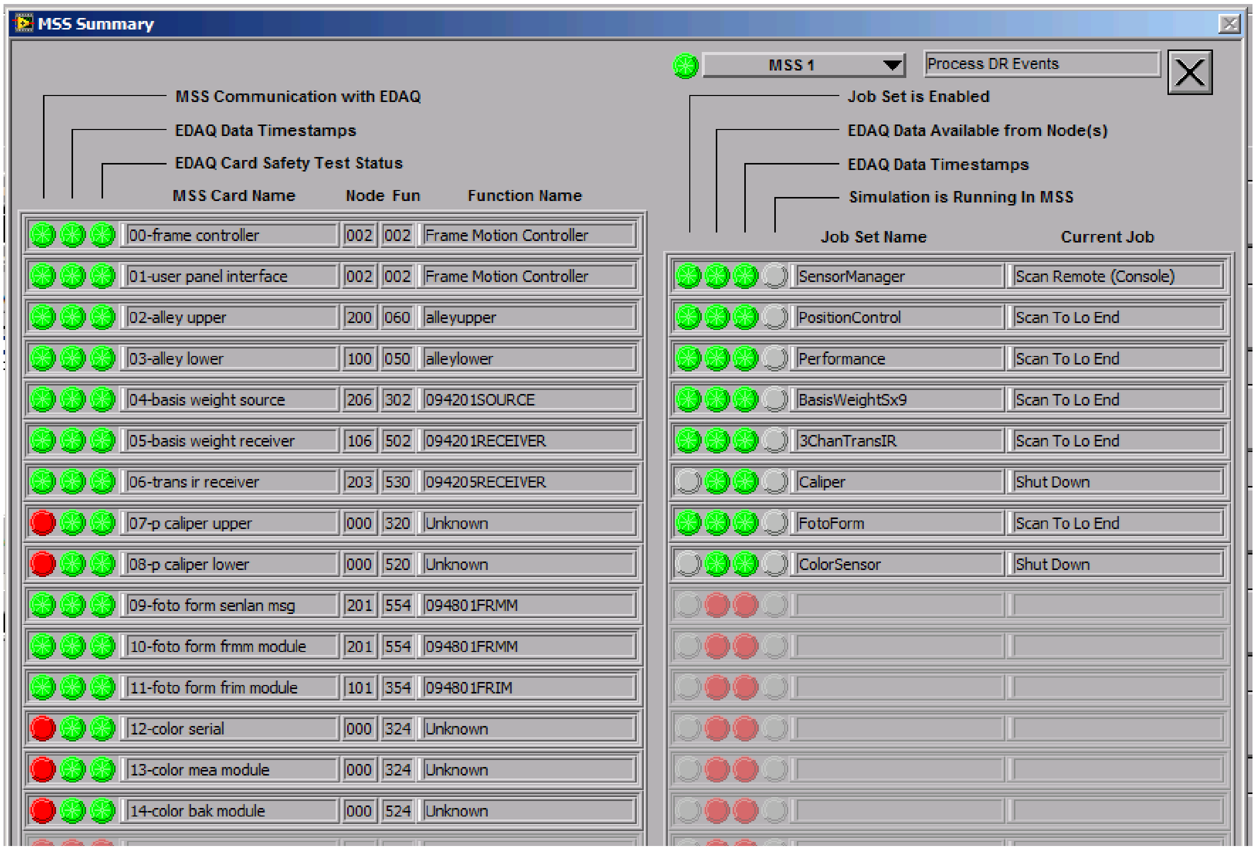


Figure 3-3 MSS Summary

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

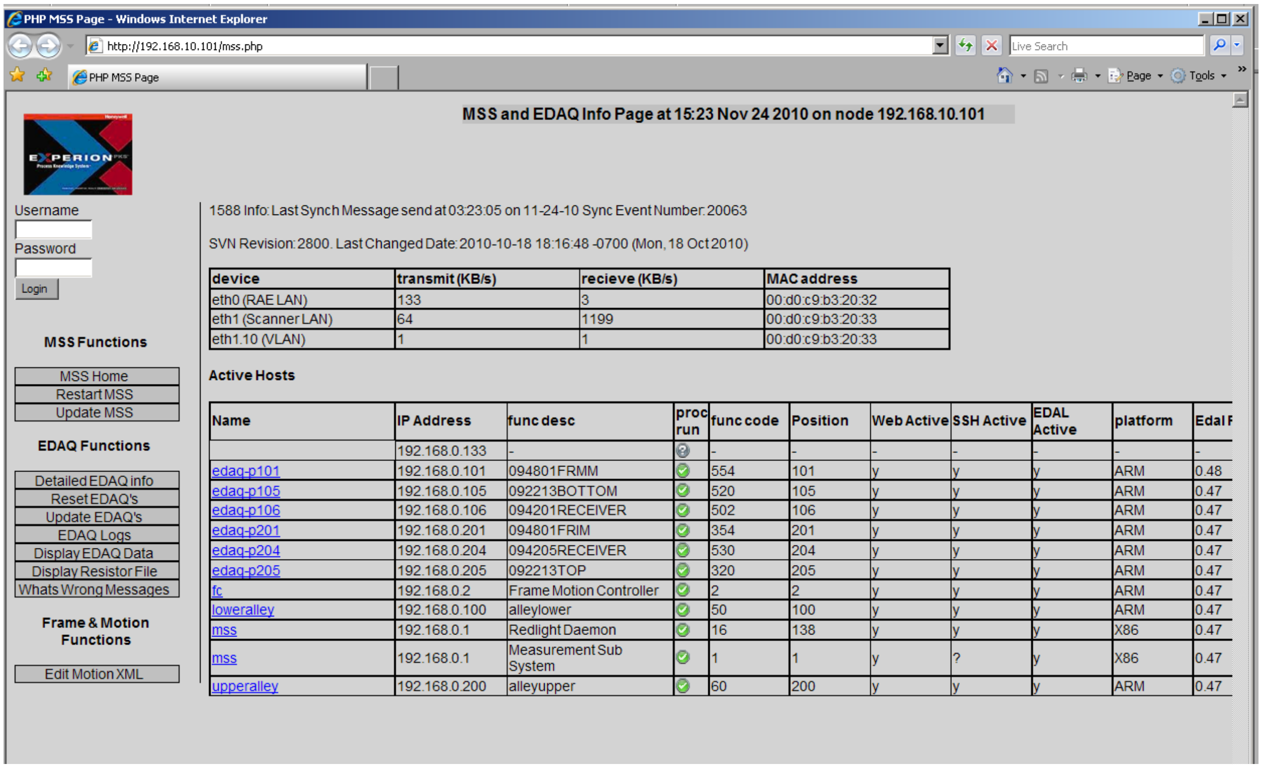
Sensors that are part of the QCS database, but are not enabled on the scanner, appear in the left column indicators in red, for example, *07-caliper upper* in Figure 3-3.

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:

- go to the **MSS Diagnostic** tab, click on **MSS Monitor**, choose the appropriate MSS, and click on **MSS Web** page
- open a browser on any computer connected to the Experion MX level network, and use 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
- open a browser on any computer connected to the scanner LAN switch, and use 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 **PHP MSS Page** (the main MSS Web page).



device	transmit (KB/s)	recieve (KB/s)	MAC address
eth0 (RAE LAN)	133	3	00:d0:c9:b3:20:32
eth1 (Scanner LAN)	64	1199	00:d0:c9:b3:20:33
eth1.10 (VLAN)	1	1	00:d0:c9:b3:20:33

Active Hosts

Name	IP Address	func desc	proc run	func code	Position	Web Active	SSH Active	EDAL Active	platform	Edal F
	192.168.0.133	-		-	-	-	-	-	-	-
edaq-p101	192.168.0.101	094801FRMM		554	101	y	y	y	ARM	0.48
edaq-p105	192.168.0.105	092213BOTTOM		520	105	y	y	y	ARM	0.47
edaq-p106	192.168.0.106	094201RECEIVER		502	106	y	y	y	ARM	0.47
edaq-p201	192.168.0.201	094801FRIM		354	201	y	y	y	ARM	0.47
edaq-p204	192.168.0.204	094205RECEIVER		530	204	y	y	y	ARM	0.47
edaq-p205	192.168.0.205	092213TOP		320	205	y	y	y	ARM	0.47
fc	192.168.0.2	Frame Motion Controller		2	2	y	y	y	ARM	0.47
loweralley	192.168.0.100	alleylower		50	100	y	y	y	ARM	0.47
mss	192.168.0.1	Redlight Daemon		16	138	y	y	y	X86	0.47
mss	192.168.0.1	Measurement Sub System		1	1	y	?	y	X86	0.47
upperalley	192.168.0.200	alleyupper		60	200	y	y	y	ARM	0.47

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 area 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 (RAELAN)** address is the one required in the setup.

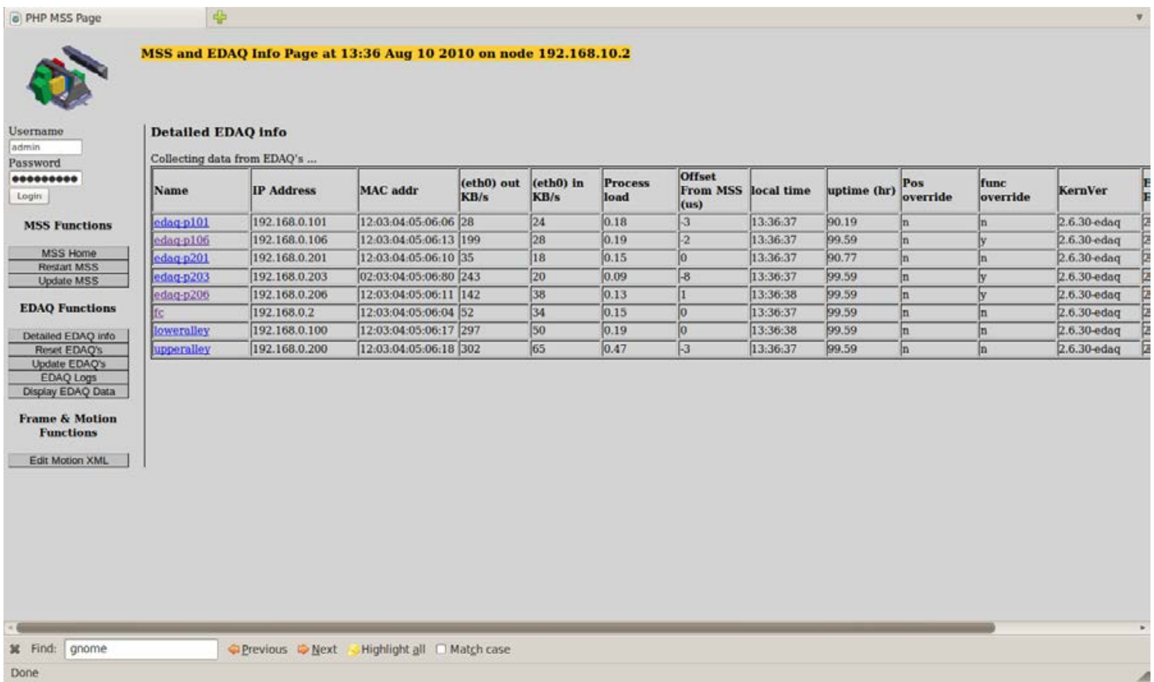
The second table lists all EDAQs discovered on the scanner LAN, their IP numbers, a brief description (related to model number), a program status column, the associated function code and position code, and whether the communication protocols are running (http, SSH, and Edal, the proprietary sensor data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



Name	IP Address	MAC addr	(eth0) out KB/s	(eth0) in KB/s	Process load	Offset From MSS (us)	local time	uptime (hr)	Pos override	func override	KernVer
edaq-p101	192.168.0.101	12:03:04:05:06:06	28	24	0.18	-3	13:36:37	90.19	n	n	2.6.30-edaq
edaq-p106	192.168.0.106	12:03:04:05:06:13	199	28	0.19	-2	13:36:37	99.59	n	y	2.6.30-edaq
edaq-p201	192.168.0.201	12:03:04:05:06:10	35	18	0.15	0	13:36:37	90.77	n	n	2.6.30-edaq
edaq-p203	192.168.0.203	02:03:04:05:06:80	243	20	0.09	-8	13:36:37	99.59	n	y	2.6.30-edaq
edaq-p206	192.168.0.206	12:03:04:05:06:11	142	38	0.13	1	13:36:38	99.59	n	y	2.6.30-edaq
fc	192.168.0.2	12:03:04:05:06:04	52	34	0.15	0	13:36:37	99.59	n	n	2.6.30-edaq
loweralley	192.168.0.100	12:03:04:05:06:17	297	50	0.19	0	13:36:38	99.59	n	n	2.6.30-edaq
upperalley	192.168.0.200	12:03:04:05:06:18	302	65	0.47	-3	13:36:37	99.59	n	n	2.6.30-edaq

Figure 3-5 Detailed EDAQ Information: Partial Display

4. Installation

Before installing an Infrared Moisture Measurement sensor, read Chapter 1 and Chapter 2.

4.1. Mounting and electrical connections

The receiver and source part of the moisture sensor can be installed by sliding the sensor part and sheet guide combination in the appropriate location. See your Scanner manual for details on head design.

The moisture sensor source is typically installed in the bottom head while the receiver is installed in the top head. Make sure that the Infrand plates are oriented properly. Make sure the borders around the plates appear as in Figure 4-1.

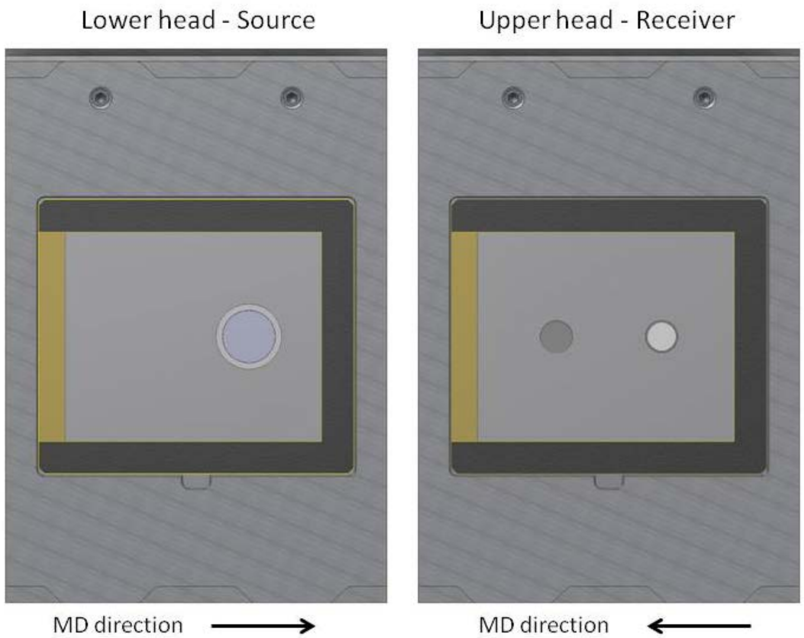


Figure 4-1 Correct orientation of Infrand plates

Only the sensor receiver uses an EDAQ. Connections to the EDAQ are shown in Figure 4-2.

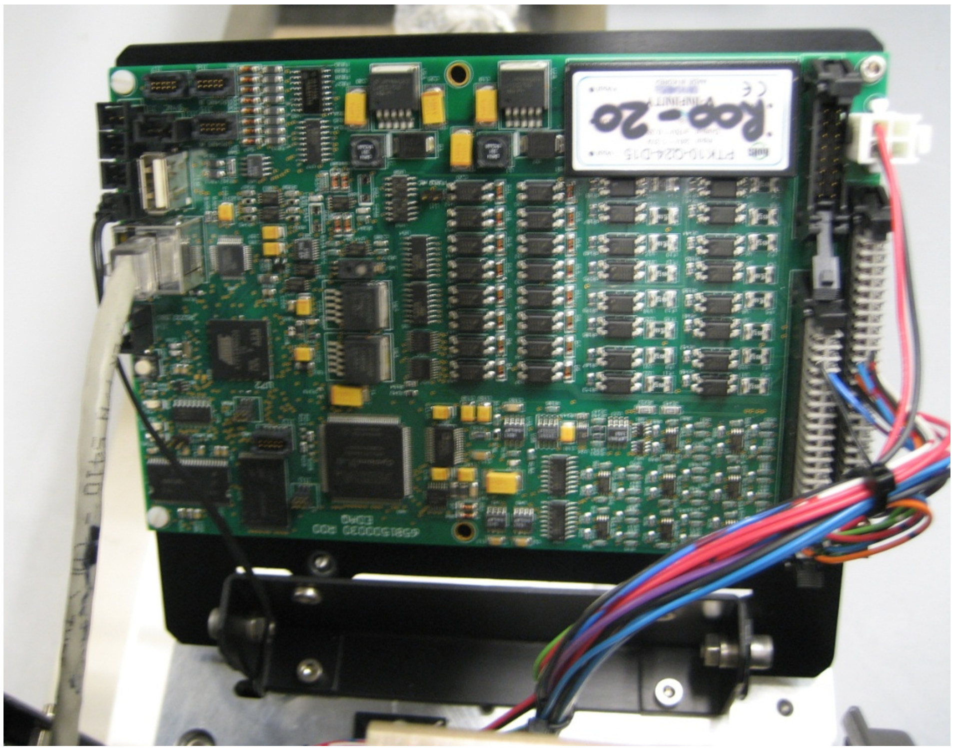


Figure 4-2 Electrical connections to EDAQ in moisture receiver

4.2. Sensor commissioning task list

1. Check that the calibration constants in maintenance mode or production mode for a given code match the ones in the calibration data sheets provided with the system.

2. Check the source alignment. See Subsection 2.1.1.

3. Check the receiver alignment. See Subsection 2.1.2.

4. Verify the static calibration samples (see Section 7.3).

5. Recalibrate as needed (see Chapter 7).

6. Enable Z-Correction and enter the appropriate Z-Correction calibration constants (see Subsection 6.3.4).

7. Enable Dirt Correction if required and enter the appropriate Dirt Correction calibration constants (see Subsection 6.3.4).

8. Enter nominal Dynamic Correction calibration constants (see Subsection 6.3.1).

9. Perform dynamic calibration (see Section 6.3).

5. Software Configuration Parameters

This chapter describes how to setup grade codes with the proper gain and flag settings and calibration tables in the Experion MX software.

5.1. Gain and flag setup

To set up gain and flag:

1. Go to **Setup** and choose the **Recipe Maintenance** display.
2. Create a table for each gain/flag setting in the following setup and configuration tables:
   - MSS Setup
   - IRP Configuration Table

The appropriate tables created can be selected in the Main Code Table of each grade code (Recipe) for the desired gain/flag settings.

You can also set up a MOIP Calibration Table for each of the recipe codes, and select the appropriate table in the Main Code Table for each of the grade codes (Recipe).

For temporary usage, the calibration constants can also be entered through the **Calibration Constants Table** under **Calibration Parameters** in the Sensor Maintenance display.

For permanent storage, enable/disable the appropriate correctors in the grade codes through the MOIP 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 MOIP Configuration Table. These can also be enabled or disabled through the recipe-based options under the configuration parameters in the Sensor Maintenance display for temporary usage.

To enable a corrector, double-click on the appropriate corrector and a check mark shows in front of it to indicate that it is enabled. To disable a corrector, double-click on it again and the check mark disappears.

5.1.1. MSS setup

Create an MSS Setup Table for each gain/flag; for example, MSS 1 Setup00 to MSS 1 Setup03 (see Figure 5-1).

For each MSS Setup:

1. Set the desired gain settings at the following lines: **IR11 Measure With Gain 1** and **IR11 Measure With Gain 2**. Set these locations to **1** for gain enabled or to **0** for gain disabled.

2. Also set up the **IR11 Measure With Flag**. Set this location to **1** for Flag IN or to **0** for Flag OUT.

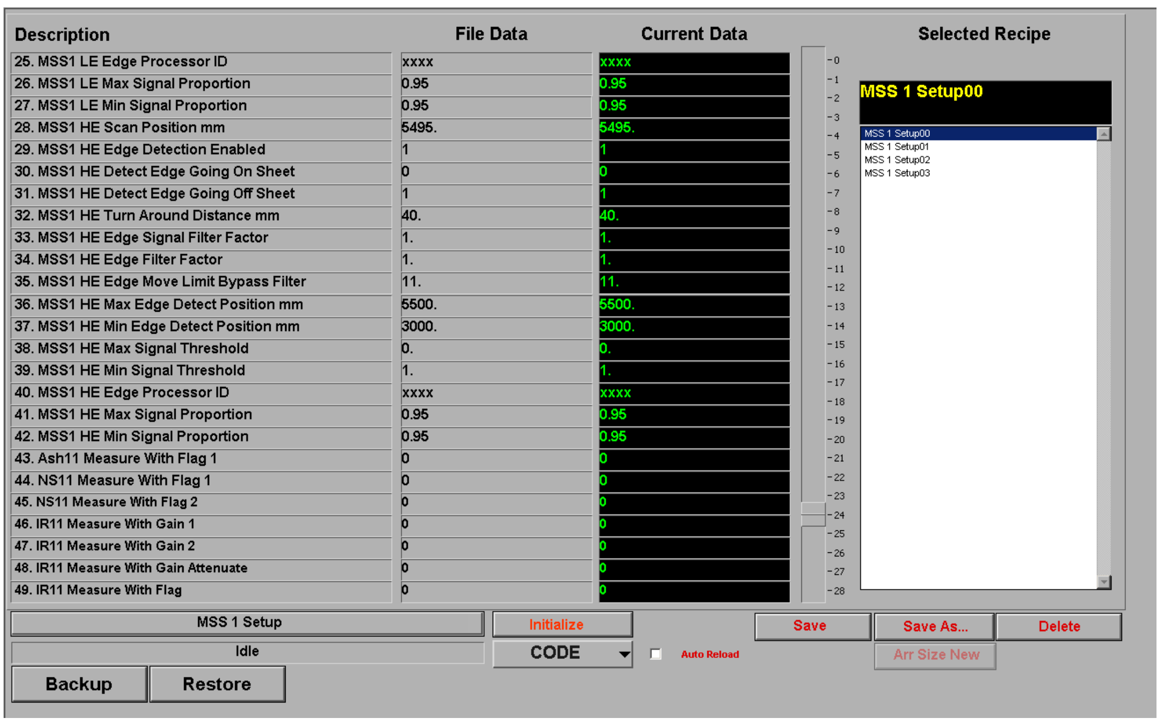


Figure 5-1 MSS Setup Table

5.1.2. MOIP Configuration Table

Create a MOIP Configuration Table for each calibration group; for example, MOIP11 Configuration Table00 to MOIP11 Configuration Table01 (see Figure 5-2).

For each table, set the value to **True** if the corresponding corrector is used; for example, dynamic intercept, hi curve and single cal correctors.

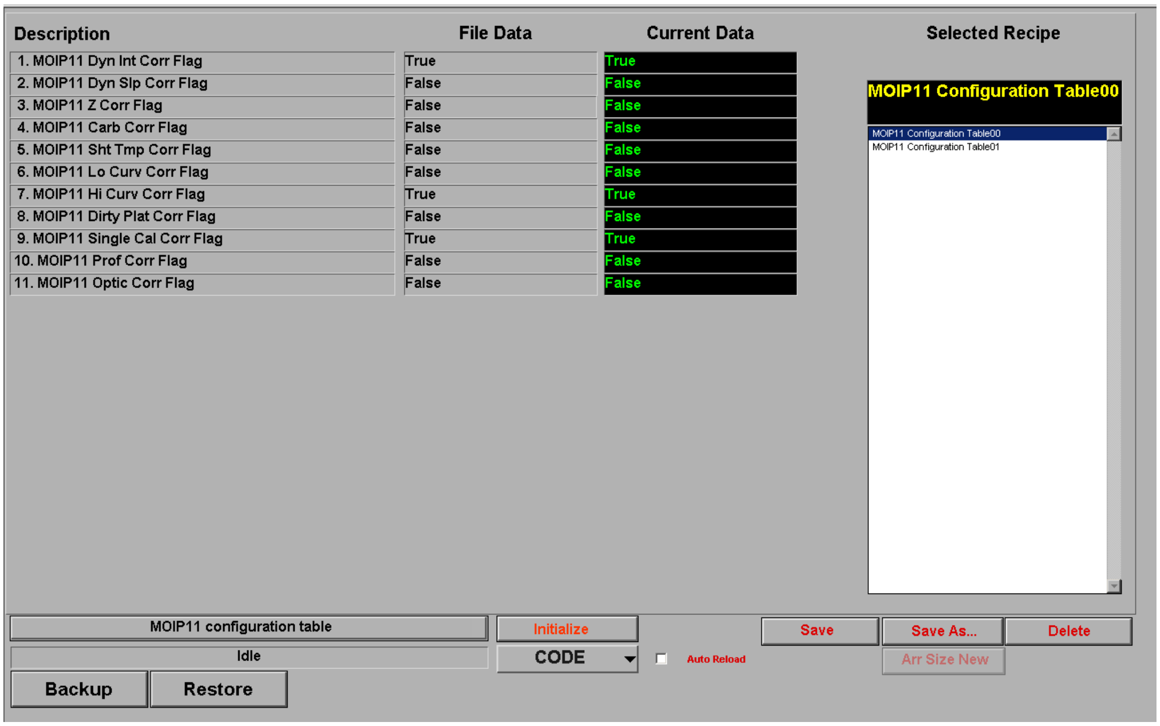


Figure 5-2 MOIP Configuration Table

5.1.3. MOIP Calibration Table

Create a MOIP Calibration Table for each calibration group; for example, MOIP11 Calibration Table00 to MOIP11 Calibration Table01 (see Figure 5-3). Enter the appropriate calibration constants in each table.

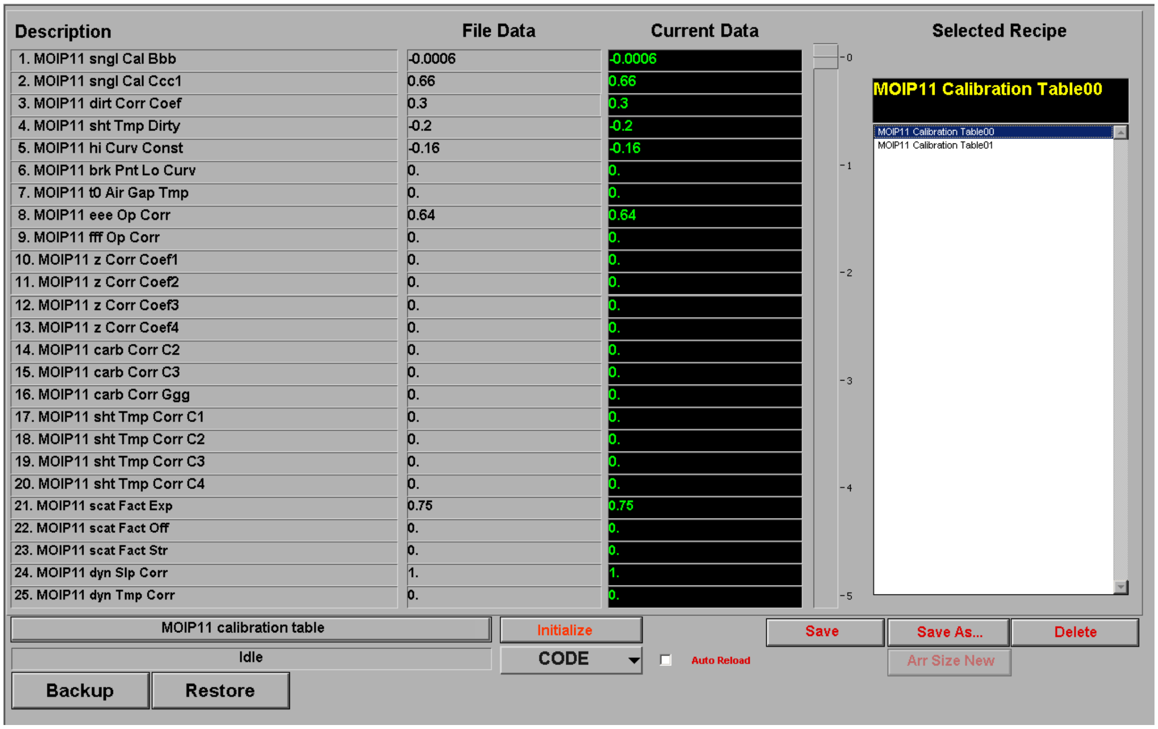


Figure 5-3 MOIP Calibration Table

5.1.4. MOIP Limit Table

Allowed dark volt range, drift and ratio limits can be changed in the MOIP Limit Table. Default values are in Figure 5-4.

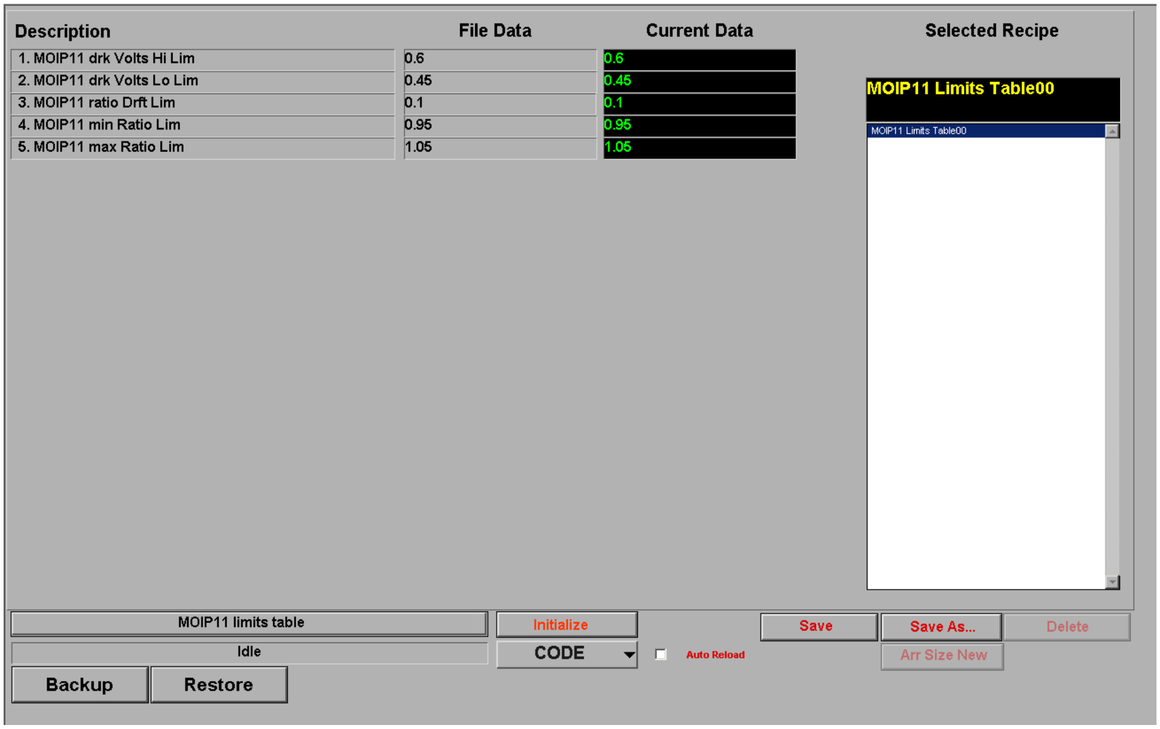


Figure 5-4 MOIP Limit Table

5.1.5. Main Code Table

Create a grade code (Recipe) for each gain/flag; for example, Code00 to Code03.

For each Main Code Table in a grade code, select the appropriate tables created for MSS Setup, MOIP Configuration Table, MOIP Calibration Table and MOIP Limit Table (see Figure 5-5).

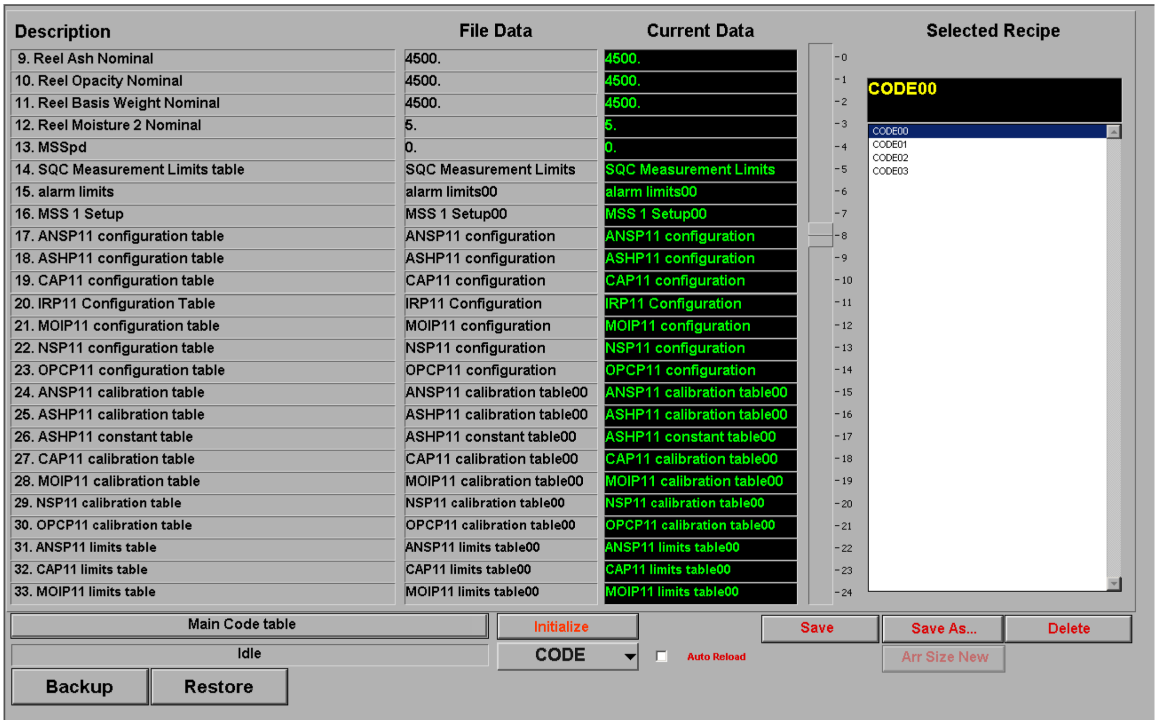


Figure 5-5 Main Code Table

Table 5-1 is the summary table of gain setup for an IR Moisture Sensor for scanner #1 and sensor #1.

Table 5-1 Summary table of gain setup

Gain Setting	Gain 0	Gain 1
MSS 1 Setup	*MSS 1 Setup00:* IR11 Measure With Gain 1 = 0 IR11 Measure With Gain 2 = 0	*MSS 1 Setup01:* IR11 Measure With Gain 1 = 1 IR11 Measure With Gain 2 = 0

Gain Setting	Gain 2	Gain 3
MSS 1 Setup	*MSS 1 Setup02:* IR11 Measure With Gain 1 = 0 IR11 Measure With Gain 2 = 1	*MSS 1 Setup03:* IR11 Measure With Gain 1 = 1 IR11 Measure With Gain 2 = 1

Grade Code	Code00	Code01
Gain Setting	Gain 0	Gain 1
MSS 1 Setup	*MSS 1 Setup00*	*MSS 1 Setup01*

Grade Code	Code02	Code03
Gain Setting	Gain 2	Gain 3
MSS 1 Setup	*MSS 1 Setup02*	*MSS 1 Setup03*

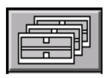
ATTENTION

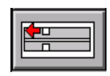
If required, in addition to the Gain settings set the **IR11 Measure With Flag** to **1** for Flag IN and to **0** for Flag OUT in MSS 1 Setup.

6. Operations

6.1. Maintenance Mode setup

To set up Maintenance Mode:

1. Press  to bring up the Scanner Control display.

2. Select the appropriate scanner(s) and press  on the Scanner Control display to take the selected head(s) offsheet.

3. Load a grade code.

   a. Press **Retrieve/Save Recipes…** on the Sensor Maintenance display to bring up the **Scanner modes & Maintenance recipes** (see Figure 6-1).

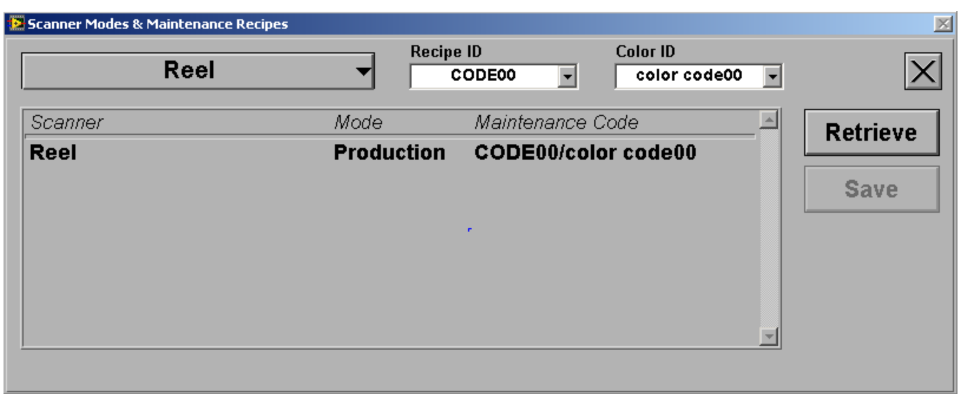


Figure 6-1 Scanner Modes & Maintenance Recipes Display

   b. Select the appropriate scanner.

   c. Under Recipe ID, select the code.

d. Under Color ID, select a grade code that is set up for the particular gain of interest.

e. Press **Retrieve**.

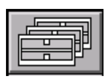
f. Close the **Scanner Modes & Maintenance Recipes** display.

4. Select **Maintenance Mode** in the drop-down selector on the **Sensor Maintenance** page. Use the same selector to return to **Production Mode**.

6.2. Scanning in Production Mode

Before scanning, make sure that the proper recipe codes have been retrieved and that proper correctors have been enabled in the recipe-based options (See Chapter 5).

To start scanning:

1. Press the  button on the top horizontal dispatcher to bring up the **Scanner control** display, as shown in Figure 6-2.

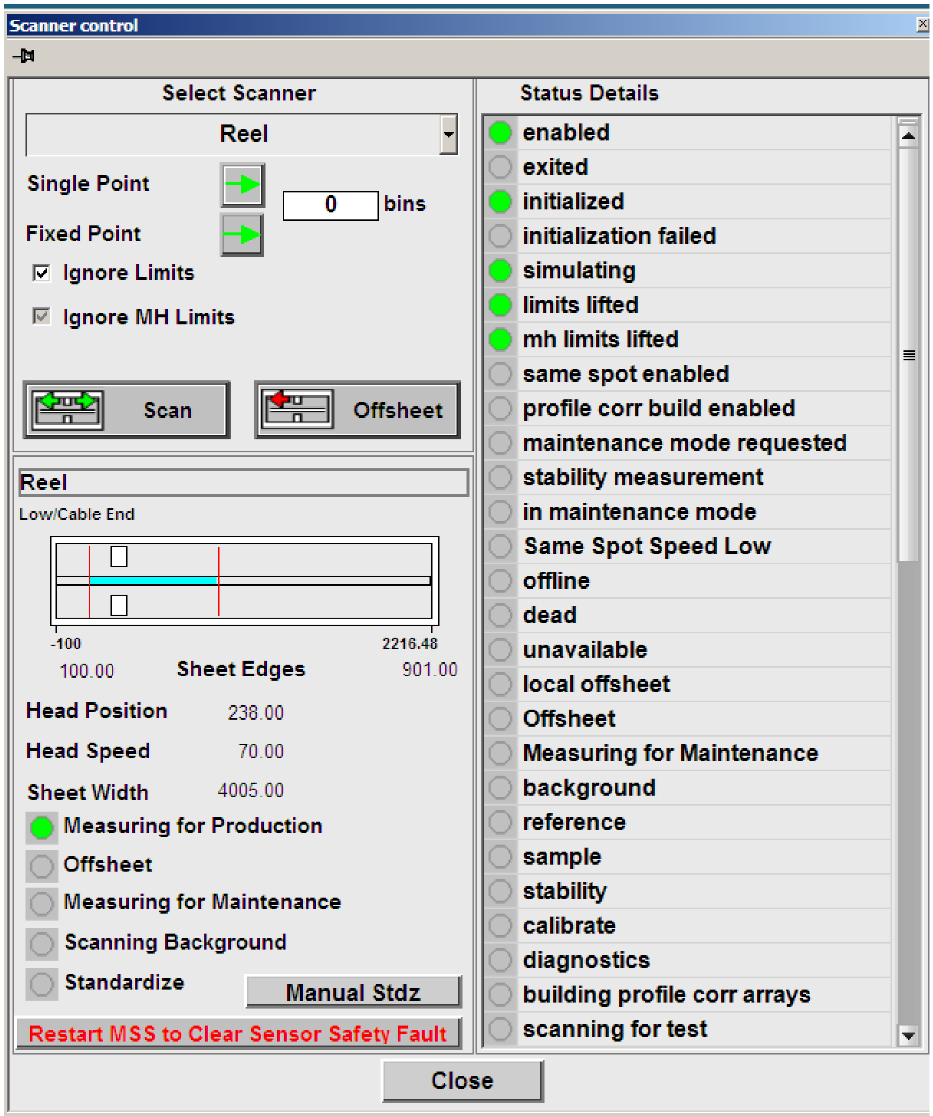
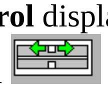


Figure 6-2 Scanner Control Display

2. In the **Scanner control** display, select the appropriate scanner and press the scan button  to scan the head. Before the sensor starts scanning, it takes the background and Reference reading from all of the sensors (Basis Weight, Moisture, and so on) and stores it.

6.2.1. Types of scan and sensor data snapshot

While scanning, you can choose the position snapshot, the partial scan snapshot, or the single point by selecting the appropriate button in the Sensor maintenance display (see Figure 6-3).

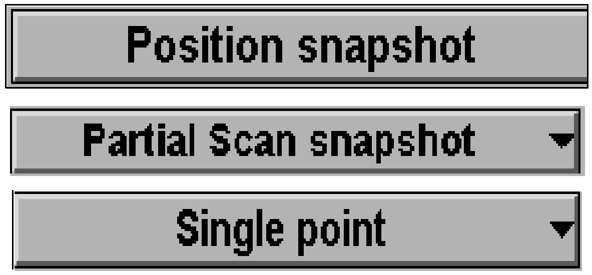


Figure 6-3 Selector Bars for snapshot options

For the single point snapshot, it is necessary to single point the head to the desired position.

1. Send the head Offsheet.
2. Enter the single point position (in terms of bins) in the Scanner Control display.
3. Press the Single Point button (see Figure 6-2).

For the position snapshot and partial scan snapshot, the head should be scanning.

For the position snapshot, you can set the position on the Sensor Maintenance of the Production display and the measurement readings can be monitored on the Sensor Maintenance display as shown in Figure 6-4.

For the partial scan snapshot, select **Partial Scan** snapshot. For forward scans the partial scan snapshot position is the highest bin number in the segment, while for reverse scans it is the lowest bin number in the segment.

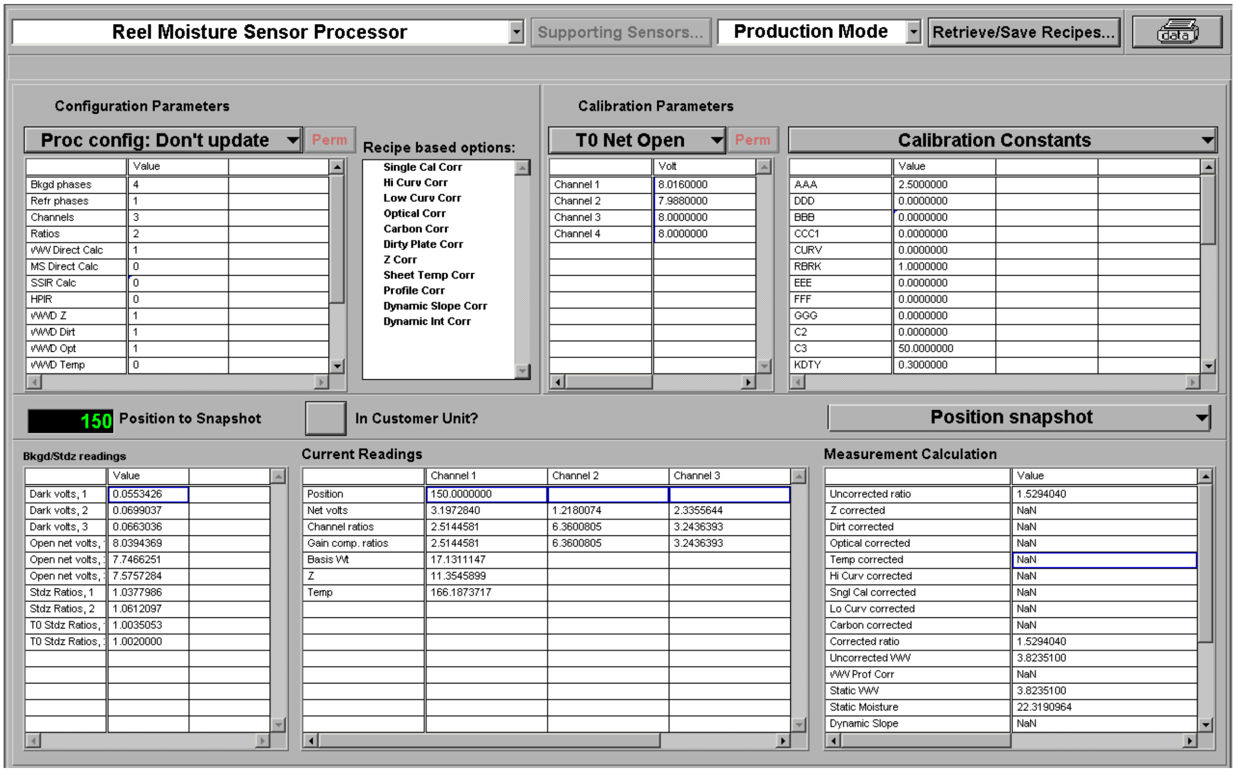
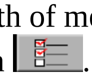


Figure 6-4 Sensor Maintenance Display for Production Mode

6.2.2. Measurement setup and profile display

Customer unit can be chosen by enabling the customer unit. Default will be set in grams/square meter (gsm), Degree C, and unit length of meters. You can change the units by pressing System Setup & Debug button . Units can be set by pressing the **Report Units** setup.

To set the filter factor on the Scanner Setup Display to 0.2:

1. Press the scanner/sensor button.
2. Press the **Measurement Setup** button.
3. In the Measurement setup display, under the select measurement option, choose **Moisture** for measurement.
4. Under the measurement arrays, set the trend filter factor to **0.2** (see **Figure 6-5**).

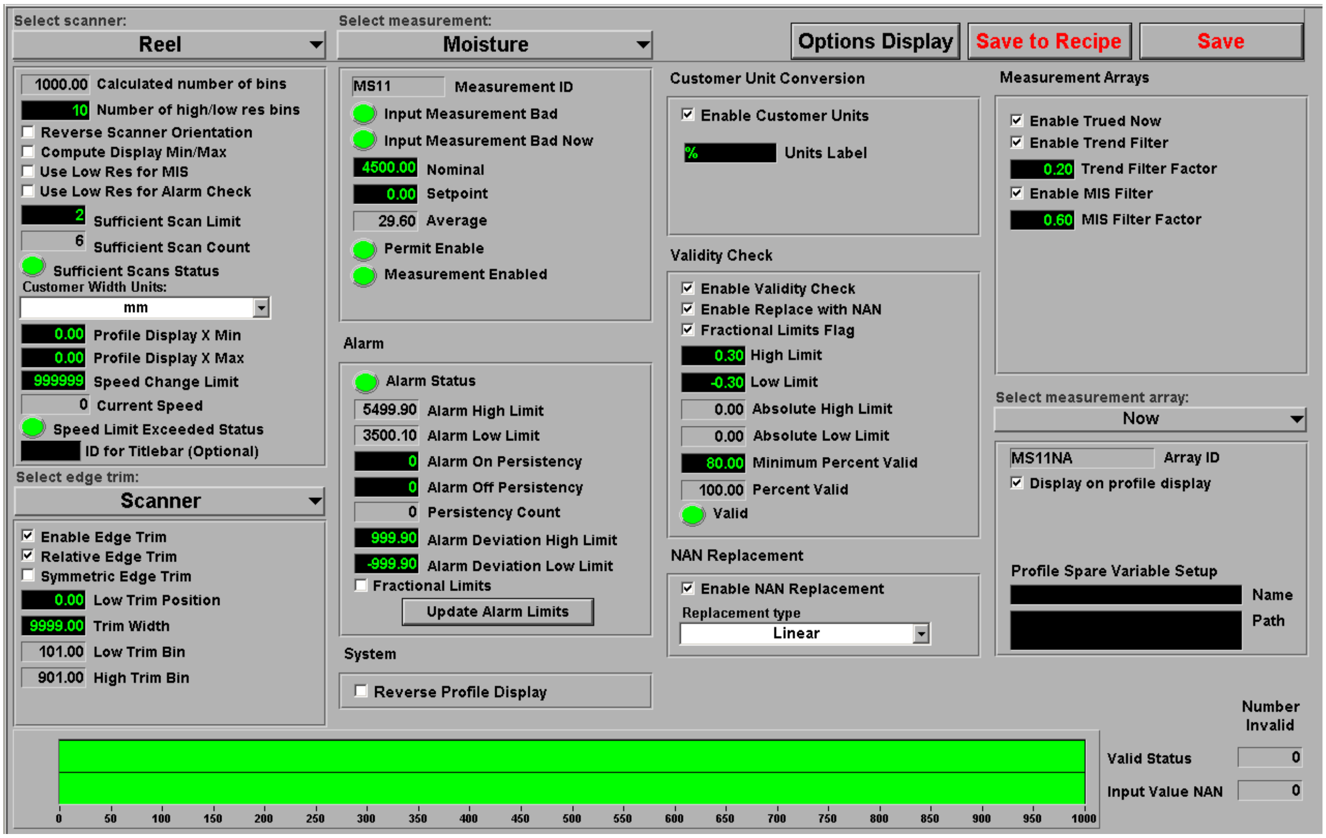


Figure 6-5 Measurement Setup Display

To set up the profile display:

1. Choose **Home**.
2. In Home, choose the profiles button.
3. In the Profiles display, choose the desired measurement; for example, basis weight, moisture, or air gap temperature.
4. Monitor **Now** value or trend value by making an appropriate selection.

For a sample of the profile display, see Figure 6-6, which shows the profile of the basis weight, moisture, and air gap temperature.

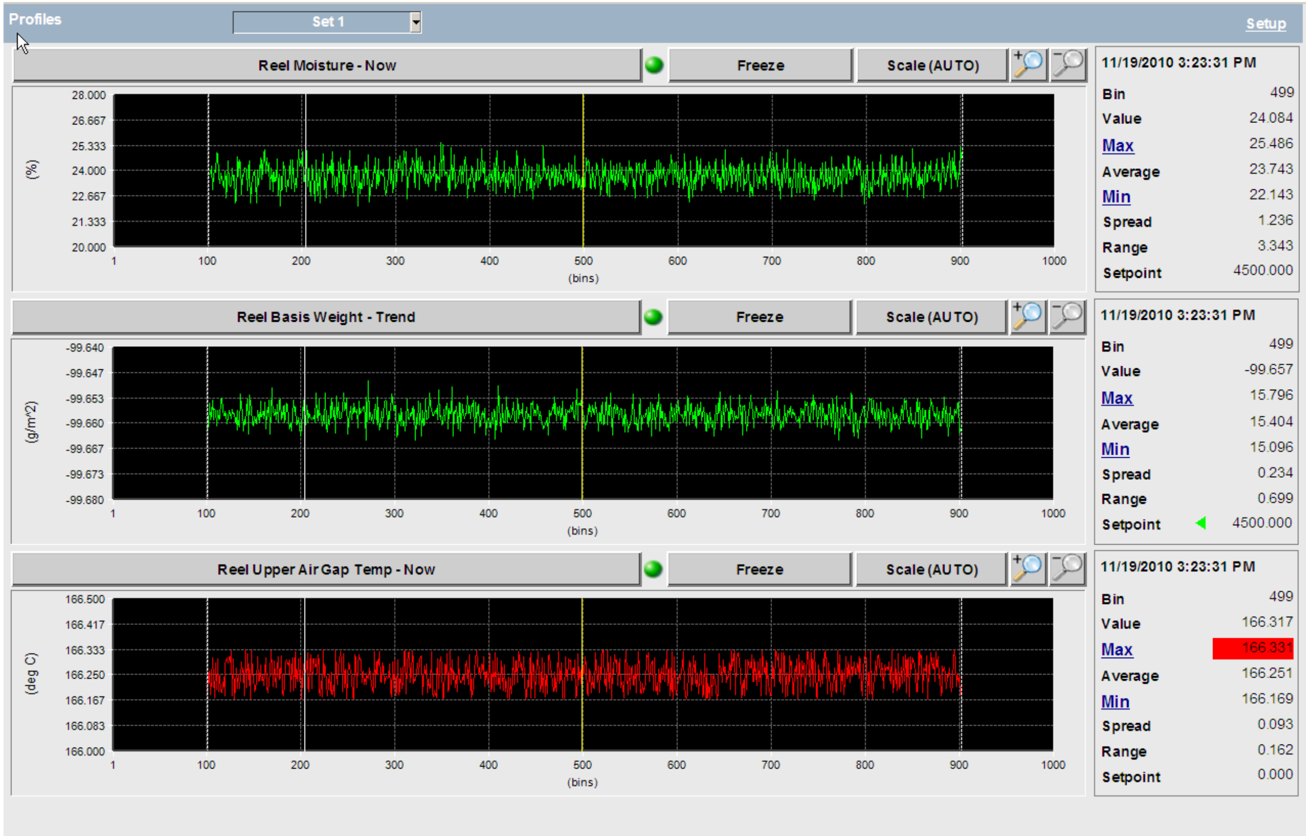


Figure 6-6 Profile Display of Moisture, Basis Weight and Air Gap Temperature

6.3. Dynamic calibration

Dynamic correction is included to correct for flashoff (evaporation from hot sheet) of moisture between the scanner and reel (Reel scanners only), any difference between static calibration readings on bagged samples and onsheet readings, and/or for any residual sheet temperature dependence in the sensor.

Dynamic calibration should only be performed after static calibrations (See Chapter 7) have been performed and verified. Dynamic verification is necessary whenever a quartz window is replaced, a filter is changed, or the static calibration is significantly changed.

It is advisable to perform dynamic verification once a week.

6.3.1. Nominal dynamic correction constants

The recommended initial value for dynamic correction for board at 6% moisture is DMBE = 0.25%. This value may be used before dynamic testing is possible. This recommended dynamic correction (DMBE) value includes flashoff for Reel Scanners, but not for other scanners that cannot be dynamically verified.

The value is only approximate because the sheet temperature varies widely in different applications, and the sheet temperature strongly affects flashoff.

A sheet temperature drop of 13°C (23°F) is normally accompanied by evaporation of 1% moisture. Flashoff may also be negative for very dry sheets. The effect from any residual sheet temperature dependence of the sensor should be less than ±0.25% and would be unpredictable, so it is not included.

If the moisture target is significantly different from 6%, the effect should be multiplied by (0.17•Target Moisture). Both effects are truly slope rather than offset effects. If there is likely to be more than 2% range in moisture, the dynamic slope corrector DMAE should be used instead of DMBE. In this case, use DMAE = 1 - 0.17 • (Suggested DMBE) and DMBE=0.

6.3.2. Dynamic sampling

A minimum of 30 samples from five or more reels is needed for a verifiable dynamic calibration. Gathering and processing the samples should take place as soon as possible after startup. However, no dynamic samples should be taken before verifying sensor stability and static calibration.

1. Prior to taking samples, verify:
    - The sensor has been aligned and stability-checked (Background/reference values check - see Section 9.2. Short term stability check – see Section 9.3).
    - The static calibration has been verified (see Chapter 7).
    - The Air Gap Temperature sensors have been adjusted (see your Basis Weight Measurement manual).
    - Dynamic calibration constants have been set either to best-known values or to the appropriate default values given in Subsection 6.3.1.
2. Choose the section of the reel to be sampled.

3. Take measurements or mark the reel (see Figure 6-7) to assure that the section being sampled corresponds to the slices chosen on the profile display.

4. Cut and bag the samples very quickly to reduce conditioning effects. This usually requires two people.

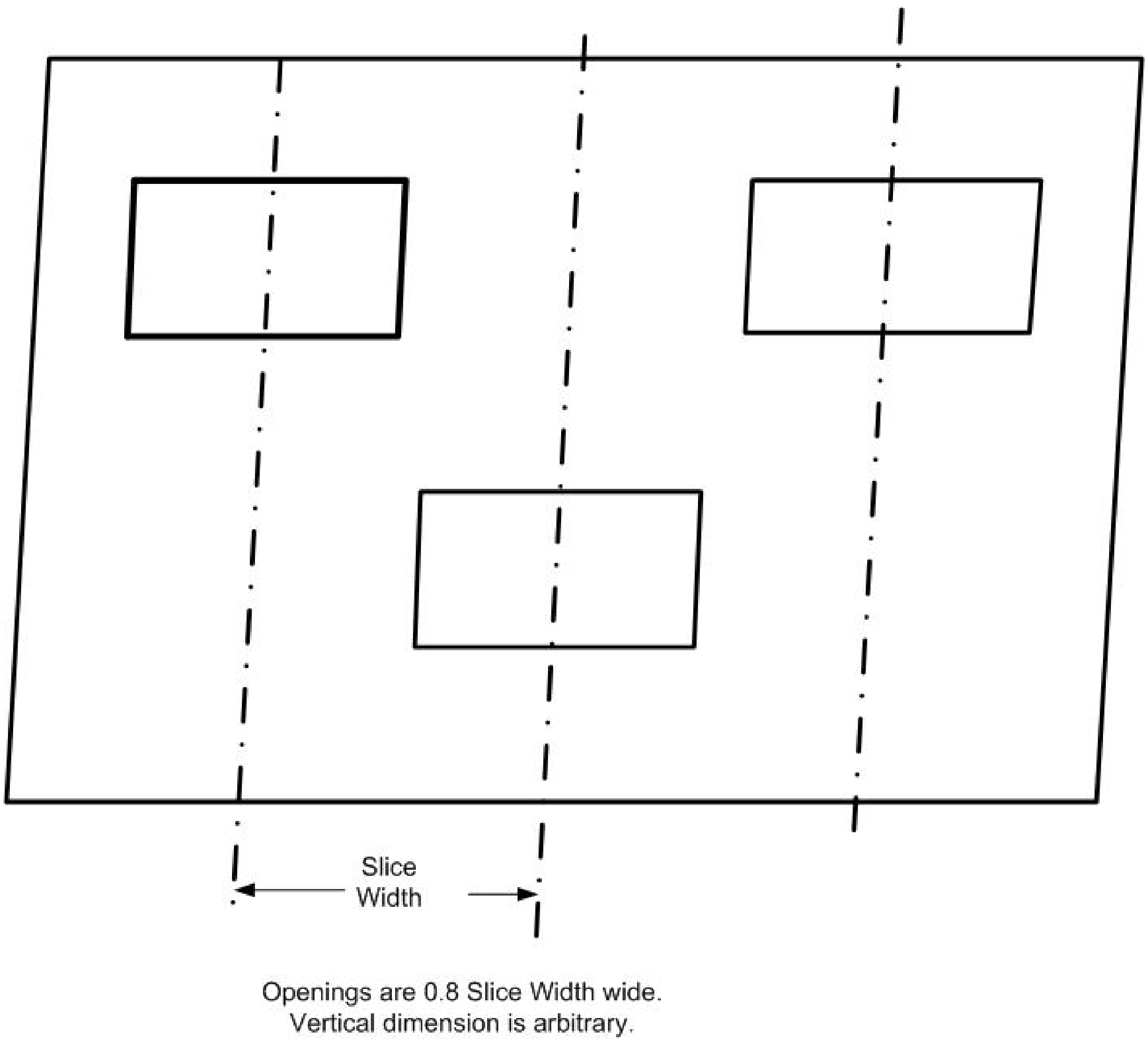


Figure 6-7 Reel Marked with Sampling Template

6.3.2.1. Sampling for medium and heavy weight grades

Equipment required

- Pre-weighed and numbered plastic bags, at least 11 by 18 inches (28 by 46 cm)

- Pre-weighed rubber bands
- Tape measure (of adequate length to measure from edge to center of sheet)
- Reel Sampling Template (see Figure 6-7)
- Sharp utility knife for cutting samples from reel
- Dynamic Sampling worksheet (Honeywell p/n 42000852, page 5)
- Laboratory balance accurate to 0.05% of sample weight.

  (Usually a top-loading balance accurate to .01g is acceptable.)
- Forced-draft, temperature-regulated drying oven, located in a room with constant temperature and humidity. The oven must be set for 105.0 ±0.5°C (221.0 ± 0.9 °F).

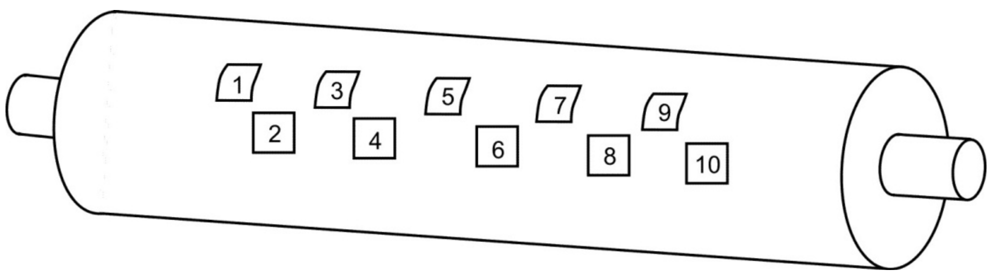


Figure 6-8 Reel Sampling Template for Medium and Heavy Grades

6.3.2.2. Sampling procedure for medium and heavy grades

Set the filter factor on the Scanner Setup display to 0.2:

1. Choose the Scanner/Sensor button.
2. Press **Measurement Setup**.
3. In the **Measurement Setup** display, under **Select Measurement**, choose **Moisture**.
4. Under **Measurement Arrays**, enable the trend filter and set the trend filter factor to 0.2.

For dynamic calibration, set the dynamic calibration constants (DMAE, DMBE, and KAYE) either to best-known values or to the appropriate default values given in Subsection 6.3.1.

To set the calibration constant:

1. Press **Setup** followed by **Recipe Maintenance**.

2. In the Recipe Maintenance display, press **Main Code Table** and, under that, choose the **MOIP Calibration Table.**

3. In the **MOIP Calibration Table**, enter the dynamic calibration constants and click **Save**. After saving, reload the code to make the new calibration constants active.

   When you load the code, the correct calibration constants appear in the calibration constant table in the sensor maintenance display.

Choose the section to be sampled:

1. Prior to turn up, use the **Profile Display** to locate one or more sections of six slices or more where the moisture and basis weight profiles are relatively flat.

   If more than one section is used, try to find sections with different average moisture.

2. Single-point the scanner at a slice at the center of the chosen area.

3. Monitor successive moisture Now values on the **Quality Summary** display.

   If the values vary by more than 1% moisture, the short-term variations are too high to produce usable calibration data. In this case, do not perform calibration; instead, either try another area or investigate the causes of such high variations.

4. Make sure that the section being sampled is the same as the slice chosen by measuring from the edge of the sheet to the centerline of the basis weight and moisture sensors. Record the distance and slice.

5. Return the sensor to Scan mode.

6. Set up the profile display to automatically produce a profile of moisture, basis weight, and air gap temperature.

7. Allow the scanner to complete 15 scans before turn-up, and monitor the average moisture on the **Quality Summary** display until turn-up.

   If the average moisture differs from the trended value by more than 0.5%, do not sample the reel.

8. As soon as possible after turn up, locate the slice at which the sensor was single-pointed and center the template over it. Mark the sections corresponding to the chosen slices (see Figure 6-8).

9. Use the knife to cut at least six wraps into the reel (more for lighter grades) at each slice using the template marks.

10. Quickly peel off the layers together and insert them into a plastic bag.

11. Peel off two layers from the top and one from the bottom, and then seal the bag with a rubber band, squeezing out the excess air.

12. Mark each bag with the slice number.

13. Put the bagged samples in a large plastic bag, and then take them to the lab for weighing and drying.

6.3.2.3. Weighing and drying medium and heavy grade samples

To weigh and dry medium and heavy grade samples:

1. Use the same scale for all weighing, and record all entries on a Dynamic Sampling worksheet.

2. Verify the oven setting and the oven temperature with a thermometer 105.0 ±0.5°C (221.0 ±0.9°F).

3. Record the lab temperature and humidity.

4. Weigh the bagged samples as soon as possible. Record their weights in the column **Wet Sample + Bag**. Record the bag weight in the column **Wet Bag**.

5. Remove each sample from its bag and mark it by slice number.

6. Check that the oven is empty, and then place the marked samples in the oven, fanning out each one to promote drying.

   Avoid crowding. It is not necessary to dry all of the samples at once. Place a sign on the oven to prevent others from opening the door, changing the oven setting, or putting in other samples.

7. Allow the samples to dry for 4 hours at 105.0 ±0.5°C (221.0 ±0.9°F)

8. While the samples are drying, weigh a second set of bags and rubber bands (one per sample) for the dried samples.

Do not re-use the **Wet Sample** bags as trapped moisture may cause errors.

9. Remove one sample at a time from the oven and quickly put it in a pre-weighed bag in the hot oven air. Keep the oven door open only long enough to get the one sample bagged.

WARNING	The samples will be very hot. Be sure to wear gloves when removing them from the oven.

10. Squeeze as much air as possible out of the bag and seal it with the rubber band. Let the oven return to 105°C (221°F) before opening the door again.

11. Weigh the sample and record it in the column **Dry Sample + Bag**. Record the bag plus rubber band weight in the column **Dry Bag**.

12. For each sample, calculate the Wet Sample and Dry Sample weights, and the percent moisture:

    Wet Sample = Wet Sample+Bag - Wet Bag

    Dry Sample = Dry Sample+Bag - Dry Bag

    Lab Moi = 100 • (1 - Dry Sample/Wet Sample)

6.3.3. Dynamic correction

When taking profile samples, check for positioning errors (correspondence between slice number and sample taken) by plotting the moisture value from the lab (MLAB) and the moisture value from the sensor (MDYN) against slice position on the same graph. If they do not track, there may be a positioning error.

1. If you have only a few data points (<20), it is probably best to use only an intercept correction. If dynamic correction was turned off while collecting the data:

   DMBE = Average[MDYN - MLAB].

   If dynamic correction was turned on while collecting the data, calculate for each point the sensor value without dynamic correction, MSTAT (see Subsection 2.4.9 for definitions). In the simplest and most common case, DMAE=1 and KAYE=0; therefore, MSTAT = MDYN + DMBE. Use:

DMBE = Average[MSTAT - MLAB].

2. When you have at least 20 data points, make a graph of lab percent moisture MLAB (vertical axis) against Sensor percent moisture (if dynamic correction was turned on while collecting the data, use MSTAT as calculated in the previous step).

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

   If the range of moisture levels is narrow, the points may form a ball. In this case, the best you can do is to use a simple intercept correction. Use DMBE = Average [MSTAT - MLAB]. Be sure to use DMAE = 1.

   If the range of values is great enough that a line can be discerned, perform a linear regression on MLAB (y) vs. Sensor (x). Use DMAE = slope and DMBE = - intercept.

Use a computer spreadsheet to keep track of dynamic test results and corrector values. To avoid making arbitrary or hasty changes in DMBE, use a running average of the [MSTAT - MLAB] column as the appropriate value for DMBE.

6.3.4. Z-Correction and dirt correction

Z-Correction and Dirty Plate Correction are onsheet correctors that may be enabled on the **Moisture Maintenance** display and calibrated on site.

6.3.4.1. Z (Gap) correction

Z-Correction is used to correct for the variations in gap in a scanner that bows due to differential heating of the beams. Scanners may have gap variations of ±0.05 inches (1.27 mm). Because a narrowed gap will cause more average passes of light through the sheet, the sensitivity of the sensor will increase.

The need for Z-Correction may be evaluated by examination of the moisture and Z-sensor profiles.

Nominal correction

The Z-Corrector is applied to onsheet and Sample readings on the basis of the Z value relative to that at Standardize. The Z-Correction algorithm is given in Subsection 2.4.2. The calibration constants ZCR1 and ZCR2 correct the ratio RN, while ZCR3 and ZCR4 correct RN2.

The standard values are shown in Table 6-1. If different values are supplied with your system, they should be used instead of those given in the table.

Table 6-1 Standard Values

ZCR1	ZCR2	ZCR3	ZCR4
0.5	0.6	-0.5	0.6

Check the adequacy of these values by entering them in the MOIP calibration table, putting shims under the wheels of the upper head to increase the gap over a few slices. Look at profiles with the Z-Corrector enabled and shims present vs. profiles without shims. The profiles should look the same, with no step in the profile where the shims are.

Sampling

If the nominal corrector values are not adequate, calibrate using the bagged calibration samples and shims under the wheels of the upper head.

Choose a set of grades of representative basis weight (typically three are used). Pick the nominal moisture level sample from each. Disable the Z-Corrector. Without shims, perform a Reference of the Z-Sensor (or a Standardize) with an empty gap and note the Z value.

Perform a Moisture sensor Reference with the paddle and rings (See Section 7.3). Perform a Sample with each of the samples. If you need to change gain, perform a Reference again before sampling.

Shim the wheels of the upper head and perform a Z-Sensor Sample, noting the Z value. Repeat the Samples without References. If you need to change gain, perform the Reference without the shims and the Sample with the shims.

Data reduction

For the easiest and best results, use the Advanced Moisture Calibration Tool in Experion MX (see Subsection 7.3.4).

For data reduction by hand, note the RN, RN2, and REFA for each Sample measurement. Calculate for each sample:

$$ZCF = \frac{\dfrac{RN(noshims) - 1}{RN(shims) - 1} - 1}{\dfrac{Z}{ZST} - 1} \qquad ZCF2 = \frac{\dfrac{RN2(no\ shims)}{RN2(shims)} - 1}{\dfrac{Z}{ZST} - 1}$$

It is normally sufficient to assume the ZCR2 and ZCR4 values from Table 6-1, and calculate only ZCR1 and ZCR3 from the following formulas:

ZCR1 = Avg[ZCF/(REFA+ZCR2)]   ZCR3 = Avg[ZCF2/(REFA+ZCR4]

In some cases where there is a large basis weight range, you may find it necessary to fit both ZCR1 and ZCR2. Plot ZCF vs. REFA and perform a linear regression to obtain the slope and intercept; that is, ZCF = A • REFA+D. Then

ZCR1 = A, and ZCR2 = D/A.

Similarly for ZCF2 = A2 • REFA+D2, then

ZCR3 = A2 and ZCR4 = D2/A2.

Enter the values in the MOIP calibration table and check it with shims. See Nominal correction.

6.3.4.2. Dirty plate correction

Buildup of pitch or other light-absorbing material on the sensor windows causes them to be less reflective, reducing the sensitivity of the sensor. The need for Dirty Plate Correction should be checked if the dirt buildup causes the REF volts at Standardize to decrease by more than 20%.

To determine the need for Dirty Plate Correction:

1. Choose a typical sample.
2. Clean the windows.
3. Perform a Reference with the paddle and rings in the gap.
4. Allow the sensors to scan until the plates are dirty.
5. Take the scanner offsheet, and enter the REF volts from step 3 as T0 REF (T0 Channel1) in calibration parameters in the sensor maintenance display.
6. Enable Dirty Plate Corrector in the recipe-based options of the Moisture Sensor Maintenance display.
7. Perform a Reference with the paddle and rings.
8. Perform a Sample with dirty plates.
9. Repeat the Reference and Sample again after cleaning the windows.

If the sample readings differ by more than 0.25% moisture, then use Dirt Correction.

Nominal correction

The corrector is applied onsheet and during Sample to the ratios RN and RN2 after Z-Correction. The Dirt Correction algorithm used when measuring products above 100 gsm typically has grade-dependent KDTY.

The calibration constant KDTY applies to RN, and KDT2 applies to RN2.

The nominal value for these correctors is 0.3. Test them by entering the values for KDTY and KDT2 in the MOIP calibration table. Load the code and repeat the test. If different suggested values are supplied with your system, use them instead.

Sampling

If the nominal values are not adequate, calibrate the values:

1. Choose samples representative of the full basis weight range and moisture values near nominal moisture.
2. Allow buildup of dirt on the plates for a maximum period between cleaning.
3. For each grade, enter the grade code and target basis weight.
4. Perform a Reference with the paddle and rings.
5. Perform a Sample on the sample for that grade.
6. Repeat the grade code entry, target weight entry, and Reference and Sample for each grade.
7. Clean the plates and repeat the sampling.

Data reduction

1. Note the value for N0: N0 = T0 REF = the clean window REF volts at Reference
2. Note the value for NS: NS = the dirty window REF volts at Reference.
3. Note the RN, RN2, and REFA for each Sample.

For easiest and best results, use the advanced calibration display (see Subsection 7.3.4).

For data reduction by hand,

1. Calculate for each sample:

$$\mathrm{CF} = \frac{(\mathrm{RN}-1)\ \mathrm{Clean}}{(\mathrm{RN}-1)\ \mathrm{Dirty}} \qquad \mathrm{KGDTY} = \mathrm{AVG}\left[\frac{(\mathrm{CF}-1)}{\mathrm{REFA}\bullet\left[\frac{\mathrm{N0}}{\mathrm{NS}}-1\right]}\right]$$

$$\mathrm{CF2} = \frac{(\mathrm{RN2}-1)\ \mathrm{Clean}}{(\mathrm{RN2}-1)\ \mathrm{Dirty}} \qquad \mathrm{KGDT2} = \mathrm{AVG}\left[\frac{(\mathrm{CF2}-1)}{\mathrm{REFA}\bullet\left[\frac{\mathrm{N0}}{\mathrm{NS}}-1\right]}\right]$$

2. Use the REF volts on a clean window Standardize as the value for T0 REF.

3. Enter these values in the calibration table and repeat the sampling with clean and dirty windows, as above, to verify the corrector.

ATTENTION

Always perform subsequent recalibration and verification on bagged samples on clean sensor windows, either with the Dirt Corrector disabled or with the REF volts on a paddle with the rings entered as T0 REF. It prevents erroneous correction resulting from the drop in REF volts caused by the paddle and rings. During onsheet measurement, the empty gap value of REF volts should always be used as T0 REF.

7. Static Calibration

This chapter describes all of the procedures for performing static calibration. Normal installation requires only hardware checks (see Section 9.1, Section 9.2 and Section 9.3) and verification or recalibration (see Section 7.3 and Subsection 7.4.1).

Read this chapter if no static calibration was provided with the system, or if a change in grade structure occurs requiring a complete new static calibration.

Operation of the scanner buttons and switching to maintenance mode are described in Operations (see Section 6.1).

7.1. Sample selection

7.1.1. Standard sample selection

Five moisturized samples of each grade are required for calibration (typically 2, 4, 6, 8, and 10% for reel scanners). Select five target moisture values spanning the range needed.

If it is feasible, prepare samples for each grade; if not, select a representative set of grades (see Section 7.1.2).

ATTENTION	A 5.5-inch die must be used to eliminate light leaks around the samples

7.1.2. 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, use the method of **Ambient Grade Grouping**:

1. For each grade, die out one sample and label it to indicate the grade.
2. Weigh each sample and calculate its basis weight:
3. Basis Weight (gsm) = Weight (grams) • (gsm Conversion Factor); using the appropriate gsm Conversion Factor for the sample size from Table 7-1.
4. Perform a Reference on the sensor with the sample paddle including the sample rings in the gap.
5. Using the sample paddle, measure each sample on the sensor.
6. Plot the sensor ratio RN-1 (vertical) vs. basis weight using symbols to identify the grades.
7. Draw a straight line through the main body of the points starting from near the origin.
8. Check to see if any points lay more than 10% above or below this line. If so, draw additional lines 10% above and below the central line, as needed (that is, pick a basis weight, note the corresponding RN-1, and multiply it by 1.1 and 0.9 to determine the positions of the lines using a common origin).
9. Select the grades to be moisturized using the following criteria:
    - Include grades that cover the full basis weight range.
    - Select representative grades for each line.
    - Choose grades that represent a large percentage of the customer's production, if this is known.

7.1.3. Carbon detection

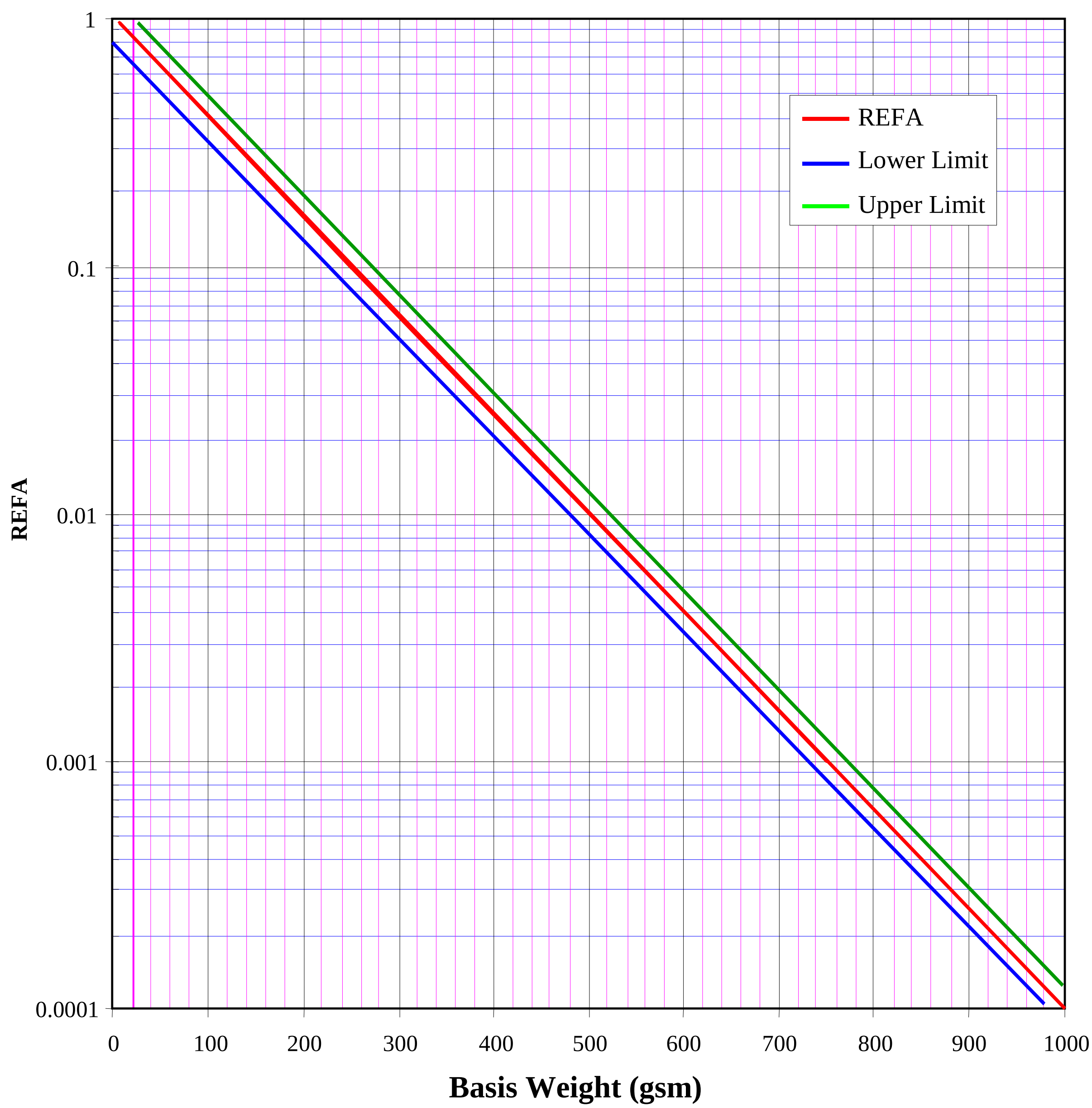
If you suspect that there is carbon, but cannot be certain, use the following procedure to determine if carbon is present:

1. Die out a sample at ambient moisture for each grade suspected, and weigh it to determine its basis weight.
2. Bag the sample without sealing it.

3. Perform a Reference with the paddle and rings in the gap.

4. Perform a Sample on the sample using the rings and paddle. If the volts in each channel are not adequate, adjust the gain/flag settings and repeat the Reference and Sample.

5. Note the REFA on the Sample printout and plot REFA versus basis weight (see Figure 7-1). If they fall below the central band, there is probably elemental carbon or iron oxide present in the sample.



The central diagonal band is for paper with no carbon or iron oxide.
Paper with carbon or iron oxide will give REFA values below the band.

Figure 7-1 Sensor REFA vs. Paper Basis Weight in gsm for IR Moisture Measurement Sensors

7.1.4. Selection of samples with high and low carbon content

If variable levels of carbon may be present due to use of recycle, use this procedure to select samples with low and high levels of carbon for the calibration. Ideally, each grade with variable levels of carbon should be represented by moisturized samples with high and low levels of carbon.

1. Collect a variety of samples (at least 21 by 28 cm, or 8.5 by 11 inches) from different days of production.
2. Check the samples visually for the grayest or darkest and the brownest or whitest ones. Select the extremes of color for trial measurement on the sensor, and arrange them by grade.
3. Perform a Reference with an empty gap.
4. Insert a sheet into the gap so that it is centered on the sensor windows, and perform a Sample. Be sure that the gain settings are correct (see Subsection 2.2.3).
5. Repeat the Sample for the other samples of that grade.

   The samples of the same basis weight with the lower REFA have the most carbon. For each grade, choose those samples with the highest and lowest REFA for sample preparation. The REFAs should differ by more than 10% to be significant.

7.2. Sample preparation

7.2.1. Materials required

These materials are required for sample preparation:

- Lab with controlled humidity and temperature (23°C or 73°F and 50% relative humidity), free from drafts and vibration
- Forced-air drying oven, controlled to 105 ± 0.5°C (221 ± 0.9°F), with drying racks and accurate thermometer
- Analytical balance, accurate to 0.1 mg
- Faraday cage balance pan

- Aclar bags (5.5-inch)
- Bag sealer
- Sample die (5.5-inch)
- Mallet for die
- Wood or hard rubber backing block for sample die
- Permanent ink pen for bags
- Rubber gloves
- Aluminum foil for sample protection
- Humidity cabinets, or beaker of boiling water (covered by screen) and tweezers
- Moisture Samples Worksheet (See Appendix B).

7.2.2. Dry weight determination

To determine dry weight:

1. Die out five samples for each grade selected.

   Do not use samples with worn or frayed edges; they will cause errors if pieces fall off.

2. Mark the sample I.D. and target moisture on each sample, near the edge.

   Be sure to use gloves and to keep bags and samples clean and dry. Accumulation of dirt and fingerprints will cause errors.

3. Dry all samples for four hours in the 105 ± 0.5°C (221 ± 0.9°F) oven.

   Make sure that no other materials are drying in the oven and that they are not disturbed.

4. Pre-weigh two Aclar bags for each sample: one bag for weighing the bone-dried sample (*dry* bag), and one bag for weighing the moisturized sample (*wet* bag).

5. Label each bag with the grade and target moisture level.

6. Record bag weights on the moisture sample worksheet.

7. Remove each bone-dry sample, quickly insert it in its dry bag and seal it, removing excess air.

8. Weigh the bone-dry samples and subtract the bag weights to get the dry sample weight.

9. Enter the dry sample weight on the worksheet.

10. Calculate a target weight for the wet samples using the following formula:

    $T = 100 \bullet Dg/ (100\text{-}M)$

    where

    T = target sample weight in grams

    M = target percent moisture

    Dg = bone-dry sample weight in grams

11. Enter the wet sample target weight on the worksheet.

12. For each sample to be moisturized, remove it from its dry bag (cut the bag open carefully) and bring it up to target moisture and weight.

    For moisture up to 4%, this can be done in the balance. For higher moistures, it will be necessary to use steam or conditioning chambers. In steaming samples, do the following:

    a. Hold the samples over boiling water and steam both sides evenly.

    b. Use a screen over the water as large errors can result from uneven wetting.

    Water drops from spattered, condensed, or picked up water will cause large errors. Discard and replace any samples that pick up drops.

13. Let each sample dry to the target weight on the balance, then seal it quickly in its Aclar bag, removing excess air.

14. Weigh the bagged samples and record the weights. Calculate the following:

    Wet Sample Weight (grams) = Sealed Bag & Wet Sample (grams) – Bag (grams)

Basis Weight (gsm) = Wet Sample Weight (grams) • gsm Conversion Factor

using the appropriate gsm Conversion Factor for the sample size from Table 7-1.

15. Calculate the water weight in grams in the sample:

    Water Weight (grams) = Wet Sample Weight (grams) - Dry Sample Weight (grams)

16. Calculate the water weight per unit area in gsm.

    WW(gsm) = Water Weight(grams) X gsm Conversion Factor

17. Calculate the percent moisture:

$$\%\ \text{Moisture} = \frac{100 \bullet \text{Water Weight (grams)}}{\text{Wet Sample Weight (grams)}}$$

18. Wrap each grade of samples in aluminum foil for protection, and allow them to condition for at least 24 hours before measurement on the sensor.

19. Reweigh and recalculate the lab values before measurement on the sensor.

Table 7-1 Basis Weight Unit Conversion Factors

Basis Weight Units	5.5-Inch Sample Conversion Factor
gsm	65.24
lbs/3300 ft2	44.1
lbs/3000 ft2	40.09
lbs/1000 ft2	13.362

7.2.3. Hardware checks

Before shooting calibration samples, make sure that the sensor is stable and up to specifications.

1. Check background/standardize values (See Section 9.2).

2. Check short term stability (See Section 9.3).

7.3. Sample measurement

7.3.1. Sample paddle setup

1. Clean the quartz-Teflon plates if they are dirty.
2. Slide the paddle into the gap and position it properly (make sure that the interlocking black rings are approximately centered over the quartz-Teflon plates).
3. Ensure the paddle handle is perpendicular to the sheet guide.

7.3.2. Reference

1. Set the Reference Integration Time to four seconds on the Sensor Maintenance display.
2. Insert the paddle and interlocking black rings without any sample.
3. Turn on the paddle's motor to start the sample rotating. Turn the paddle Reference switch on.
4. When the light goes out, remove the paddle from the gap.

When using the interlocking black rings, the REF, MES and 3RD voltages should not be lower than those for the empty gap by more than 0.5V. RS and RS2 should not have changed by more than 2% compared with those obtained for the empty gap. See Table 7-2 for a summary of allowed voltage levels.

If the channel voltages and ratios have changed more than what is specified in Table 7-2, check the paddle setup and alignment.

Table 7-2 Allowed Voltage Levels for alignment check of sample paddle

Hardware Check	Value
Allowed maximum REF, MES and 3RD volts drop with paddle and black rings at Reference	0.5V
Allowed maximum change for RS and RS2 with paddle and black rings	2%

7.3.3. Sample procedure

Before proceeding to shoot all the samples for all the grades, make sure that the gain/flag settings for the various grades are correct:

1. If the appropriate gain/flag for the grade is unknown, perform a Sample on the lowest moisture sample for the grade and make sure the REF channel gives between 1 and 8V.

2. As needed, raise or lower the gain/flag by loading a grade code that has been set up for the appropriate gain.

3. Make sure that the sensor is not saturated. Lowering the gain by one unit should lead to the expected drop in channels volts (approximately x3). If not, the sensor may be saturated.

Sample procedure:

1. Set Sample Integration Time to **4** seconds on the **Sensor Maintenance** display.

2. Clamp the sample into the interlocking black rings, taking care to center it well, and twist the rings to lock them.

3. Put the interlocking black rings and sample in the paddle.

4. Slide the paddle into the gap and position it properly (make sure that the rings are approximately centered over the quartz-Teflon plates). Ensure the paddle handle is perpendicular to the sheet guide.

5. Turn on the paddle's motor to start the sample rotating.

6. Press the sample button on the paddle.

7. When the sample light goes out, turn off the motor and remove the paddle from the gap.

ATTENTION

Fastcards saturate at 10V; however, with strong enough signals, the output voltage does not stay at 10V but drops to as low as 7.5V. Raise gain only if the REF voltages are below the lower limit.

7.3.4. Calibration tool

Sensor calibration is done by using the Advanced Moisture Calibration Tool in Experion MX (see Figure 7-2). The tool is accessed by pressing **Advanced** on the **Sensor Maintenance** display while in Maintenance mode and with the appropriate Moisture sensor selected.

The Advanced Moisture Calibration Display provides a user interface to perform calibration and verification of the moisture sensor.

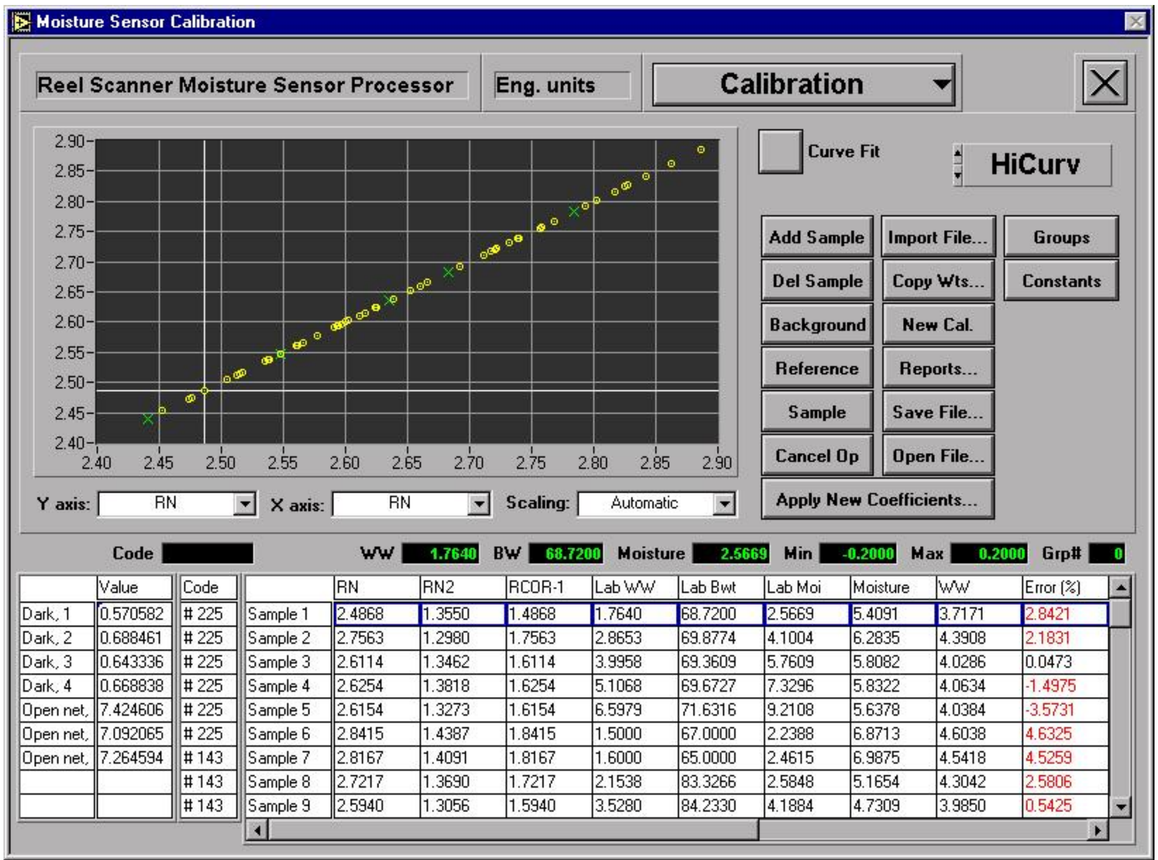


Figure 7-2 Advanced Moisture Sensor Calibration Display

While Maintenance Mode applies to an entire scanner, maintenance operations are targeted to a single sensor, therefore only one **Advanced** screen can be brought up at a time. The common interface maintains only one copy of working memory for the verification.

On top, the window 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.

7.3.4.1. Data entry

1. Select **Calibration** in the selector bar on the top right of the display.
2. Click **Import File…** to import the calibration file from the legacy calibration software MOICAL.

   Or you can enter the basis weight, lab water weight, and grade information manually. For this, click **Add Sample** to create the number of sample entries required, and then enter the values for each sample in the green entries above the table (See Figure 7-2).
3. Perform a background.
4. Perform a reference with the rotating sample paddle and interlocking black rings in the gap (see Subsection 7.3.2 for correct reference values).
5. Select the first row (Sample 1 in Figure 7-2) by clicking any field in the first row.

   Perform a Sample on each sample in the grade. See Subsection 7.3.3 for correct sampling procedure.

   When the operation is complete, the result is displayed in the Sample data table. The cursor (the highlighted row) automatically moves down to the next entry.
6. Change the gain/flag settings if required before proceeding to sampling the next grade.
7. If the gain/flag settings have changed or if more than 10 minutes has passed since the last Reference, perform a Reference (with sample paddle and interlocking black rings in the gap).
8. Perform a Sample on each sample in the next grade. All samples from a grade must be measured with the same gain/flag settings.
9. Repeat for each grade of bagged samples prepared.
10. Save the raw data by clicking **Save File…**. Two files are created. The first is a binary file that you can reload using **Open File…**. The second is a text file with the *.txt* extension.

CAUTION

When all sampling is complete, visually inspect the gap to make sure that it is clear before scanning the heads.

7.4. Calibration fit and data reduction

For calibration fit and data reduction, follow the procedures in this section. In case of difficulty, request the assistance of Honeywell Technical Assistance (TAC).

7.4.1. Recalibration

The static calibration from the factory should verify on site within accuracy specifications. After verification using the procedure in Section 7.5, dynamic calibration is required (see Section 6.3).

A recalibration may be required if the factory calibration does not verify within accuracy specifications. It may also be performed to calibrate new grades or if significant hardware components were changed (for example, Infrand plates).

In a typical recalibration, only the slope and intercept are refitted. The other calibration constants such as SingleCal, HiCurve, and so on, stay with the factory settings.

Prepare the appropriate samples and measure them on the sensor, following the procedures in Section 7.1. Then recalibrate:

1. In the **Advanced Moisture Sensor Calibration** display, load the raw calibration data file. Select **Calibration** in the drop down menu.

2. Click **Constants** and the **Moisture Calibration Constants** dialog appears (Figure 7-3).

3. Enter the factory values. Do not enter the AAA and DDD values as these will be recalculated.

Figure 7-3 Moisture Calibration Constants

4. In the display, select **Cal** in the selector bar, and then click **Curve Fit**.

5. Accept the recalibration. If the recalibration is performed on the same grades as the ones used by the factory, the slope value (AAA) should not differ from the factory value by more than 10-20%.

6. Inspect the calibration data using the plot function, selecting Error (%) on the Y axis and Moisture on the X axis. Most of the errors should be equal or less than the static accuracy (usually ±0.25% - see Section 1.6).

7. If the calibration does not meet the static accuracy:

   a. Some samples may have either poor lab or sensor values and should be repeated or discarded and replaced.

   b. Another possibility is that there are too many grades in the group. Use the group function to remove a grade from the group. Once the groups have been identified, it may be convenient to save the calibration data in a separate file (that is, one calibration file per group of grades).

8. Print the calibration report by clicking **Reports…** and then selecting **Calibration**. Make sure that the appropriate correctors are selected on the Sensor Maintenance display so that all the calibration parameters appear on the report.

7.4.2. Full calibration

A full calibration may be required to calibrate new grades if the accuracy specifications are not met with a recalibration. In a full calibration, the necessary correctors are identified and all the static calibration parameters are refitted.

Prepare the appropriate samples and measure them on the sensor, following the procedures in Section 7.1. Then proceed to the full calibration:

1. In the **Advanced Moisture Sensor Calibration** Display, load the raw calibration data file. Select **Calibration** in the drop-down selector bar).

2. Click **Constants** and the **Moisture Calibration Constants** dialog appears (Figure 7-3).

3. Enter **0** in all the fields except in the AAA and DDD fields.

4. In the display, select **Cal** in the selector bar and then click **Curve Fit**. This calculates a slope and an intercept. Click **Accept**.

5. Inspect the raw data using the plot function, selecting **Lab WW** on the Y axis and **RN** on the X axis. The data should spread like a hand fan. One grade is represented by a line. If the hand fan is very wide, the SingleCal corrector may need to be used. If the lines are curved, the HiCurv corrector may be required.

6. If the data set includes a number of grades and/or if the basis weight range is significant (± 10%), SingleCal may be necessary. Select **SingleCal** and click **Curve Fit** and then **Accept**.

7. If necessary, select **HiCurv**, click **Curve Fit** then **Accept**. HiCurv is typically required for wide moisture range (≥10%), high moisture samples (above ambient) and/or medium to high basis weight.

8. If carbon is present in the sheet (see Section 7.1.3), carbon correction may be required. Make sure that the C2 and C3 calibration parameters are set to their default values in the recipe calibration table (C2 = **0** and C3 = **50**). Select Carbon, click **Curve Fit** then **Accept**. For a successful Carbon calibration, it is imperative that a good sample set be used (see Section 7.1.4).

9. Check the calibration parameters. They must be within the range specified in Table 7-3. If the calibration parameters are outside the specified limit then:

    a. One of the correctors used may not be needed.

b. The data set does not support the use of one of the correctors selected (that is, there is not enough range in the sample set for percentage moisture, Basis weight and/or carbon content).

10. Select **Cal** in the drop down menu and click **Curve Fit**. This recalculates a slope and an intercept. Click **Accept**.

11. Inspect the calibration data using the plot function, selecting **Error (%)** on the Y axis and **Moisture** on the X axis. Most of the errors should be equal or less than the static accuracy (usually ±0.25%, see Section 1.6).

12. The calibration may not meet the static accuracy for the following reasons:

    a. Some samples may have either poor lab or sensor values and should be repeated or discarded and replaced.

    b. There are too many grades in the group. Use the group function to remove a grade from the group. Once the groups have been identified, it may be convenient to save the calibration data in separate file (that is, one calibration file per group of grades).

    c. The proper corrector(s) has (have) not been selected. Try other correctors.

13. Print the calibration report by clicking **Reports…** then selecting **Calibration**. Make sure that the appropriate correctors are selected on the **Sensor Maintenance** display so that all the calibration parameters appear on the report.

CAUTION

The calibration process is iterative. It is necessary to use the Curve Fit function iteratively selecting the appropriate corrector(s), then selecting **Cal**, the corrector(s) again, then **Cal**, and so on until the calibration tool finds the optimum minimum.

CAUTION

To remove a corrector, click **Constants** and put a zero in the appropriate field(s) (see Table 7-3 for a list of calibration parameters and associated corrector).

CAUTION

Only use a corrector if it improves the calibration significantly. The calibration error should drop by a minimum of 10-20% when the corrector is used.

Table 7-3 Calibration parameters

Calibration parameter	Range	Description
AAA	0.5 - 20	Water weight slope
DDD	±10	Water weight intercept
BBB	±0.01	SingleCal primary corrector
CCC	±100	SingleCal secondary corrector
CURV	±0.3	HiCurv corrector
GGG	0 – 1.25	Carbon primary corrector

7.4.3. Entry of calibration constants

In the **Advanced Moisture Calibration** display, click **Apply New Coefficients…** to store calibration constants to the recipe database (see Figure 7-4). A new table can be created to link to a particular recipe. Otherwise, the data is stored in the current code's table. Check or uncheck each coefficient to store. Only checked values are written to the recipe database.

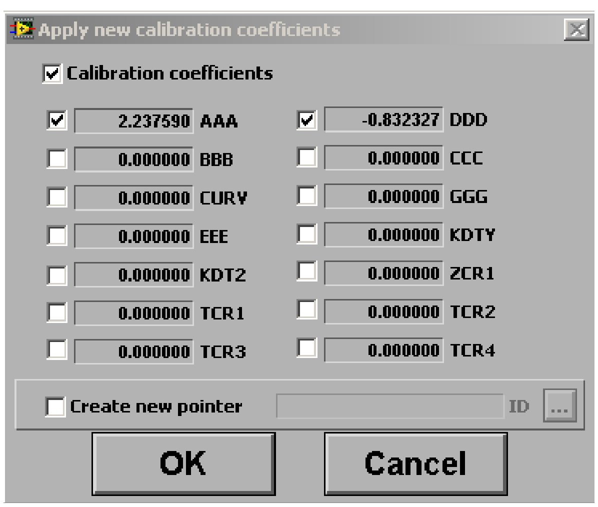


Figure 7-4 Apply new calibration coefficients

It is also possible to manually enter the calibration constants in a grade code through the Recipe Maintenance display on the **Setup** menu. In the appropriate recipe, click on the **Main Code Table** tab and select the M**oisture sensor Calibration Table**. Enter the calibration coefficients and click **Save**. The appropriate correctors also need to be enabled/disabled in the Moisture Sensor Configuration Table (see Chapter 5).

For temporary usage, the calibration constants can be entered through the Calibration Constants Table under **Calibration Constants** in the **Sensor Maintenance** display. Enable or disable Correctors through the Recipe-based options in the Sensor Maintenance display. To enable a corrector, double-click on it. A check mark shows in front to indicate that it has been enabled (to disable a corrector, double-click on it again and the check mark disappears).

7.5. Verification

Verification of the factory static calibration is required during installation. Verification can also be performed at any time to confirm the calibration parameters of current and/or new grades.

Like calibration, verification is done using the **Advanced** display. Bring up the Advanced display by clicking **Advanced…** in Maintenance mode from the **Sensor Maintenance** display. To enter verification, select **Verification** in the drop-down selector bar. See Figure 7-5.

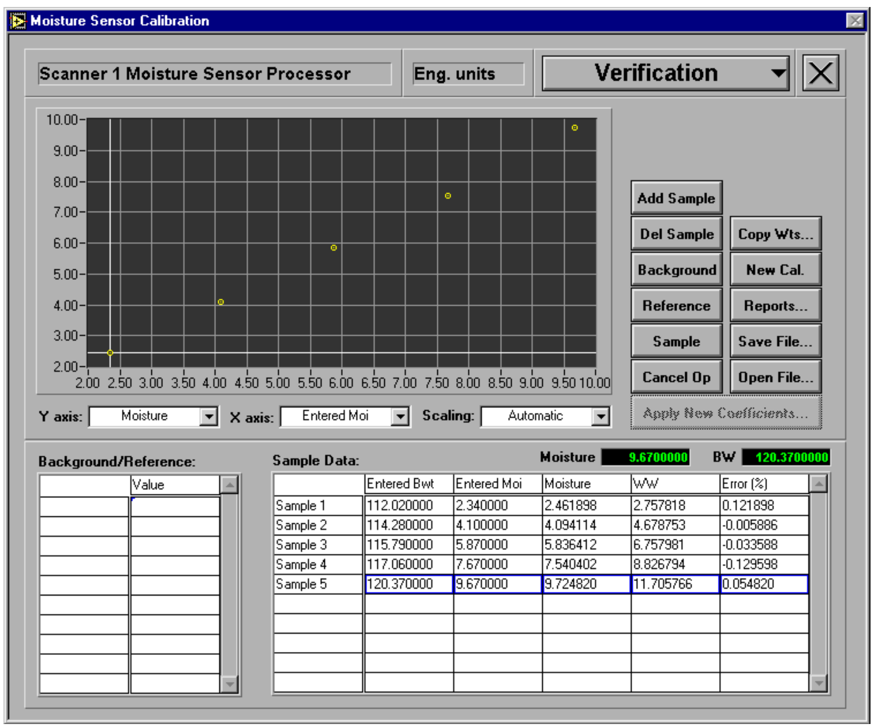


Figure 7-5 Advanced Display

To verify previously calibrated grades:

1. Ensure that the sensor is stable. See Section 9.3.

2. Load a grade code containing the calibration constants and correctors of the samples to be verified.

3. Ensure that the appropriate calibration constants and correctors are properly restored on the **Sensor Maintenance** display.

4. Request a printout of the calibration constants by clicking **data** (printer icon) on the **Sensor Maintenance** display.

5. In Maintenance mode, click **Advanced…** from the **Sensor Maintenance** display.

6. Start from a blank Sample data table.

   It is blank the first time you call up the Advanced screen; otherwise, click **New Cal.** to reset the working space to blank.

7. Load the lab values from a file if the appropriate file exists, or click **Copy Wts…** to copy the lab values from the Calibration table to the verification table.

8. If the lab values have never been entered, set up the Sample data table by clicking **Add Sample** once for every sample in a grade. For each sample, enter the lab basis weight and %moisture in the green field above the table. Save the entered data to a file before starting shooting samples.

9. With nothing in the gap, click **Background** to request a background operation.

   The result appears in the **Background/Reference** table in the lower left corner.

10. Perform a Reference with the paddle and interlocking black rings in the gap. See Subsection 7.3.2 for the Reference measurement procedure.

    The result also appears in the Background/Reference Table.

11. Place the cursor on the first row in the Sample data table, and perform a Sample using the paddle and interlocking black rings. See Subsection 7.3.3 for the proper procedure on sample measurement.

    When the operation is complete, the result is displayed in the Sample data table. The cursor (the highlighted row) automatically moves down to the next entry.

Repeat the sample measurement until all of the samples in a grade are measured.

12. Save the data again to include the verified data.

13. Repeat the steps above from step 2 for each grade of samples prepared.

14. Select **Error (%)** on the vertical Y axis and **lab Moisture** on the horizontal X-axis to view the verification results graphically.

15. Make a note of any samples that measure with an error of greater than the 2•σ accuracy specification (see Section 1.6). If more than 20% of the samples that were not omitted during calibration fail this criterion, repeat the verification and/or calibration until success is achieved. If more than one sample needs to be omitted per grade, then replace the omitted samples for that grade with freshly-made samples.

7.5.1. Verification of sheet temperature insensitivity

This procedure is normally only performed when there is reason to suspect that the temperature compensation is not adequate.

To perform this procedure, you need:

- Glass-encased samples
- Empty glass Reference disk
- An oven set to 60°C (140°F)
- Sample paddle
- A towel, cloth, and/or hot glove (to protect the hands and to keep the samples hot on the way to the scanner)

1. Set up a grade code or codes with the appropriate gain/flag, calibration constants, and correctors to be used for the glass-encased samples.

2. Load the appropriate grade, and ensure that the proper grade data is loaded on the **Sensor Maintenance** display.

3. Set up the Sample Data Table for the glass samples to be measured through **Advanced**; enter the appropriate sample calculated basis weight. For more details on how to perform this step, see Section 7.5.

ATTENTION

When there is a change in gain/flag, a new Reference is required before sampling.

4. Perform a Reference with the paddle and empty glass Reference pair.

   The REF, MES and 3RD volts should be about 5% lower than those obtained with an empty gap.

5. Perform a Sample with the paddle and the appropriate glass-encased sample at ambient temperature (do not use rings or the pair of glass plates used for the Reference). Repeat for the other glass-encased samples.

6. Heat the samples for five minutes in the 60°C (140°F) oven along with the Reference pair, and then carry them to the sensor in a towel.

7. Perform a Reference on the empty glass Reference pair, and repeat Steps 1 – 5 for each hot glass-encased sample.

8. Allow the sample to cool to ambient temperature for at least ten minutes (longer for heavier samples).

9. Perform a Reference with the Reference pair, and repeat Steps 1 – 5 for each cooled glass-encased sample.

   The result should be that the two ambient temperature readings would repeat within 0.10% moisture.

10. Calculate the percent moisture reading change between the averaged ambient temperature readings and the hot reading; it should be less than ± 0.30% moisture.

If the above conditions are not met, request the assistance of Honeywell Technical Assistance (TAC).

7.5.2. Determination of GFLAGs

It is necessary to determine GFLAG, GFLG2, and GFLG3. These constants correct for the attenuation of the flag that is not inserted for certain grades. These values are measured by the factory during calibration. Follow the procedure below if you suspect that the flag correction parameters are inadequate.

Find a glass-encased sample that gives adequate volts (all three channels give between 0.5 and 8.0V) with the Flag in and gain 2 or 3 on and with the Flag out and Gain 0 on, and then follow the procedure:

1. Set GFLAG, GFLG2, and GFLG3 to 1.0 in the **Calibration Table** through the **Recipe Maintenance** display in the **Setup** menu.

   These constants can also be entered on the **Calibration Table** in the **Sensor Maintenance** display.

2. Load a grade code that is set up for Flag IN Gain 2 or 3; verify that GFLAG, GFLG2, and GFLG3 are set to 1.0 on the **Calibration Table** in the **Sensor Maintenance** display.

3. Perform a Background.

4. Perform a Reference with the glass Reference disk in the paddle.

5. Measure the glass sample on the sensor with the paddle.

6. Load a grade code that is set up for Flag OUT and Gain 0; verify that GFLAG, GFLG2, and GFLG3 are set to 1.0 on the **Calibration Table** in the **Sensor Maintenance** display.

7. Perform a Background.

8. Perform a Reference with the glass Reference disk in the paddle.

9. Measure the glass sample on the sensor with the paddle.

10. Request a printout of the REFA values:

    a. Change over to the **Sensor Reporting** display.

    b. Select **Moisture Sample Report**.

    c. Select the desired parameters to be printed under **Field Names** by double-clicking on the field.

       A check mark shows in front of the field to indicate that it is selected. To deselect a field, double-click on it again and the check mark disappears.

    d. Press **data** (printer icon) to request a printout of the selected parameters.

11. Calculate:

$$\text{GFLAG} = \frac{\text{REFA (Flag OUT, Gain 0)}}{\text{REFA (Flag IN, Gain 2 or 3)}}$$

$$\text{GFLG2} = \frac{\text{RN (Flag IN, Gain 2 or 3)}}{\text{RN (Flag OUT, Gain 0)}}$$

$$\text{GFLG3} = \frac{\text{RN2 (Flag IN, Gain 2 or 3)}}{\text{RN2 (Flag OUT, Gain 0)}}$$

12. Enter the values calculated in the previous step into the grade codes through the **Recipe Maintenance** display for permanent storage. They can also be entered on the **Calibration Constants Table** in the **Sensor Maintenance** display for temporary usage.

8. Preventive Maintenance

8.1. Preventive Maintenance

Preventive maintenance procedures are minimal. The frequency of preventive maintenance procedures is often defined by the operating environment.

In Table 8-1, **X** indicates recommended maintenance intervals, and **AR** indicates adjust the interval on an as-required basis.

Table 8-1 Preventive Maintenance Internal checklist

Procedure	Daily	Weekly	Months		Years			Procedure Details
			1	3	1	2	5	
GENERAL								
Clean sensor window	AR							Section 9.1
Check standardize/background values		X						Section 9.2
Check short term stability			X					Section 9.3
Replace IR Lamp				X				Section 9.4
Assess sensor stability using glass samples		X						Section 9.5
Dynamic verification		X						Section 9.12

9. Tasks

This chapter contains procedures for maintaining optimal HPIR Moisture sensor function or troubleshooting issues with the HPIR 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.

9.1. Clean sensor window

Inspect the Daily Sensor Report each day to check for the level of dirt and any indications of instability or failure.

Activity Number:	Q4287-57-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

Keep the sensor windows clean. Clean with a cloth or paper towels dipped in methanol or isopropyl alcohol and wrapped on a thin stick.

CAUTION

The windows are made of thin quartz and are fragile. Broken windows must be replaced, and complete recalibration of the sensor will be required.

For recommended values for correction to moisture due to dirt buildup, see Subsection 6.3.4.2.

If the dirt buildup causes the ratio to go out of limits, clean the plates more often. It may also be necessary to increase the tolerance of the ratio limit and/or of the ratio Drift limit on the drift check to prevent alarms caused by too much dirt buildup (see Section 10.1).

To increase the tolerance:

1. Press **SETUP** on the horizontal dispatcher.
2. Select **Recipe Maintenance**.
3. Under **MAIN CODE TABLE**, select the **Moisture Sensor (e.g. MOIP11) Limits Table**.
4. Increase the **Moisture Sensor ratio limit and/or ratio drift limit** value (*MOIP Ratio Drift Lim*, *MOIP min Ratio Lim* and *MOI max Ratio Lim*).

9.2. Check standardize/background values

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

Activity Number:	Q4287-57-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:		**Post Procedures:**	Realign after replacing parts
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. In the Sensor report display, select **Moisture Background Report** (see Figure 9-1).

2. Select the desired parameters under the field name by double-clicking on them. Use the printer button to print them out.

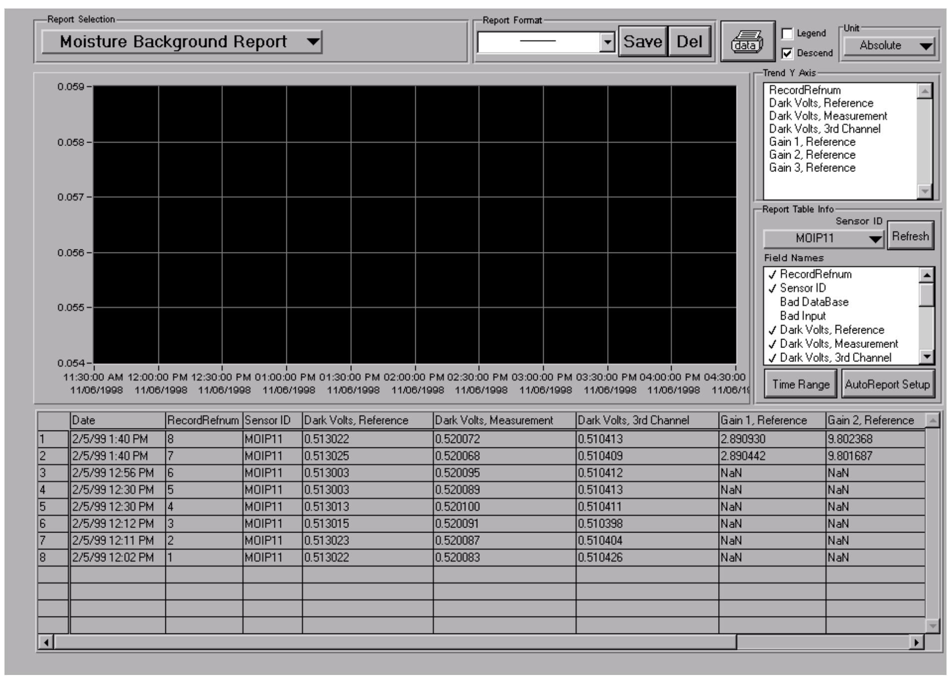


Figure 9-1 Moisture Background Report

3. **Dark volts** for the three channels (REF, MES, 3RD) should be between 0.45 V and 0.6 V.

4. **Gain 1** gain factors for the three channels should be between 2.85 and 3.05.

5. **Gain 2** gain factors for the three channels should be between 9.6 and 10.1
6. If a Dark Volt or a Gain factor is not within these limits, consult the troubleshooting table (See Section 10.2).
7. In the Sensor report display, select the **Moisture Standardize Report.**
8. Standardize volts should be within 0.5 V of each other
9. Standardize volts are expected to move up and down with head temperature. Channel volts decrease (increase) when head temperature increases (decreases).
10. Excessive common mode drift (all three channels drift in phase) may be due to the instability of the source and receiver power supplies, temperature controller card, chopper driver or lamp/lamp holder.
11. Excessive uncorrelated drift of one or more channels (that is, channels drift differently from each other) maybe due to one or more bad detectors. See Section 10.2 for troubleshooting.
12. In the event that the standardize volts are stable but far apart (that is, greater than 0.5 V from each other), hardware alignment is required (see Align Fastcard board).

ATTENTION

The maximum number of records per sensor in the Sensor Reports file is 100 for Background and 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 it is advisable to save the sensor report regularly.

9.3. Check short term stability

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

Activity Number:	Q4287-57-ACT-003	**Applicable Models:**	All
Type of procedure:	Inspect	**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:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To check Background measurements:

1. Go into maintenance mode (see Chapter 6).
2. On the **Sensor Maintenance** display (see Figure 9-2), set **Bkdg. Integr. Time** for background (in seconds) to **4.00** for four seconds.
3. Perform two Background operations with nothing in the gap.

   The Dark volts should be repeated within 2% and be between 0.45 and 0.6 for Fastcards.

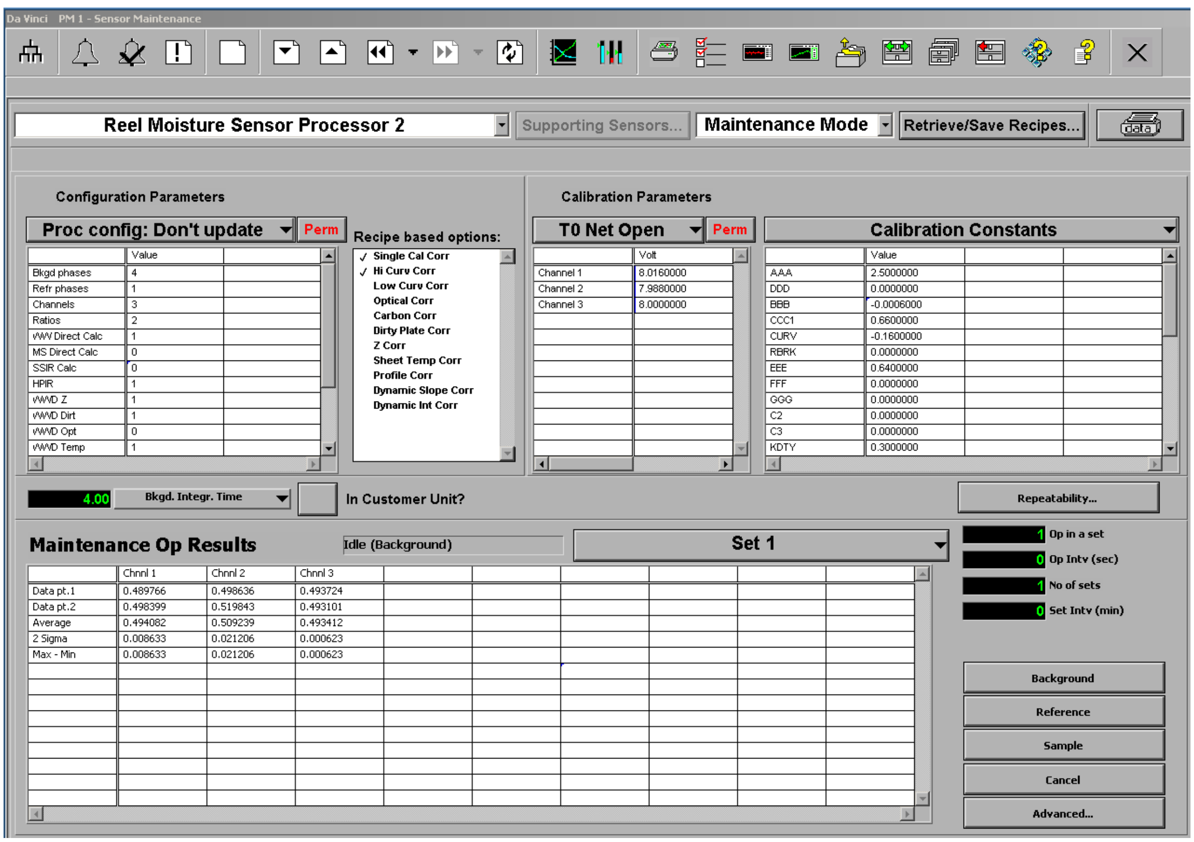


Figure 9-2 Sensor Maintenance Display

To check Standardize measurements:

1. Ensure that the head temperature is within specifications (typically ±1 °C) and is stable (refer to your scanner manual).

2. On the Sensor Maintenance display, set **Integration Time** for reference (in seconds) to **4.00** for four seconds.

3. Set up to request at least 2 sets of 10 reference operations in a 10 minute period with nothing in the gap (see Figure 9-3).

The results of more than one set of (10) operations usually give a reliable picture of the short-term stability of the sensor. Compare the resulting statistics against the specification. If all four of the following conditions are met, the sensor is within specifications:

- REF, MES, and 3RD channel volts are within 0.5V of each other
- $2 \cdot \sigma(RS)/\text{Average}(RS) < 0.0010$
- $2 \cdot \sigma(RS2)/\text{Average}(RS2) < 0.0010$
- (Max-Min) volts for each channel is no more than 12 mV

If the sensor is close to but does not meet the specifications, check that the head temperature is stable. If the head temperature is not stable, wait until it becomes stable (or fix head temperature stability issue – refer to your scanner manual) and then redo the stability test. If the sensor still does not meet the specifications, consult the troubleshooting guide (see Section 10.2).

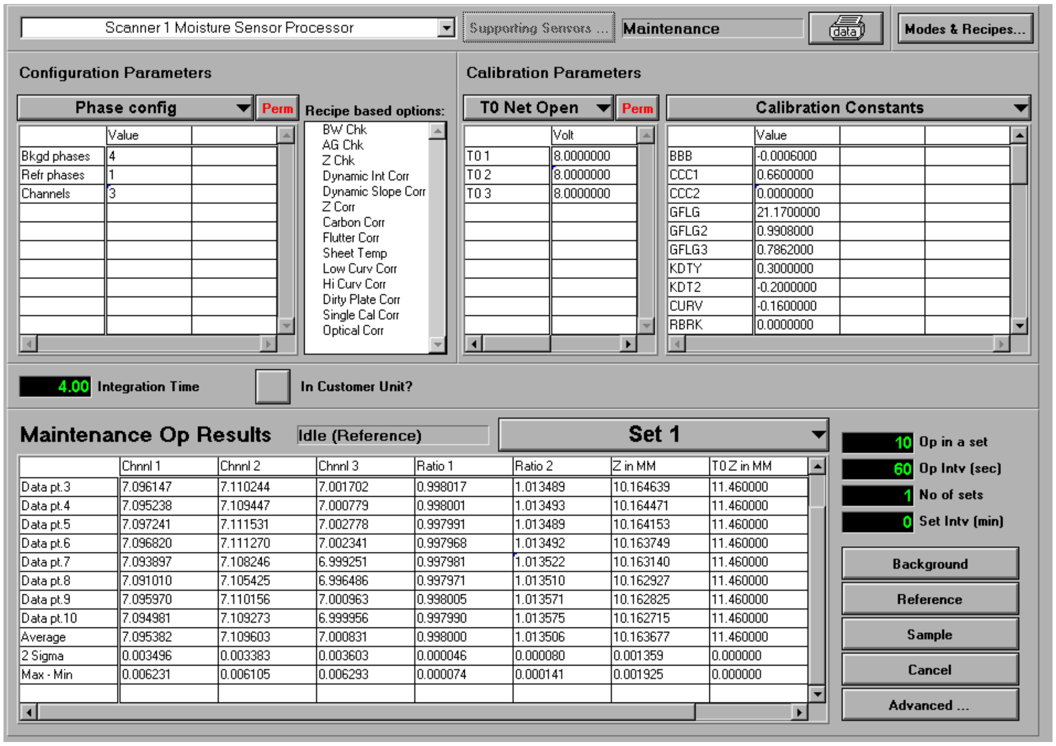


Figure 9-3 Reference Display

9.4. Replace IR lamp

Regular replacement of the IR lamp ensures continuous operation of the moisture sensor and prevents unexpected failures. The IR lamp is powered directly by the 24 VDC power supply. The lifetime of the lamp can vary greatly from one lamp to another and is hard to predict.

Activity Number:	Q4287-57-ACT-004	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	Electric Shock
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	3 months
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	Align Fastcard board
	Part Number	Quantity	Lead Time
Required Parts:	38000007	1	In stock

	Part Number	Quantity	Lead Time
Required Tools:	• Cloth • Phillips-head screwdriver • Allen key 5/32		

Change the lamp on a regular basis (default is every three months). The lamp (38000007) comes assembled with a mounting holder and the electrical connection wires.

1. Turn off scanner power (refer to your scanner manual for the procedure to safely disconnect power).

2. Pull sensor source out from the scanner head for easier access if required (refer to your scanner manual for details).

3. Remove clamp holding the lamp cover and remove lamp cover (Figure 9-4).

4. Disconnect the lamp leads at TB1 on the backplane board (See Subsection 2.1.1).

Figure 9-4 Lamp cover

5. Loosen the three screws securing lamp (Figure 9-5).

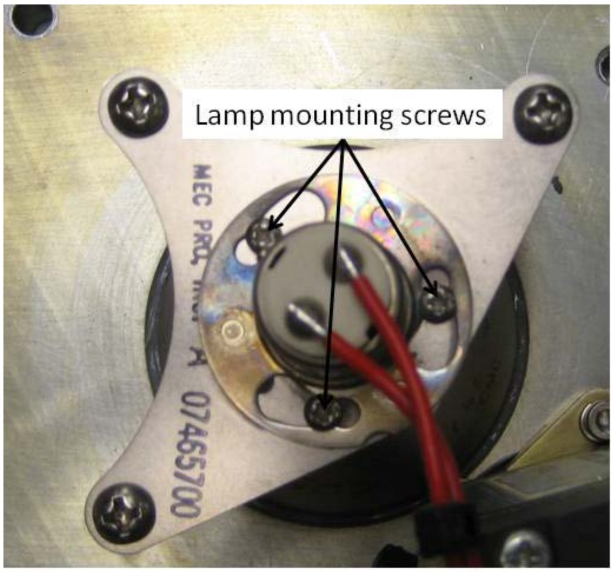


Figure 9-5 Lamp mounting screws

6. Carefully remove the lamp.

CAUTION	Remove lamp using a cloth, as the lamp could still be hot.

7. Insert the new lamp. Always use a cloth. Do not touch the lamp with your bare fingers. Tighten the three screws.

8. Reinstall the lamp cover and secure it with the two clamps.

9. Reconnect the leads to the terminal block (TB1 on backplane).

10. Turn the power to the scanner back on (refer to your scanner manual for the procedure to reconnect power).

11. Check and adjust gain and phase of Fastcards. See Align Fastcard board.

9.5. Check long term stability

The long term stability of the sensor can be assessed by shooting glass samples regularly. Glass samples are ambient samples encased in glass which, if stored properly, stay stable for months. A large shift in the sensor reading can be the indication of a hardware issue.

Activity Number:	Q4287-57-ACT-005	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 week
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:	Check short term stability	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	• Sample paddle • Reference glass disk • Glass-encased samples		
	Part Number	Quantity	Lead Time
Required Tools:			

Verification of glass-encased samples involves the following steps:

1. Go into maintenance mode (see Chapter 6).
2. Check the sensor stability (See Check short term stability).
3. Click **Advanced…** and select **Verification** on the drop down menu.
4. Load the file containing the glass samples basis weight and lab moisture values using the **Open File…** command or enter the values manually. See Section 7.5 for more details on data entry if required.
5. Perform a background.

6. Load the (first) grade for the glass sample(s) to download the calibration constants. Check that the proper calibration constants and correctors appear on the **Sensor Maintenance** display.

7. Perform a Reference with the paddle and reference glass disk.

8. Perform a Sample on each glass sample within a grade. With the appropriate gain/flag settings, the voltage readings should be between 0.5 and 8V for each channel.

9. Repeat steps 6-8 for each grade.

10. Save the verification file using the **Save File…** function.

11. Seasonal shifts in the moisture readings are expected when verifying glass samples. However, a sudden shift in the readings is indicative of a problem.

12. Ensure that the proper gain/flag settings, calibration constants, correctors are loaded.

13. Confirm that the glass sample seal is not damaged (that is, use more than one glass verification sample).

14. If a hardware issue is suspected, check sensor alignment (Section 2.1) and proceed to the troubleshooting section.

9.6. Replace board

Printed circuit boards are not to be repaired in the field. Replace defective boards and return them to Honeywell for repair.

Activity Number:	Q4287-57-ACT-006	**Applicable Models:**	All
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	Electric Shock
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	Realign after replacing parts
	Part Number	Quantity	Lead Time

Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

CAUTION

Wear a static electricity discharge band on your wrist and ground its wire.

1. Turn off head power before removing or inserting a board.
2. Handle boards by their edges or wear clean gloves. Do not touch edge connectors on printed circuit boards.
3. Exchange only one board at a time.
4. If a replacement board does not solve a problem, reinstall the original before proceeding.
5. Set jumpers and/or switches of new boards exactly as positioned on the replaced board and/or check jumper settings (see Section 2.1).
6. Tag the defective board (at the time you confirm that it is defective) with the suspected trouble or symptom.

9.7. Realign after replacing parts

Replacement of some parts requires realignment of other parts (See Table 9-1).

Activity Number:	Q4287-57-ACT-007	**Applicable Models:**	All
Type of procedure:	Adjust	**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:	Replace a board	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			

	Part Number	Quantity	Lead Time
Required Tools:			

Table 9-1 Replaced Parts Requiring Realignment of Other Parts

Replaced Item	Check/Section
Source:	
Lamp	Gain, and phase of Fastcards See Replace IR lamp and Align Fastcard board
Motor	Motor frequency (See Subsection 2.1.1.2) Gain and phase of Fastcards (See Align Fastcard board)
Source Backplane	Check R1 if using pulse-width power (See Subsection 2.1.1.3)
Sync Gen/Lamp Mod Board	Align Sync signal Gain and phase of Fastcards (See Align Fastcard board)
Motor Controller Board	Motor frequency (See Subsection 2.1.1.2)
Single-Sided Detector Board	Align Sync signal Gain and phase of Fastcards (See Align Fastcard board)
Receiver:	
Detector Preamp	Peltier cooler voltages (See Subsection 2.1.2.2) Gain and phase of Fastcards (See Align Fastcard board)
Fastcard	Gain and phase of Fastcards (See Align Fastcard board)
Temp Control Board	Peltier cooler voltages (See Subsection 2.1.2.2) Gain and phase of Fastcards (See Align Fastcard board)
Unigauge Backplane Board	See Subsection 2.1.2.1 Gain and phase of Fastcards (See Align Fastcard board) Edge detect, if used (See Subsection 2.1.2.4)
Quartz Plates:	
Optically Tuned Plates	Gain of Fastcards (See Align Fastcard board); Check dynamic calibration (See Dynamic verification) and if required static calibration (See Chapter 7)

9.8. Check for water in Quartz-Teflon Plates

HPIR Moisture sensors use composite Quartz-Teflon plates to create an optical cavity around the sheet, requiring the light to make multiple passes through the sheet to reach the offset optics detectors. The quartz is breakable, and the Teflon is porous and can become filled with water.

Perform this test if you suspect that moisture trapped in the plates is affecting the measurement.

Activity Number:	Q4287-57-ACT-008	**Applicable Models:**	All
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	Replace Quartz-Teflon plate
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	Blow dryer		

If water has entered a plate, the water will cause a very strong reduction in the MES volts during Standardize/Reference and may be visible upon inspection.

To check for water in the plates:

1. Perform a Reference.
2. Split the heads.
3. Heat the central area of the Quartz-Teflon plate (7.5 cm by 2.5 cm, or 1 in. long by 1 in. wide) with a blow dryer to drive the water away.

   You should observe some change in appearance.
4. Once the plate is hot, quickly put the heads back together and perform several References.

If water has entered a plate, the MES volts should increase when the plate is hot and then gradually fall as the plate cools down and the moisture redistributes itself.

If water has entered a plate, in most cases the Quartz-Teflon plates must be replaced. See Replace Quartz-Teflon Plates.

9.9. Replace Quartz-Teflon Plates

HPIR Moisture sensors use composite Quartz-Teflon plates to create an optical cavity around the sheet, requiring the light to make multiple passes through the sheet to reach the offset optics detectors.

The quartz is breakable. The Teflon is porous and can become filled with water. Replace any cracked or broken plates.

Activity Number:	Q4287-57-ACT-009	**Applicable Models:**	All
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	6 hours	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	Realign after replacing parts Dynamic verification
	Part Number	Quantity	Lead Time
Required Parts:	See Table 9-2		
	Part Number	Quantity	Lead Time
Required Tools:	• Exacto knife • Flat head screwdriver • Alcohol • Tissue		

See Remove the Plate and Install the Plate.

9.9.1. Remove the Plate

1. Remove the plate using an Exacto knife to cut the RTV around the edge and a screwdriver to pry it out.

2. Clean the RTV off the sheet guide using the knife and screwdriver, followed by alcohol and tissue.

3. Remove the Light Pipe, using a knife to cut away the RTV at the sheet guide and the RTV holding the Light Pipe to the head platform.

4. Push the Light Pipe in either direction to dislodge it.
5. Clean away the RTV using a knife, followed by alcohol and tissue.

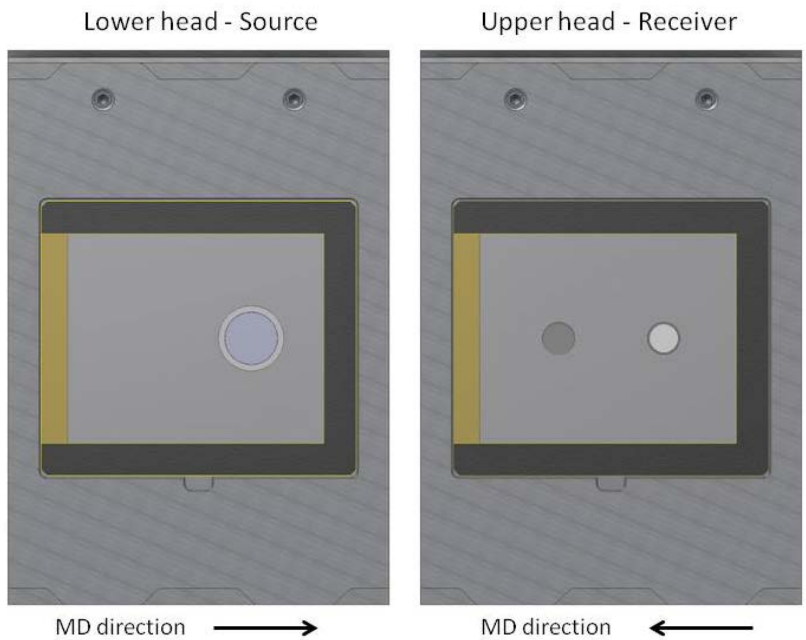


Figure 9-6 Orientation of Black-Border Quartz-Teflon Plates

9.9.2. Install the Plate

The part numbers for materials needed to install the plate are listed in Table 9-2.

Table 9-2 Plate Installation Part Numbers

Description	Upper Head		Lower Head	
	Part No.	Quantity	Part No.	Quantity
Plate	08607801	1	08632100	1
Light Pipe	00300000	1	-	-
Plug	00309700	1	00309700	1
Clear RTV	16000001	As required	16000001	As required

Optically tuned black border plates minimize dynamic correction. Because of the consistency of manufacture of the plates, a sensor does not normally require recalibration if the plates have been replaced. Check the calibration, however.

1. Place the sheet guide on a flat surface facing up.
2. Insert the Light Pipe into the hole so that it projects about 6mm (0.25 in.) at the sheet guide.
3. Fill the circular cavity around the Light Pipe with clear RTV.
4. Push the Light Pipe back in until it only projects by about 3mm (0.125 in.).
5. Without pausing, lay down a bead of clear RTV about 6 mm (0.25 in.) wide around the inside of the rectangular recess for the plate.
6. Place the Quartz-Teflon plate into the recess, pushing against the RTV and Light Pipe until the plate is flush with the sheet guide. Optically Tuned plates should be mounted with the white edges opposing:

   On the lower head, the white edge should be on the offset optics side; on the upper head, the white edge should be on the straight-through optics side (See Figure 9-6).

   Make sure that the Light Pipe does not fall through. It may be helpful to gently restrain it with masking tape and a ball of paper in the head (make sure the restraint does not lift the plate).
7. Using tissue and alcohol, wipe off any excess RTV around the plate. Be sure the side cavities are filled with RTV. Allow the RTV to dry for at least four hours.

9.10. Align Fastcard board

Fastcard boards need to be aligned every time a sensor part (electronic or optical part) has been replaced. It is also necessary to align a Fastcard board when the corresponding channel voltage has drifted significantly.

Follow the procedure in this section for all three boards.

Activity Number:	Q4287-57-ACT-010	**Applicable Models:**	All
Type of procedure:	Adjust	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	Electric Shock
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	

Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	• Voltmeter • Oscilloscope • Small flat head screwdriver		

1. There are five jumpers on the Fastcard board. Four of the jumpers are labeled H/L, and they govern the frequency response. Check to see that these are in the H position for the High power sensor (See Figure 9-7).

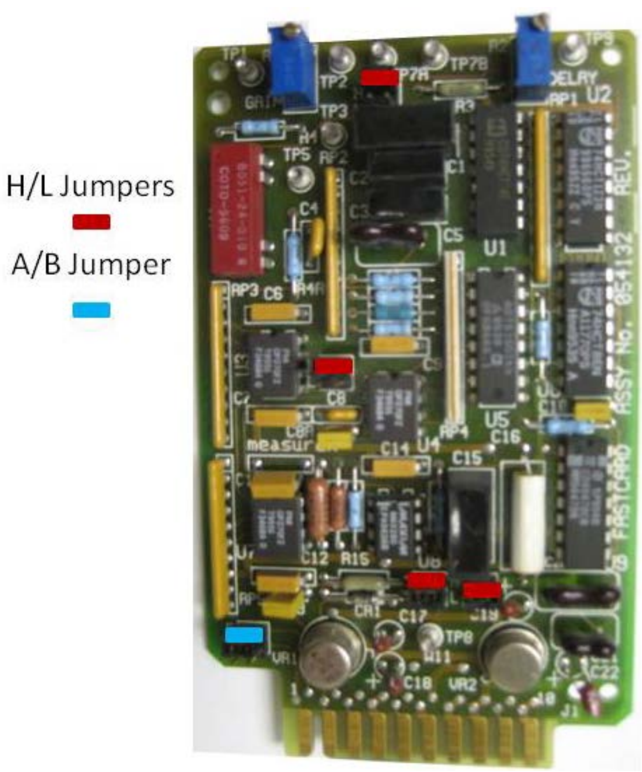


Figure 9-7 Fastcard – location of the High/Low Power jumpers (x4) and A/B jumper

2. The fifth jumper is labeled A/B and it governs the phase delay. Check to see this is on B – where it is normally for the High power sensor, but it may need to be switched to A in order to be able to adjust the phase properly (See Figure 9-7).

3. Check the output of the Detector Preamp by connecting the oscilloscope probe to TP2 (signal) and TP1 (Gnd) of the Fastcard. The signal should be a 170 Hz sine wave of amplitude between 0.3 and 3V peak-to-peak.

4. If the signal is greater than 3V, select a lower gain on the corresponding PbS detector assembly by changing the jumper selection on the Fast Preamp board (See Figure 9-8).

   If the signal is less than 0.3V, select a higher gain by changing the jumper selection on the Fast Preamp board.

   There are three jumper-selectable gains; their exact values depend on the revision of the assembly.

   The highest gain is selected by placing a jumper in position W1, medium gain is selected by placing the jumper in position W2 and the lowest gain is selected by removing the jumper or by placing it across the W1 and W2 positions as shown in Figure 9-8.

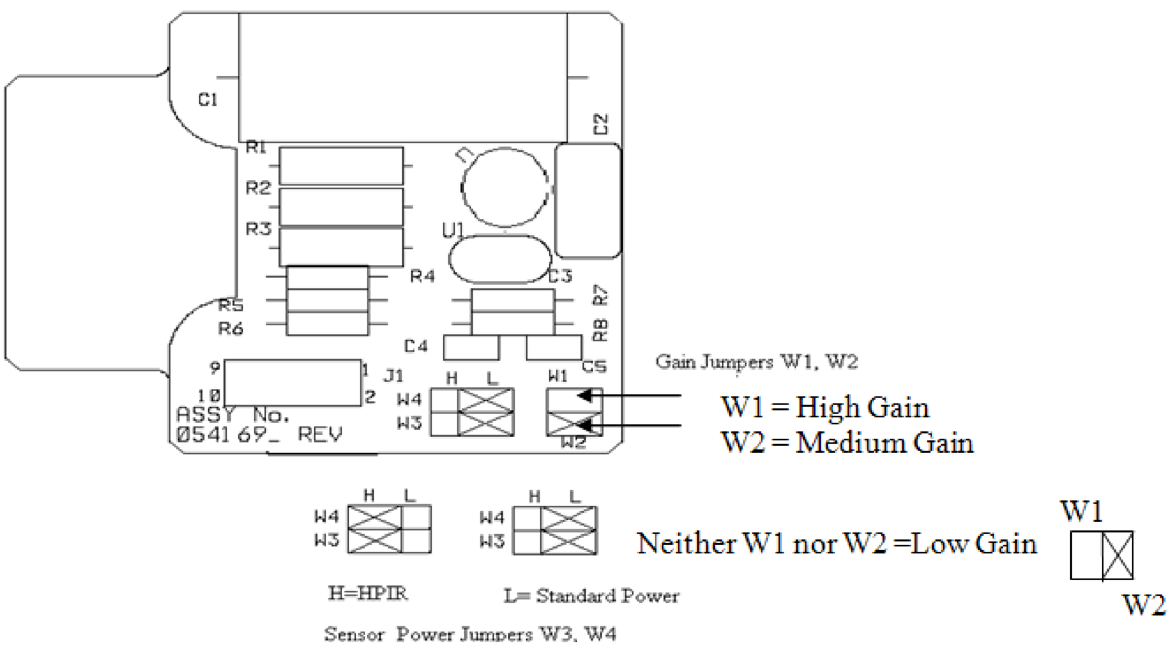


Figure 9-8 PbS Detector Assembly

5. Connect the voltmeter to TP9(+) and TP1(Gnd) and connect the oscilloscope probe to TP7A and TP1(Gnd) of the Fastcard. Adjust R1

on the Fastcard to bring the meter reading into the range from 4 to 8 VDC.

6. Adjust R2 to balance the phase (see Figure 9-9). Phasing adjustment can be done using TP7A and TP7B on the Fastcards. If phasing is impossible on Fastcard, change the selection on jumper W5/W6.

ATTENTION

> Switching spikes will appear on some sensors. Disregard their position and magnitude. If the sine wave from the preamp is asymmetric, the balance could be above or below ground (B1 or B3).

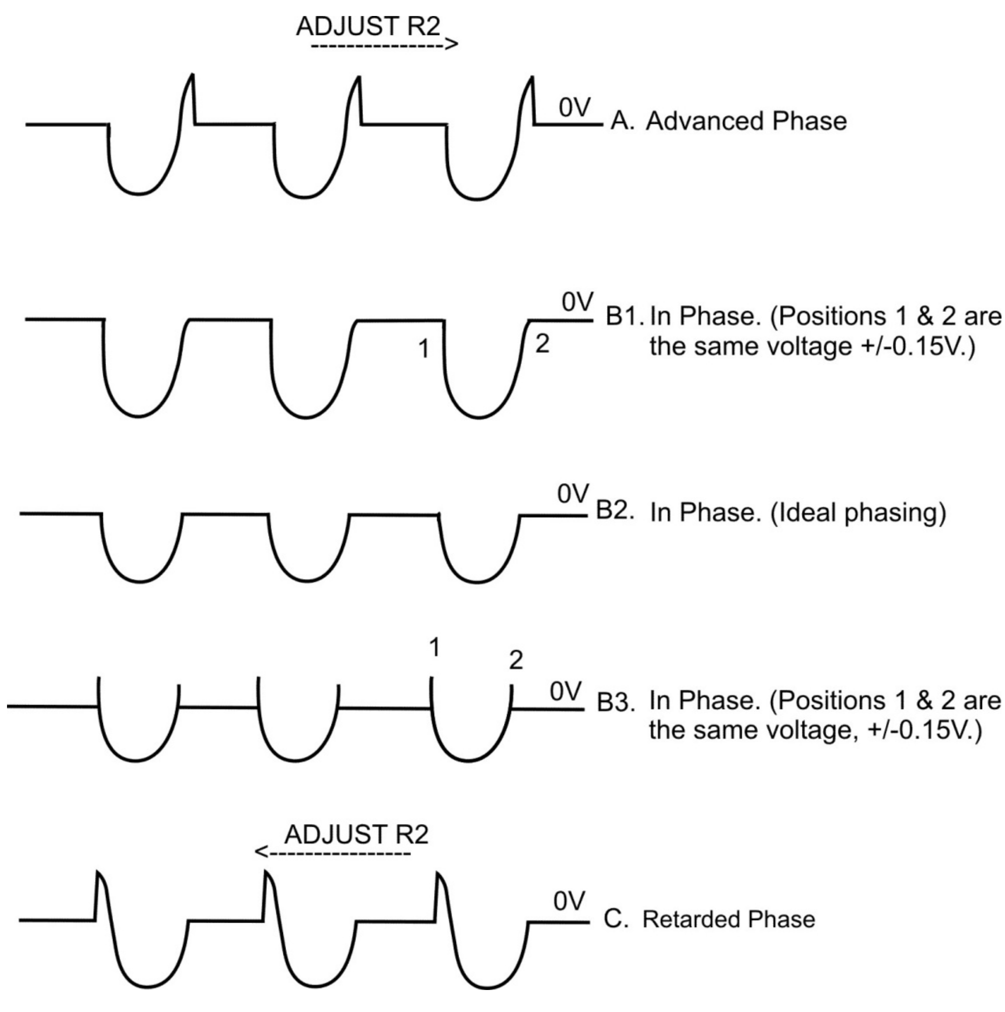


Figure 9-9 Phase Adjustment

7. Adjust R1 again to bring the meter reading to 7.5 ± 0.1 VDC. If it is not possible to bring the meter reading to this level, select a different jumper on the Fast Preamp board in the Detector Preamp Assembly.

The test points should be as shown in the summary Table 9- (with TP1 as ground).

Table 9-3 Test Points for the Fastcard Board

Test Point	Voltage
TP2	0.3 to 3 VAC peak-to-peak
TP3	0.6 VAC peak-to-peak
TP4	N/A
TP5	1.2 VAC peak-to-peak
TP6	N/A
TP7A, TP7B	4V trough-to-peak half-sine wave
TP8	3.5V trough-to-peak both half-sine waves
TP9	7.5 VDC

None of the AC signals should be clipped.

9.11. Align Sync signal

The Sync signal is generated by the Single-Sided Detector board and the Sync Gen board in the source head.

A missing sync signal might be due to misalignment of the detector board.

Activity Number:	Q4287-57-ACT-011	**Applicable Models:**	All
Type of procedure:	Adjust	**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):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	• Voltmeter • Oscilloscope • Small Phillips-head screwdriver		

1. Connect oscilloscope probes to TP3 and TP4 with TP5 as ground on the Sync Gen/Lamp Modulator board (See Figure 2-4 for location of test points).

   TP3 should give a clean square wave, which indicates clear detection of the chopper wheel position by the Single-Sided Detector. See Figure 9-10 for a photograph of the Single-Sided Detector board.

   TP4 should give narrow clock pulses generated from the small holes in the wheel. Amplitudes should be about 9V.

2. If the signals are not clean or of adequate magnitude, adjust the three spring-loaded mounting screws on the Single-Sided Detector to correct the signals (Figure 9-10).

   TP2 should give a clean square wave of 10V amplitude. The frequency is 170 Hz (period 5.88 ms) +/- 25 Hz.

3. If necessary, the frequency can be adjusted using the pot on top of the Motor Controller board (See Figure 2-6 for location of potentiometer R2).

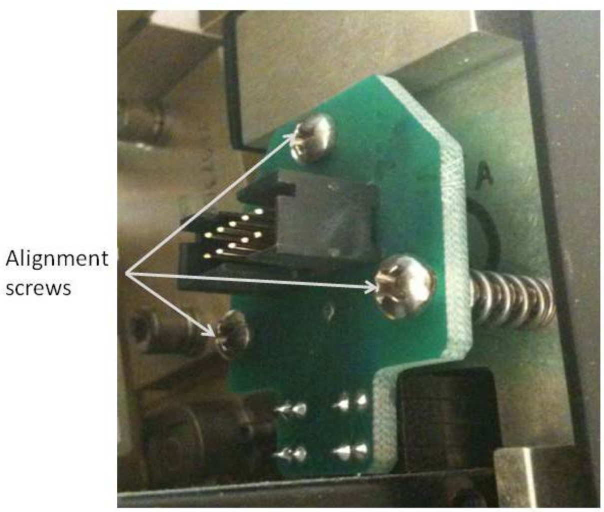


Figure 9-10 Single-Sided Detector board

9.12. Dynamic verification

Dynamic correction is included to correct for flashoff (evaporation from hot sheet) of moisture between the scanner and reel (Reel scanners only), any difference between static calibration readings on bagged samples and onsheet readings, and/or for any residual sheet temperature dependence in the sensor.

Dynamic calibration should only be performed after static calibrations (See Chapter 7) have been performed and verified. Dynamic verification is necessary whenever a quartz window is replaced, a filter is changed, or the static calibration is significantly changed.

Perform dynamic verification once a week.

Activity Number:	Q4287-57-ACT-012	**Applicable Models:**	All
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	None	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 week
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	• Pre-weighed and numbered plastic bags, at least 11 by 18 inches (28 by 46 cm) • Pre-weighed rubber bands • Tape measure of adequate length to measure from edge to center of sheet • Reel Sampling Template (see Figure 6-7) • Sharp utility knife for cutting samples from reel • *IR Moisture Sensor worksheet* (p/n 42000852, page 5) • Laboratory balance accurate to 0.05% of sample weight. Usually a top-loading balance accurate to .01g is acceptable. • Forced-draft, temperature-regulated drying oven, located in a room with constant temperature and humidity. The oven must be set for 105.0 ±0.5°C (221.0 ± 0.9 °F).		

See Section 6.3 for a detailed procedure on performing dynamic verification.

10. Troubleshooting

The troubleshooting chapter is divided in two sections:

- Alarm based troubleshooting: Troubleshooting steps to be taken in response to a specific alarm generated in the Experion MX system.
- Non-alarm based troubleshooting: Troubleshooting steps that may not be related to a specific alarm in the Experion MX system.

10.1. Alarm based troubleshooting

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

10.1.1. Bad dark volts

Default values for upper and lower limits for dark volts are 0.6 V and 0.45 V, respectively.

Symptom	Possible Cause(s)	Solution (Tasks)
Dark volts are outside limits. For any channel, $Volts_{Dark} \geq$ Upper Limit OR $Volt_{Dark} \leq$ Lower Limit	Fastcard failure	Check standardize/background values to confirm Replace Fastcard (Replace board, Align Fastcard board)
Dark volts are outside limits. For all channels, $Volts_{Dark} \geq$ Upper Limit OR $Volt_{Dark} \leq$ Lower Limit	Harness failure	Check/replace harness between EDAQ and sensor backplane
	EDAQ failure	Replace EDAQ (See MSS and EDAQ manual Honeywell p/n 6510020381)

10.1.2. Bad standardize ratio

Default values for upper and lower limits for the standardize ratio are 1.05 and 0.95, respectively.

Symptom	Possible Cause(s)	Solution (Tasks)
One or more of the standardize ratios have drifted too much from the nominal value (1) **For any of the two standardize ratios:** **$Ratio_{Standardize}$ > Upper Limit OR** **$Ratio_{Standardize}$ < Lower Limit** **where:** **Ratio = $NetOpenVolts_{ChannelA}$ / $NetOpenVolts_{ChannelB}$** **and:** **NetOpenVolts = $Volts_{Standardize}$ – $Volts_{Dark}$**	Too much dirt on the Infrand plate	Clean sensor window If the issue cannot be avoided, increase the ratio limits in the Moisture Sensor Limit Table
	PbS detector drift issue. One or more of the channels have drifted too much from each other	Align Fastcard board Change faulty PbS detector
	Various hardware issues	See Non –alarm Based troubleshooting.

10.1.3. Standardize Ratio drift

Default value for the standardize ratio drift limit is 0.1

Symptom	Possible Cause(s)	Solution (Tasks)
One or more of the standardize ratios have drifted too much from the time zero values **For any of the two standardize ratios:** **| $Ratio_{Standardize}$ - $Ratio_{TimeZero}$ | > Ratio Drift Limit** **where:** **Ratio = $NetOpenVolts_{ChannelA}$ / $NetOpenVolts_{ChannelB}$** **and:** **NetOpenVolts = $Volts_{Standardize}$ – $Volts_{Dark}$**	Too much dirt on the Infrand plate	Clean sensor window If the issue cannot be avoided, increase the ratio drift limit in the Moisture Sensor Limit Table or change the time zero net open volts In the Sensor Maintenance display (Maintenance mode only)
	PbS detector drift issue. One or more of the channels have drifted too much from each other	Align Fastcard board Change faulty PbS detector
	Various hardware issues	See Section Non –alarm Based troubleshooting

10.1.4. Bad Net Volts

Symptom	Possible Cause(s)	Solution (Tasks)
Channel volt readings from one or more channels are lower than the dark volts for the corresponding channels	Lamp failure	Replace IR lamp
	Sync signal from the source is missing	Align Sync signal
	If only on one channel: Fastcard failure	Swap/replace Fastcard (See Replace board and Align Fastcard board)
	EDAQ failure	Replace EDAQ (Refer to Chapter 5 in MSS and EDAQ manual 6510020381).

10.1.5. Bad Gain

Symptom	Possible Cause(s)	Solution (Tasks)
Gain values calculated during the last background are outside limits	Fastcards are not adjusted properly	Align Fastcard board
	Gain attenuate relay or gain optocoupler on backplane failed	Replace backplane (See Replace board)
	Flag solenoid failed	Change flag solenoid

10.1.6. Bad Z reading

Symptom	Possible Cause(s)	Solution (Tasks)
The Z correction is ON and the Z sensor standardize was flagged as bad	Faulty Z sensor	Repeat standardize to confirm Check/replace Z-sensor – refer to your scanner manual

10.1.7. Bad Z correction

Symptom	Possible Cause(s)	Solution (Tasks)
The Z correction is ON and the Z sensor measurement was flagged as bad	Faulty Z sensor	Check/replace Z-sensor – refer to your scanner manual

10.1.8. Bad temperature correction

Symptom	Possible Cause(s)	Solution (Tasks)
The dynamic slope correction is ON, the dynamic temperature corrector is not equal to 0 and the sheet temp or air gap measurement was flagged as bad	Faulty sheet temp or air gap sensor	Check/replace sheet temp or air gap sensor – refer to your scanner manual

10.2. Non –alarm Based troubleshooting

Table 10-1 contains troubleshooting information for HPIR sensors.

Table 10-1 Troubleshooting HPIR sensors

Symptom	Possible Cause(s)	Check/Action
Lamp not lit	Lamp failure	Replace IR lamp
	24V failure	Check 24 ± 0.5V on Source Backplane board (TB1-1 and TB1-2)
	Sync Generator/Lamp Modulator board failure (if alternate lamp power method is used)	Replace Sync Gen/Lamp Mod board (See Replace board) See Subsection 2.1.1.3 for a description of the alternate lamp power method
No phase square wave at TP2 on Sync Generator/Lamp modulator board	Single-Sided Detector Board needs adjustment	Align Sync signal
	Motor failure	Check chopper motion/replace Motor
	Motor Controller Board failure	Check chopper motion/ replace Motor Controller Board (See Replace board)
	Sync Generator/Lamp Modulator board failure	Replace Sync Gen/Lamp Mod board (See Replace board)
	Single-Sided Detector board failure	Replace Single-Sided Detector board (See Replace board)

Symptom	Possible Cause(s)	Check/Action
No signal at TP2 on Fastcard	PbS Detector Module failure	Check other channels. If issue only with one channel, swap or replace PbS detector and/or harness (See Replace board).
	Failure of lamp, motor, motor controller board or backplane failure	If all the channels are affected, check lamp (Replace IR lamp), chopper operation, and backplane 250V, ±15V, 6/8V.
Fastcard cannot be adjusted into phase.	Jumper set wrong	Check Fastcard jumpers. Swap Fastcard jumper A to B or vice versa (See Align Fastcard board)
	Temp Board failure	Check/replace Temp Board (See Replace board)
Fastcard will not adjust to 7.5V at TP9.	Gain jumper on PbS Detector set too low	Check TP2 on Fastcard. The signal should be between 0.3V and 3V pk-pk with nothing in the gap. Adjust PbS detector gain accordingly (See Align Fastcard board)
	Flag is retracted	Flag should be in to adjust Fastcards. Actuate flag.
	Flag solenoid failed	Change flag solenoid
	Fastcard failure	Swap/replace Fastcard (See Replace board and Align Fastcard board)
	Temp Board failure	Check/replace Temp Board. (See Replace board)
All 3 channels unstable.	Head temperature unstable	Check head temperature
	Lamp contact oxidized	Change lamp (See Replace IR lamp)
	Single-Sided Detector board needs adjustment	Align Sync signal to give clean signals on Sync Gen board TP3 & TP4
	Motor problem	Check that the motor frequency is stable on Sync Gen board TP2
	Fastcards may be saturated	Check flag and gain settings. Check Fastcards TP7 A&B (See Align Fastcard board)
One channel unstable.	Fastcard may be saturated	Check Fastcard TP7 A&B (See Align Fastcard board)
	Detector unstable	Swap/replace PbS Detector
	Fastcard unstable	Swap/replace Fastcard (See Replace board)

Symptom	Possible Cause(s)	Check/Action
	Temp Board failure	Check/Replace Temp Board (See Replace board)
Low standardize volts and unstable channels	Temp board failure	Check/replace Temp Board (See Replace board)
	Water in the Infrand plates	Check for water in Quartz-Teflon Plates

11. Storage, Transportation, End of Life

11.1. Storage and transportation environment

In order to maintain integrity of sensor components, storage and transportation of all equipment must be within these parameters:

Duration of Storage	Acceptable Temperature Range	Acceptable Humidity Range
Short Term (less than one week)	-20°C to 45°C	20-90% non-condensing
Long Term	-10°C to 40°C	20-90% non-condensing

11.2. 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 using environmental friendly methods. Contact the factory for further details and instructions.

12. Glossary

Bin (or Measurement Bin)	The smallest measurement zone on the frame. Also called **Bucket** or **Slice**.
Bucket	See **Bin**.
CD	**Cross Direction**
	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 MD (Machine Direction) that relates to a position along the length of the paper machine.
Distant End	The end of the scanner opposite the Cable End.
DMAE	Dynamic slope corrector.
DMBE	Dynamic offset corrector.
Drive Side (DS)	The side of the paper machine where the main motor drives are located. Cabling is routed from this end. Also called **Back Side**.
Experion MX	Honeywell's latest Quality Control System. See **QCS**.
InfrandPLUS	Offset optics called INFRAND for INfinite RANDom scattering optics.
KAYE	Dynamic temperature corrector.
MD	**Machine Direction**
	The direction in which paper travels down the paper machine.
MDYN	Percent moisture reading of the sensor, including dynamic correction.
MLAB	Percent moisture of the sample determined in the lab.

MSTAT	Percent moisture reading of the sensor, without dynamic correction (correction calculated out).
QCS	**Quality Control System** A computer system that manages the quality of the product produced.
RAE	**Real-Time Application Environment** The system software used by 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 Set	The term used in the Sensor Maintenance displays to describe a set of sensors working together on a scanner to perform one measurement.
Setpoint (SP)	Target value (desired value). Setpoints are defined process values that can be modified by entering new values through the monitor, loading grade data, and changing a supervisory target.
Slice	See **Bin.**
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.
Tending Side (TS)	The side of the paper machine where the operator has unobstructed access. Also called **Front Side**.
TEESH	Air gap temperature at slice position.
T0SH	Air gap temperature at calibration time (default 100°F).
Trend	The display of data over time.

A. Part Numbers

The part numbers in Table A-1 are provided for reference purposes. Items marked with an asterisk (*) are included in Spares list (6572000062).

Table A-1 Part Number List for High Power Moisture Sensors

Part Number	Name
05298102*	Temperature Control Board
05340900*	Single-Sided Detector Board
6581500021*	Sync Generator/Lamp Modulator Board
05421400*	Motor Controller Board
05401100*	Unigauge Backplane, Type II
05413200*	Fastcard Board
08431800*	Lamp assy, High power IR source
08631800*	Fast PbS Detector Assembly
6581500030*	EDAQ
08607801	Quartz-Teflon Plate Assembly (upper)
08632100	HPIR Quartz-Teflon Plate Assembly (lower)
22000041	Solenoid, rotary
35000081	Motor
08435400	Fan assy
00300000	Light pipe, receiver
08446000	Cone assy – Hi power source
38000172	Beamsplitter
6580801557	Cable assy, Moisture receiver
6580801556	Cable assy, Moisture source
08480400	Cable assy, adapter High power source
42000806	Aclar Bags 5.5 inch
07612500	Sample die 5.5 inch
42000030	Bag Sealer
42000272	Rubber Gloves
08347804	High Power Source Assembly
08347707	High Power Receiver Assembly

B. Moisture Samples Worksheet

Print out the linked Microsoft® Excel worksheet for use in the Sampling procedure in Chapter 7.