Honeywell

Porosity Measurement

System Manual

(POROS Porosity User's Manual)

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Porosity Measurement

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Notice

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Introduction

The purpose of this manual is to introduce the Honeywell Porosity Measurement. This sensor measures the porosity (or air permeability) of a moving sheet.

This manual describes Porosity Measurement model numbers Q4219-51, and Q4219-52.

ATTENTION

The terms *Porosity sensor*, *POROS sensor*, and *POROS Porosity sensor*, refer to the *Porosity Measurement*. These terms may be used interchangeably in this manual.

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 10 chapters and two appendixes.

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

Chapter 2, **Introduction to Paper Porosity**, describes the principle and theory of paper porosity.

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

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

Chapter 5, **Calibration**, describes procedures for calibrating the system.

Chapter 6, **Preventive Maintenance**, describes recommended ongoing preventive maintenance tasks.

Chapter 7, **Tasks**, describes procedures for maintenance, diagnostic, and troubleshooting tasks.

Chapter 8, **Troubleshooting**, describes symptoms, alarms, possible causes, and links to associated diagnostic or troubleshooting tasks.

Chapter 9, **Storage, Transportation, and End of Life**, describes methods for storing, transporting, and disposing sensor components.

Chapter 10, **Glossary**, describes the terms and acronyms used in this manual.

Appendix A, **Paper Samples Collection**, lists details to be aware of when collecting paper samples.

Appendix B, **Technical Bulletin**, provides a copy of Technical Bulletin 6510493015.

Related reading

The following documents contain related reading material.

Honeywell Part Number	Document Title / Description
	Papermaking Science and Technology, Book 17, Pulp and Paper Testing, Book editors: Jan-Erik Levlin, Liva Söderhjelm, 11.10.2000
	PaperHelp OnLine, 2.7.4 Air Resistance
	Baker, C. F., "Good Practice for Refining the Types of Fiber Found in Modern Paper Furnishes," Tappi J. 78 (2): 147 (1995)
	Han, S. T., "Compressibility and Permeability of Fiber Mats," Pulp Paper Mag. Can. 70 (5): 65 (1969)
	Knauf, G. H., and Doshi, M. R., "Calculation of Aerodynamic Porosity, Specific Surface Area, and Specific Volume from Gurley Seconds Measurements," Proc. TAPPI 1986 Intl. Process and Materials Quality Eval. Conf., 33 (1986)
6510493015	Procedure of adjusting measuring element movement speed

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

1.1. Introduction

This chapter provides an overview of the POROS Porosity sensor and its functioning principles.

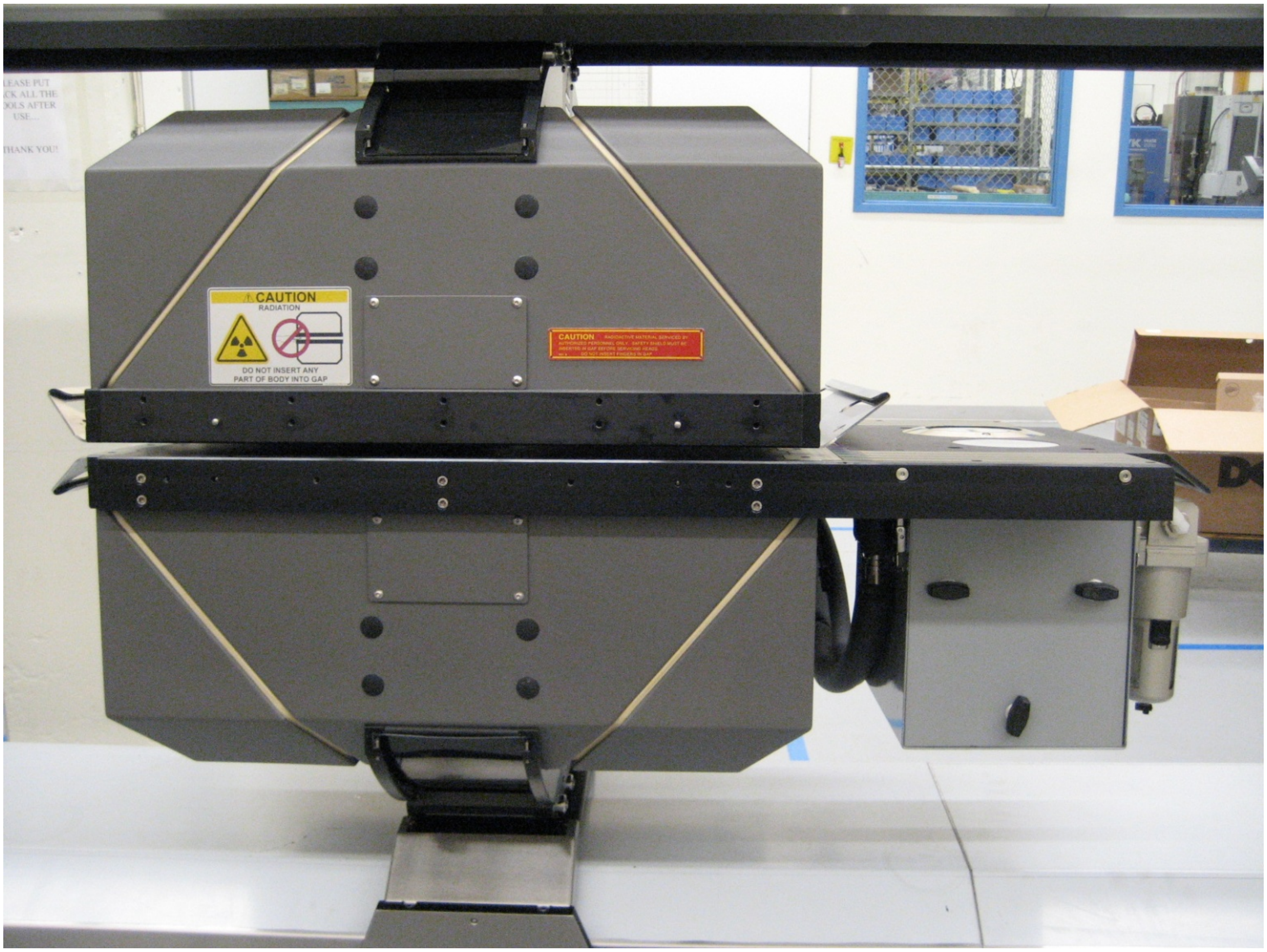


Figure 1-1 Porosity Sensor Outboard Installation

Some key features of the POROS Porosity sensor:

- single-sided
- below the paper web
- outboard configuration, normally in CD position
- contacts the sheet when measuring
- own edge detectors to control sensor cleaning
- needs one sensor slot in lower scanner head for EDAQ card

The Porosity sensor is always an outboard sensor. The recommended installation locations are the two CD positions as shown in Figure 1-2.

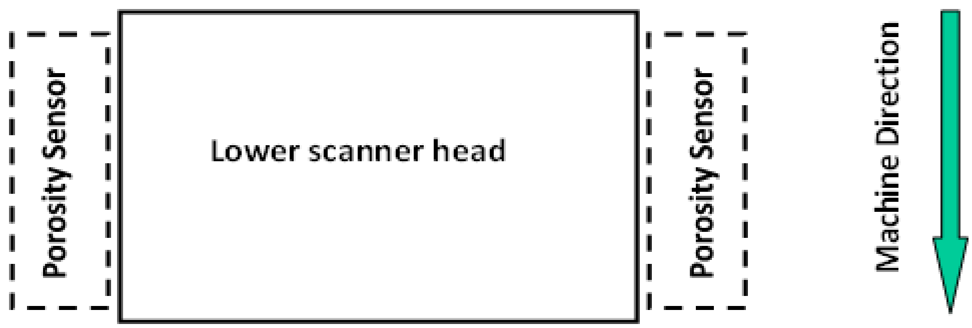


Figure 1-2 Porosity Sensor Recommended Locations (dashed boxes)

1.1.1. Sensor models

Table 1-1 lists POROS Porosity sensor versions. The sensor has two versions: one for normal environmental conditions, and one for hot environmental conditions.

Table 1-1 POROS Porosity Sensor Models

Model	Name	Temperature
Q4219-51	Porosity sensor, medium range, high temperature	10–93 °C (50–199.4 °F)
Q4219-52	Porosity sensor, medium range, normal temperature range	10–50 °C (50–122 °F)

Model Q4219-51 specific features:

- water cooling can be connected to sheetguide and sensor housing to protect the sensor against high temperatures
- sensor housing is a modified CBM (color backing module) DuoPack

Model Q4219-52 specific features:

- sensor housing designed for lower temperature applications
- water cooling should not be used with this sensor model, because cooling might cause water condensation inside the sensor that could damage electrical components

1.1.2. Main components

Figure 1-3, Figure 1-4, and Figure 1-5 illustrate the components of the Porosity sensor.

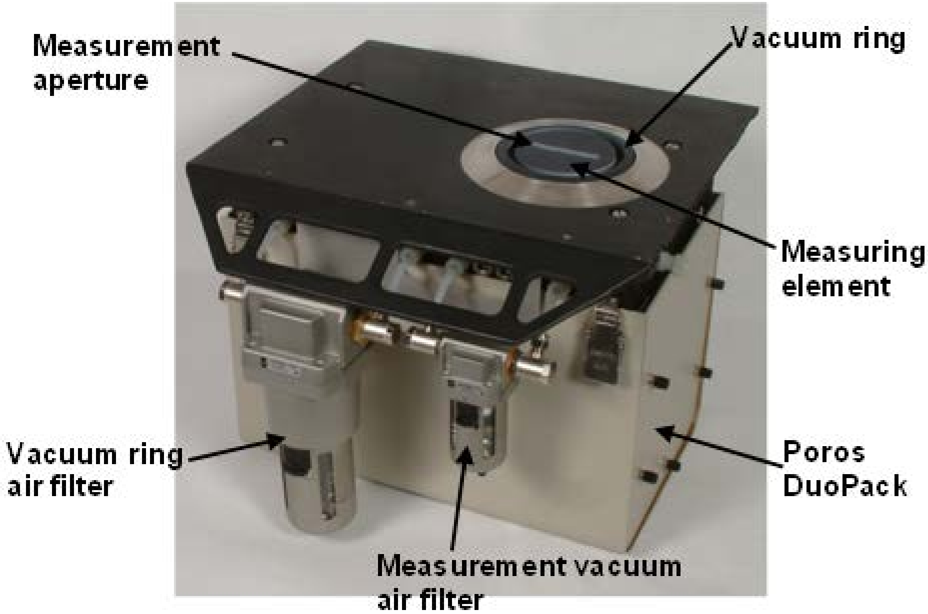


Figure 1-3 Sensor Model Q4219-51 Main Components

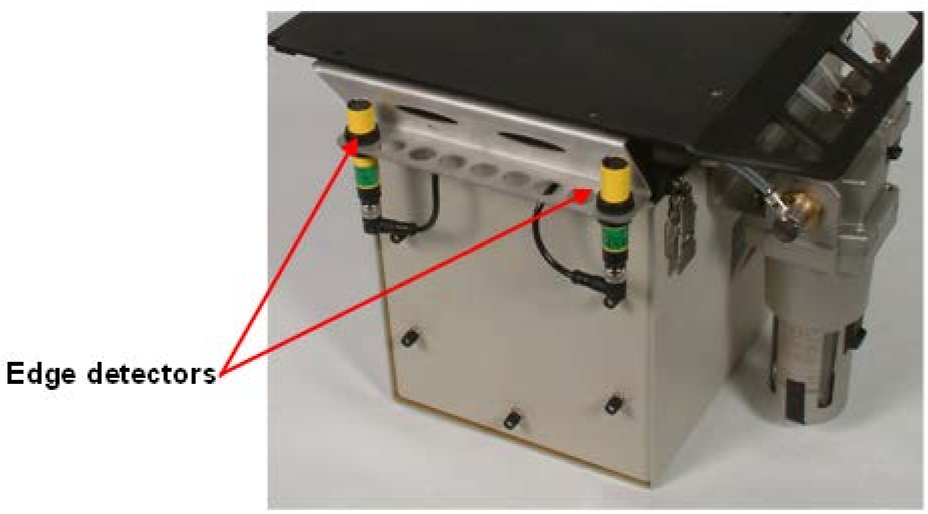


Figure 1-4 Sensor Model Q4219-51 Edge Detectors

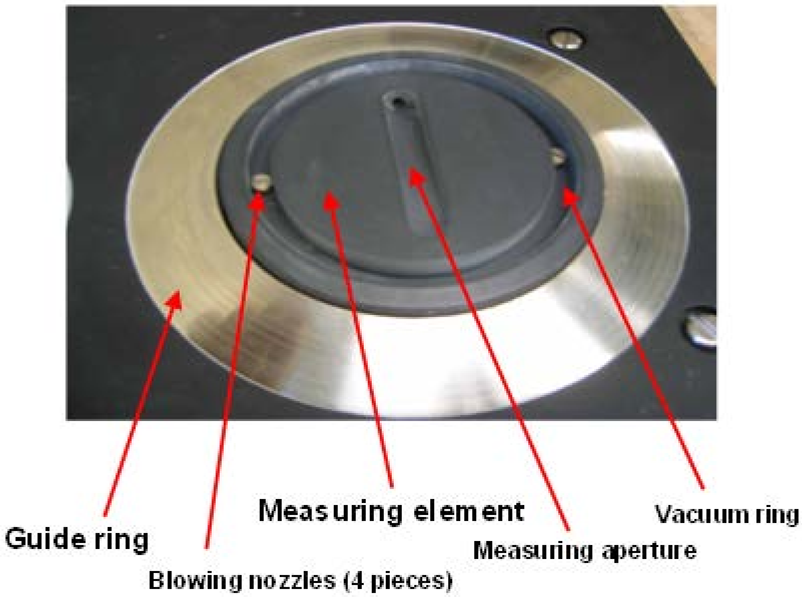


Figure 1-5 Sensor Top Side Key Elements

The Porosity sensor is always installed in housing. There are two versions of the housing, which include:

- sheetguide, cover, and access panels
- internal wiring
- connector for the Porosity sensor cable
- model 4219-51 only: water controller

The sensor, inside the housing, consists of:

- the measuring element that contacts the sheet
- a pneumatic sub-system
- sensor controlling processor and software
- a set of DIP switches for sensor configuration

1.2. Sensor operation

The sensor output is a voltage signal that correlates linearly with air volumetric flow-based laboratory methods, such as Bendtsen and Coresta.

For the time-based Gurley and Bekk methods, the computation from sensor output signal to porosity units in quality control systems (QCS) is somewhat more complicated.

1.2.1. Measurement principle

Figure 1-6 provides a graphical overview of the system.

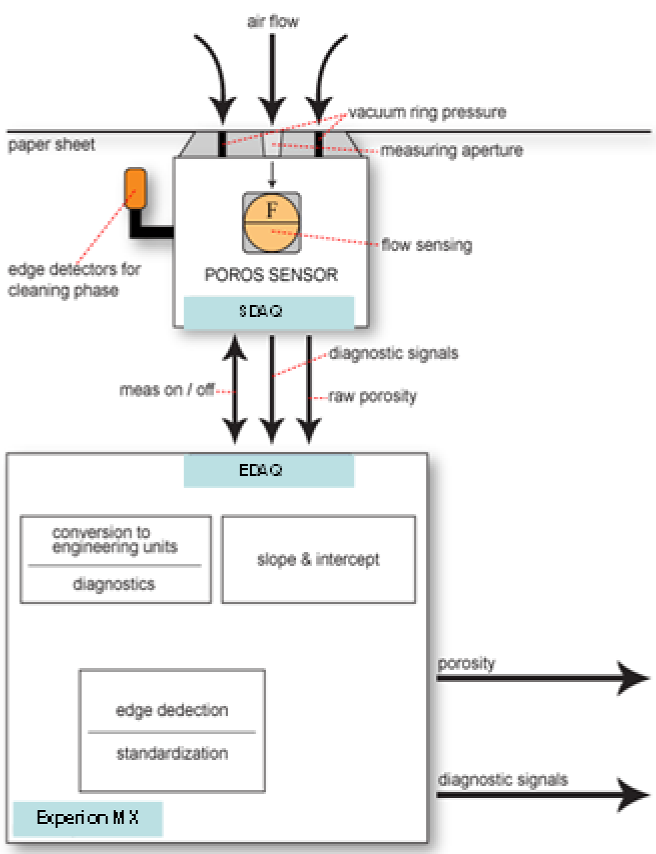


Figure 1-6 Porosity Measurement Overview

The Porosity sensor contacts a paper sheet and, by using a small stabilized vacuum, creates air flow through the paper. The air flow correlates with the sheet porosity.

The air flow reading rate is in the order of several kHz, enabling scanning porosity measurement. This measuring method is similar to laboratory analyzers, but much faster, indicating that good correlation with laboratory measurements is possible.

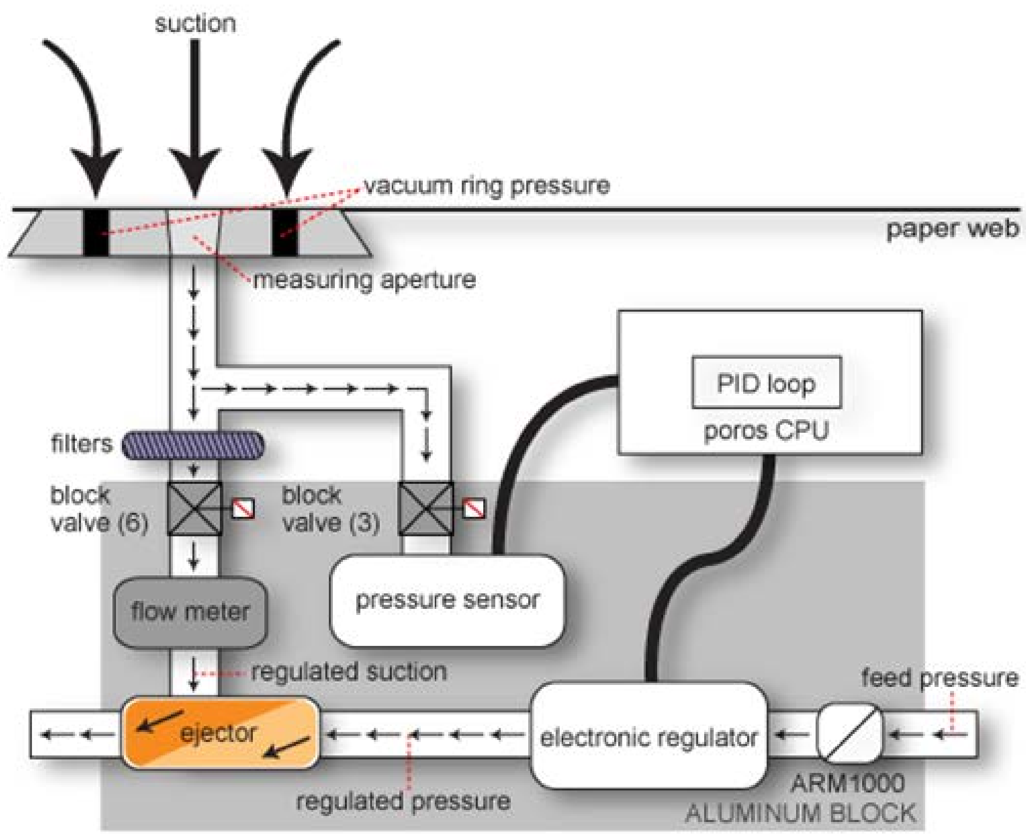


Figure 1-7 Pneumatic measurement loop

The sensor output signal is linear, so only linear transformation is needed to correlate the measurement with the laboratory methods where the measurement is expressed as air flow/time. Examples of these laboratory methods are Bendtsen (mL/min) and Schopper (mL/s). If the laboratory method uses the time/air flow measurement principle, a more complicated calculation is needed in Experion

MX. Examples of those laboratory methods are Gurley, and Bekk (both are s/100 mL).

For grade-dependent calibration, which is seldom needed, slope and intercept parameters can be used.

The sensor also uses a vacuum for the *hold vacuum*, which is intended to keep the sheet in good contact with the measuring element.

If the sheet contact is not stable, air leakage can happen, leading to erroneous measurements.

Additionally, the sensor has a diagnostic pressure signal. This is the measurement pressure used to cause the air flow through the paper.

The sensor has two states: **Meas ON** and **Meas OFF**.

ATTENTION

By default the measuring element up/down movement is disabled. In this section of the manual, the movement is assumed to be enabled.

Meas ON: This is the normal measuring mode. The sensor measuring element is raised to the up position to contact the sheet, and the measuring pressure is on, causing air flow through the paper.

Meas OFF: In this state the sensor is not measuring. The sensor measuring element is in the down position, and does not contact the sheet, and there is no measuring pressure, nor air flow, through the paper.

The sensor can be forced to **Meas ON** mode by using the sensor DIP switch.

The DIP switch has two states: normal (**OFF**) and sample (**ON**).

- When in normal (**OFF**) state, the switch has no effect on sensor operation.
- When in sample (**ON**) state, and with both edge detectors covered, the sensor goes to the **Meas ON** state, and the system commands are ignored. This feature is useful when using Experion MX sample tool to measure paper samples.

When the sensor goes offsheet, an optional cleaning phase is started, where the air is blown out of the sensor through the measuring aperture and vacuum ring.

Table 1-2 lists the sensor states. The first two columns are control inputs, and the last two columns have the sensor state information. *Number of Covered Edge Detectors* means how many detectors see the sheet. When measuring, both edge detectors see the sheet and are covered, but when offsheet, no edge detector can see the sheet and both edge detectors are uncovered.

Table 1-2 Sensor States

Number of Covered Edge Detectors	Sample DIP Switch	State	Cleaning Phase Activated
0	Off	Follows system commands	Yes
1	Off	Follows system commands	No
2	Off	Follows system commands	No
0	On	Off	No
1	On	Off	No
2	On	On	No

When the sensor causes problems to production, the sensor can be turned to disabled mode. When in disabled mode, the sensor is in the **Meas OFF** state all the time. When scanning, the sensor scans with the measuring element down, not contacting the sheet, and not measuring.

To disable the sensor:

1. Navigate to the **Scanner/Sensor** display, and then to the **Scanner Sensor Status** display. When the scanner is offsheet, the **Enable/Disable** button is activated.

2. Disable the sensor.

3. Click **Save**.

1.2.2. Standardization/reference

The Porosity sensor standardization is done in two phases:

1. In Phase 1, porosity and diagnostic signals are read with measurement pressure *off*.

2. In Phase 2, they are read with measurement pressure *on*.

Phase 1

At the start of the Phase 1, the sensor is in the **Meas OFF** state. The sensor reads porosity and diagnostic signal values without measurement pressure. These values are stored as **Air OFF** values. High alarm limit checking is done to **Air OFF** porosity voltage. At the end of Phase 1, the sensor state is changed to **Meas ON**. Signal porosity **Air OFF** volts is normally near one volt.

Phase 2

Porosity and two diagnostic signals are read with measurement pressure on. Signals are stored as **Air ON** values. Low alarm checking is done to **Air ON** porosity voltage. At the end of Phase 2, the sensor state is returned to **Meas OFF**. Signal porosity **Air ON** volts is normally between two and five volts.

1.2.3. Background

The porosity sensor does not have a background function.

1.2.4. Cleaning phase

If a cleaning phase is configured, when going offsheet, or when the sensor state is changed from on to off, a cleaning phase is started. During the cleaning phase, the sensor blows air out of the sensor through the measurement aperture and vacuum ring. The cleaning phase mode, which can be selected with the sensor DIP switches, has four options:

- no cleaning
- air blow duration two seconds
- air blow duration 20 seconds
- air blow duration 120 seconds

There are two events that finish the cleaning phase:

- the cleaning phase is ended normally by time-out
- the cleaning phase is aborted if at least one edge detector has detected the sheet (air blow under the sheet is disabled, because it might break the sheet in some situations)

1.2.5. Normal operation

There are three methods to calculate the standardization data with the Porosity sensor. Method selection is based on the parameter *Cal Method*.

Conversion from raw porosity volts to porosity units is normally a linear transformation, needing two parameters: offset and slope. These grade-independent conversion parameters are defined by static calibration. The final porosity value is calculated using the grade-dependent intercept and slope parameters, which are the results of dynamic calibration.

Definitions:

- PRV: raw porosity value in volts
- PRVSC: raw porosity volts after standardization correction
- A: grade independent linear offset (from static calibration)
- B: grade independent linear slope (from static calibration)
- UP: uncorrected porosity in engineering units
- PGDI: grade dependent intercept (from dynamic calibration)
- PGDS: grade dependent slope (from dynamic calibration)
- Porosity: final porosity value in engineering units

1.2.5.1. Standardization correction

CalcMethod = 0

In this case, standardization data is not used at all when calculating uncorrected porosity values. This is the recommended method. Before using the other methods, contact Honeywell Engineering.

PRVSC = PRV

1.2.5.2. Laboratory method dependent calculation

Laboratory method: air flow/time

In this case, no further calculation is required and you can proceed to conversion to engineering units. Examples of these laboratory methods are Bendtsen and Coresta.

Laboratory method: time/air flow

When the laboratory method is time/air flow based, for example Gurley and Bekk, a more complex calculation is required. This is not part of the Porosity sensor product. The customer project must implement this calculation in Experion MX, using the **Virtual Sensor Wizard** tool.

An inverse must be taken from the flow signal. Be careful to avoid dividing by zero.

PRVSV = 1/(PRVSC+constant)

Constant is a small positive number ensuring that no division with zero will occur.

1.2.5.3. Conversion to engineering units

Porosity units are calculated using a linear transformation:

UP = A + B*PRVSC

Parameters A and B are found by laboratory correlation (static calibration).

The use of higher order transformation is also possible, but it is not recommended. Contact Honeywell Engineering before using it.

1.2.5.4. Grade-dependent correction

In the last calculation phase, the final porosity value in engineering units is calculated from the uncorrected porosity value.

Porosity = PGDI + PGDS*UP

1.2.6. Profile building parameters

Porosity sensor has four groups of scanning related parameters. Use them to set the system to build reliable measurement profiles.

1.2.6.1. Reject profile data at sheet edge

- Reject Lo End mm (Lo to Hi)
- Reject Lo End mm (Hi to Lo)
- Reject Hi End mm (Lo to Hi)
- Reject Hi End mm (Hi to Lo)

These four parameters specify how much data is rejected from the sheet edge (in millimeters) in the beginning of the scan. You must use these parameters, because there can occasionally be problems in the measurement data in the beginning of a scan.

1.2.6.2. Reject whole profile

- Reject Lo End to Hi End Profile
- Reject Hi End to Lo End Profile

With parameters Reject Lo/Hi End to Hi/Lo End Profile, all forward or reverse scans can be rejected.

1.2.6.3. Measuring element up/down positions

- Hi End Up mm
- Hi End Down mm
- Lo End Up mm
- Lo End Down mm

When coming onsheet from offsheet, the sensor measurement status should be turned to on only after the sensor is confirmed to be onsheet. When going offsheet, measurement status must be turned off. With these parameter, you can specify the distances from the sheet edge (in millimeters) where these measuerment status changes will occur.

1.2.6.4. Delay parameter

- Delay ms

The general sensor setup parameter Delay ms specifies the time when the Porosity sensor readings are reliable after the measurement head is raised to contact the sheet.

Some of these parameters are shown in Figure 1-8. Accepted measurement data is indicated with thick black lines.

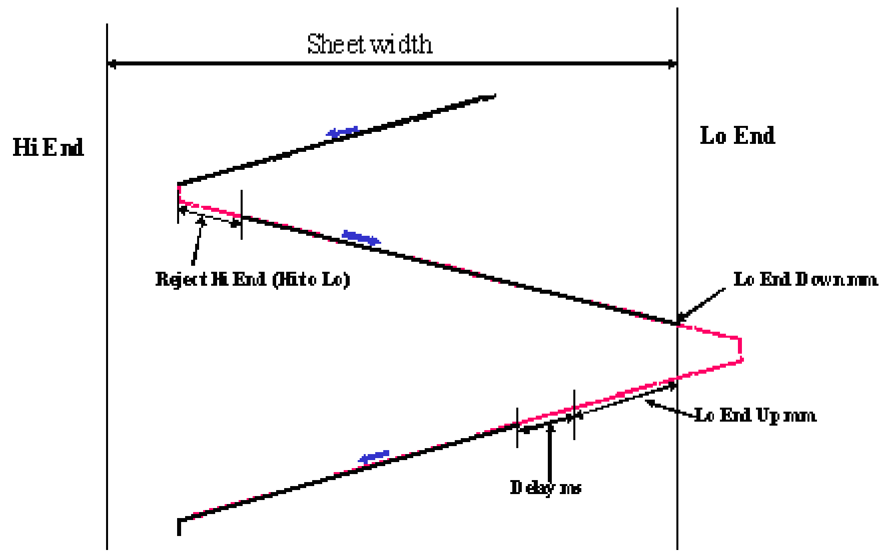


Figure 1-8 Scanning Parameters

1.2.7. System inputs from the Porosity sensor

Air flow (raw porosity)

- voltage signal 1–5 V
- This is the actual measurement signal, which correlates linearly with porosity. The porosity value is calculated from this signal utilizing normal calibration and slope and intercept parameters. Voltage values are stored in both phases of standardization.
- measurement signal values in **Meas ON** state:

  the optimum operating ranges when normally measuring paper is 1.5–3.0 V

  signal without paper (or paper of zero air resistance) is 5 V

  signal with paper of infinite air resistance is 1 V
- measurement signal values in **Meas OFF** state:

  always near 1 V

Diagnostic signal pressure

- voltage signal 1–5 V
- Indicates measurement pressure value. High and low limit checks are carried out for diagnostic purposes. Voltage values are stored in both phases of standardization.
- Measurement pressure is selected with the DIP switches (see Subsection 1.3.4). Figure 1-9 shows the dependence between selected measurement pressure, kPa, and diagnostic signal pressure, V.
- if the pressure signal is not correct, the respective DIP switches may be wrong, or the electronic regulator inside the sensor has failed

Figure 1-9 shows a measurement pressure graph with kPa on the horizontal axis, and V on the vertical axis.

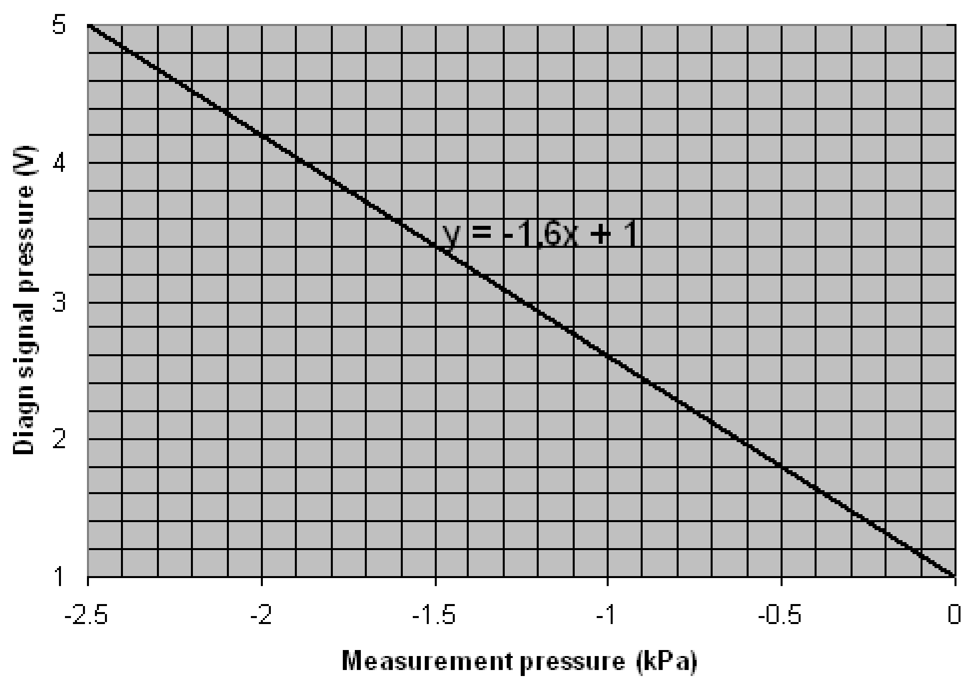


Figure 1-9 Measurement Pressure Graph

1.2.8. System outputs to the Porosity sensor

The only system output is **Meas ON** or **Meas OFF**, which controls the measurement state:

- On = 1: measurement pressure is turned on. The sensor is able to measure only when it is in this state. If the measuring element up/down movement is enabled, the element rises to the upper position to contact the sheet.

- Off = 0: measurement pressure is turned off. The sensor does not measure porosity in this state. If the measuring element up/down movement is enabled, the element moves to the lower position.

1.2.9. Timing diagrams

1.2.9.1. Onsheet/offsheet scanning

Figure 1-10 shows the timing related to the sensor moving from onsheet to offsheet.

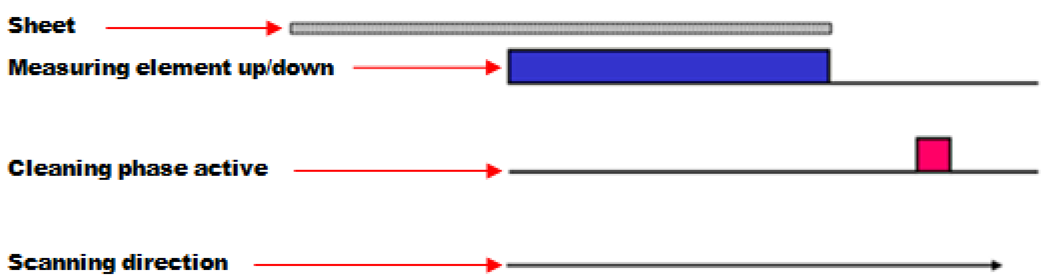


Figure 1-10 Scanning Timing Diagram: Onsheet to Offsheet

Figure 1-11 shows the timing related to the sensor moving from offsheet to onsheet.

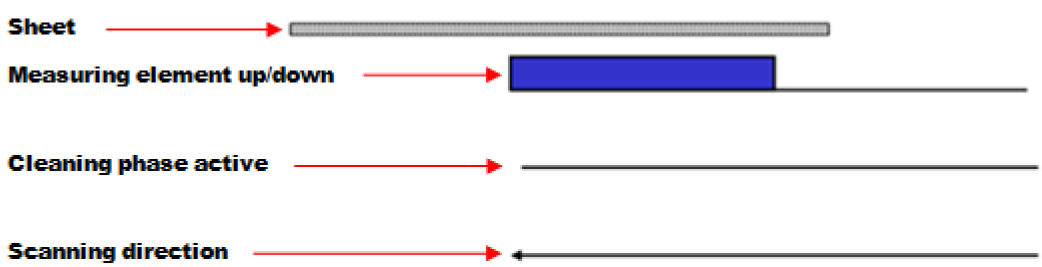


Figure 1-11 Scanning Timing Diagram: Offsheet to Onsheet

By default, the measuring element up/down movement is disabled, but in Figure 1-10 and Figure 1-11 the movement is assumed to be enabled. Also, for clarity, the cleaning phase duration is two seconds.

When scanning offsheet from onsheet, the sensor measuring element is dropped to the down position, and shortly afterwards the cleaning phase is started.

When scanning onsheet from offsheet, the measuring element is raised to the up position when the sensor is confirmed to be onsheet, in order to avoid sheet breaks.

In Figure 1-10 and Figure 1-11 the cleaning phase is configured as a short pulse. If the cleaning phase was longer, the timing diagram would be different. Remember that cleaning is aborted when the sensor goes onsheet.

1.2.9.2. Standardization

Figure 1-12 shows the timing diagram as related to the standardize function. By default, the measuring element up/down movement is disabled, but in the diagram the movement is assumed to be enabled. Also, for clarity, the cleaning phase duration is two seconds.

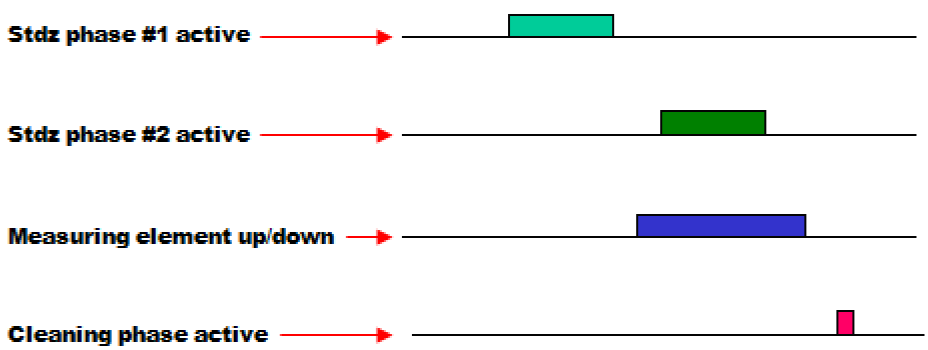


Figure 1-12 Scanning Timing Diagram: Standardize Function

During the standardization Phase 1, the measuring element is down, and when Phase 1 is completed, it is raised up for Phase 2. After Phase 2 is completed, the measuring element is lowered to the down position again. In Figure 1-12, an extra cleaning phase is started following the standardization Phase 2. The cleaning phase is shown as a short pulse.

1.2.10. Software parameters

To see the Porosity sensor general sensor setup parameters, call up the **MSS Setup Diagnostics** display, and the **MSS Job Set IO Setup** pop-up.

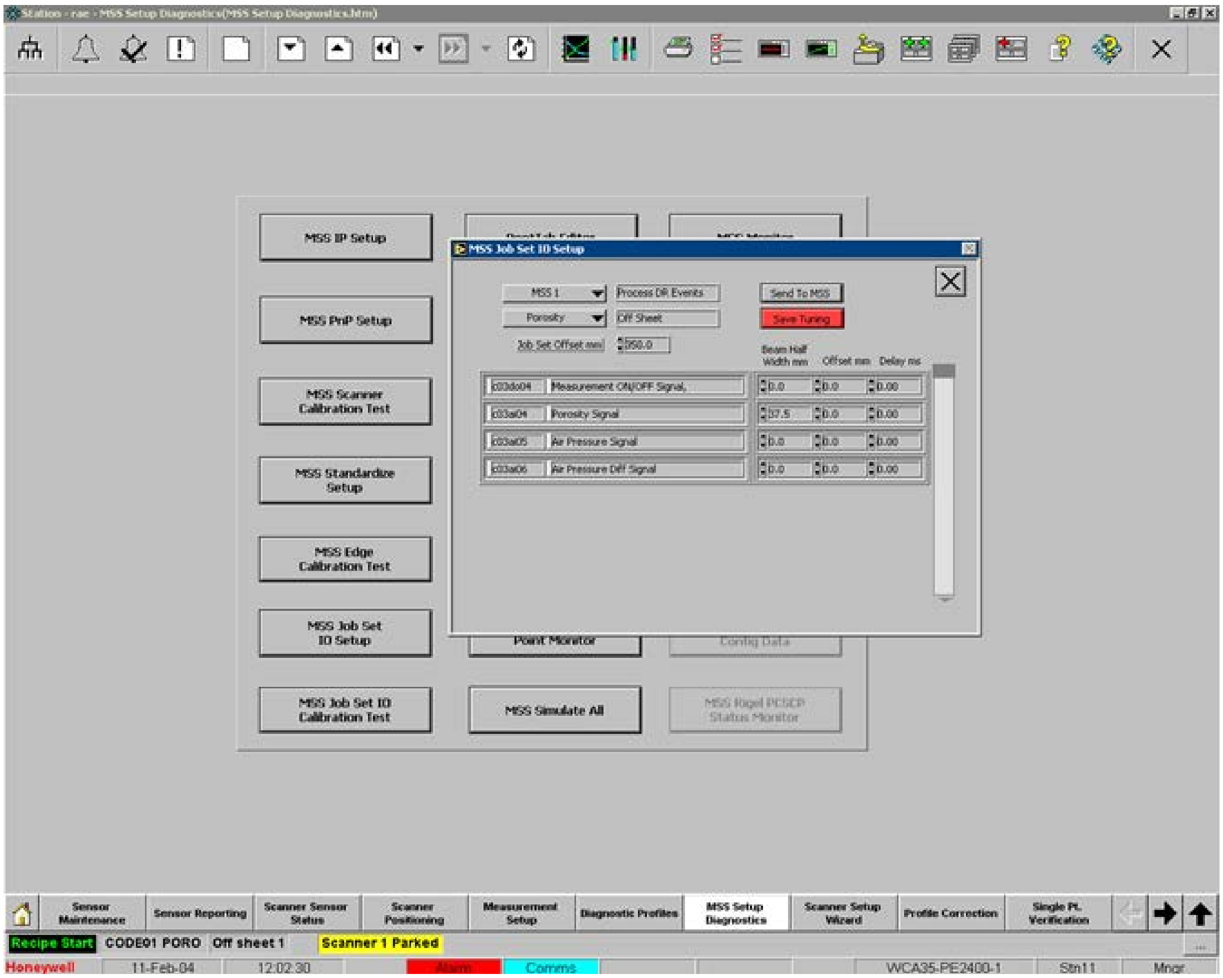


Figure 1-13 MSS Setup Diagnostics Display: MSS Job Set IO Setup pop-up

To see the Porosity sensor tuning parameters, call up the **Sensor Maintenance** display.

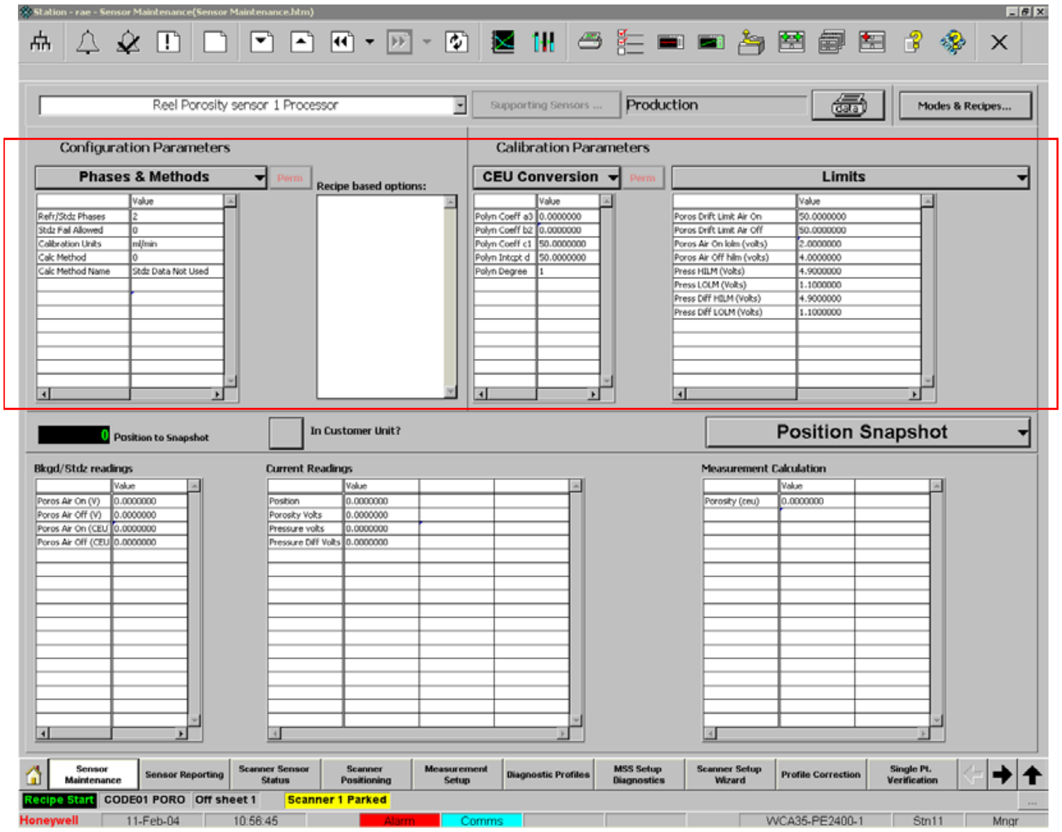


Figure 1-14 Sensor Maintenance Display

Parameters are divided into two main categories:

- **Configuration Parameters** drop-down arrow selections:

  Phases & Methods

  Scanning & Profile

- **Calibration Parameters** drop-down arrows selections:

  CEU Conversion

  Time Zero Constants

  Limits

1.2.10.1. General sensor setup parameters

The general sensor paramters are used to define offsets and delays of the job sets. They can be accessed in the **MSS Job Set IO Setup** pop-up (see Figure 1-15).

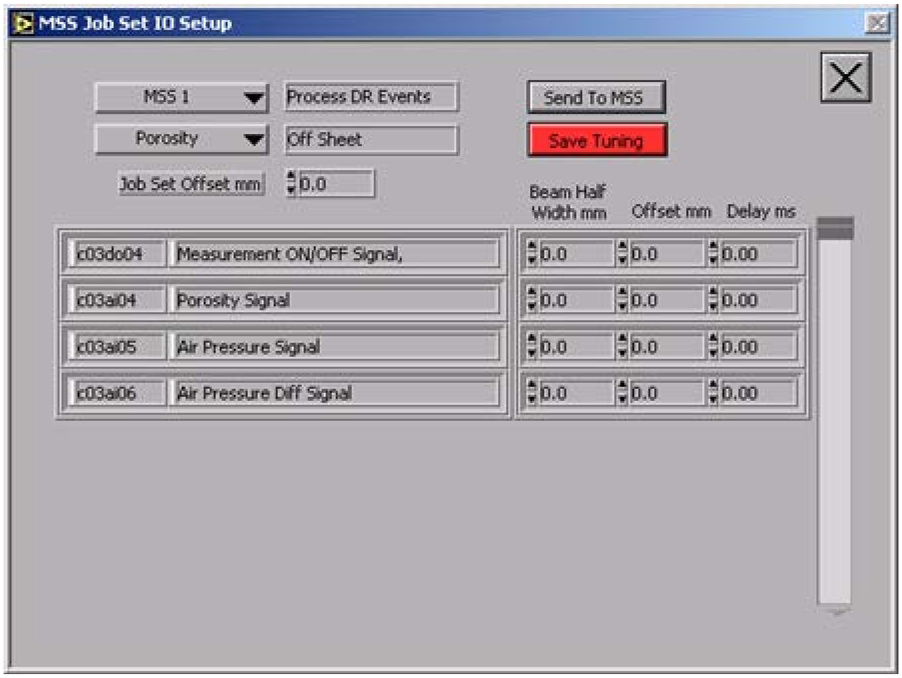


Figure 1-15 MSS Job Set IO Setup Pop-up

Table 1-3 lists general sensor setup parameters.

Table 1-3 General Sensor Setup Parameters

Parameter Name	Description	Default Value
Job Set Offset mm	Job set offset in millimeters is used to tell the bias from center line of the porosity sensor beam to center line of the primary sensor beam	350.0
Beam Half Width mm	Beam half width in millimeters is used to calculate when a sensor is completely onsheet	37.5
Offset mm	Signal offset in millimeters from the Job Set Offset. Positive is towards the high other end of the frame.	0.0
Delay ms	The bucketizer or edge detectors use this to modify the position of the DAQ signal, using the current speed of the scanner	0.00

1.2.10.2. Configuration parameters

These parameters can be found in the **Sensor Maintenance** display. Configuration parameters are presented as **Phases & Methods**, and **Scanning & Profile** (see Figure 1-16).

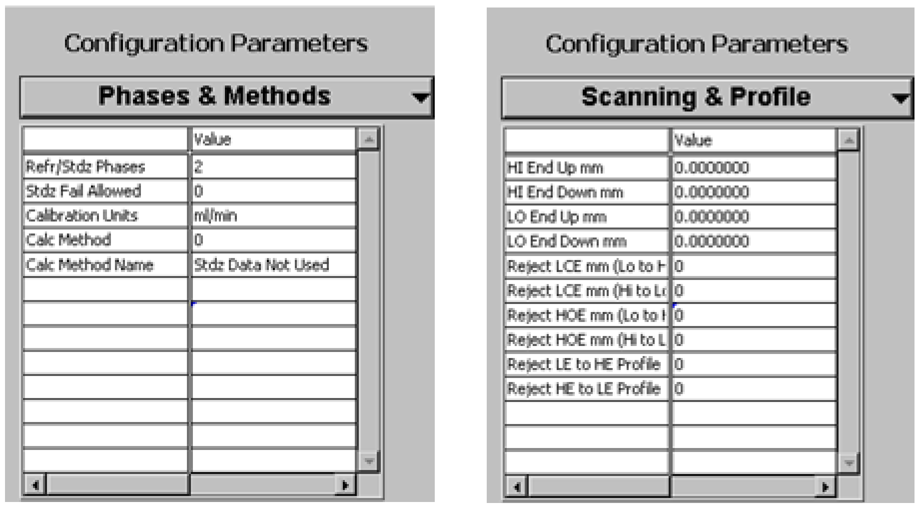


Figure 1-16 Configuration Parameters

Table 1-4 describes the parameters in **Phases & Methods**.

Table 1-4 Parameters in Phases & Methods

Parameter Name	Description	Default Value
Refr/Stdz Phases	Number of reference phases	2
Stdz Fail Allowed	• Disables/Allows standardizing failure when porosity volts limit exceeded at standardization • 0 = Scanning is not aborted after bad standardization routines and “Poros Stdz Failure” alarm is generated • 1 = Aborts scanning (offsheet) and general alarms is generated	0
Calibration Units	A customer engineering unit of the porosity	ml/min
Calc Method	Method for the calculation of the uncorrected porosity value. It depend on how the standardization data is utilized: • 0 = Standardization Data Not Used (UncPoro = Volts) • 1 = Standardization Data Partially Used (UncPoro = Volts + (Air Off Volts – 1)) • 2 = Standardization Data Fully Used (UncPoro = Volts + (Air Off Volts – 1) – (5 – Air On Volts))	0
Calc Method Name	Name of the calculation method (updated by Porosity Processor)	

Table 1-5 describes the parameters in **Scanning & Profile**.

Table 1-5 Parameters in Scanning & Profile

Parameter Name	Description	Default Value
Hi End Up mm	Distance before MSS drives sensor to Up position (start scanning from HE to LE)	100.0
Hi End Down mm	Distance when MSS drives sensor to Down position (start scanning from LE to HE)	0.0
Lo End Up mm	Distance before MSS drives sensor to Up position (start scanning from LE to HE)	100.0
Lo End Down mm	Distance when MSS drives sensor to Down position (scanning from HE to LE)	0.0
Reject Lo End mm (Lo to Hi)	How much profile data is rejected in mm from the Low End (Scanning from LE to HE)	0.0
Reject Lo End mm (Hi to Lo)	How much profile data is rejected in mm from the Low End (Scanning from HE to LE)	0.0
Reject Hi End mm (Lo to Hi)	How much profile data is rejected in mm from the High End (Scanning from LE to HE)	0.0
Reject Hi End mm (Hi to Lo)	How much profile data is rejected in mm from the High End (Scanning from HE to LE)	0.0
Reject Lo End to Hi End Profile	• Accepts/Rejects porosity forward profile data • 0 = Generates profile data at End of Scan Forward • 1 = Rejects profile data at End of Scan Forward • Last End of Scan Reverse profile data remain in force	0
Reject Hi End to Lo End Profile	• Accepts/Rejects porosity reverse profile data • 0 = Generates profile data at End of Scan Reverse • 1 = Rejects profile data at End of Scan Reverse • Last End of Scan Forward profile data remains in force	0

1.2.10.3. Calibration parameters

These parameters can be found from the **Scanner/Sensor** display category in the **Sensor Maintenance** display.

Typically, static calibration uses a linear conversion, indicating that:

- a3 = 0
- b2 = 0

- c1 = slope
- d = intercept

Figure 1-17 shows the parameters under **CEU Conversion**, and **Time Zero**.

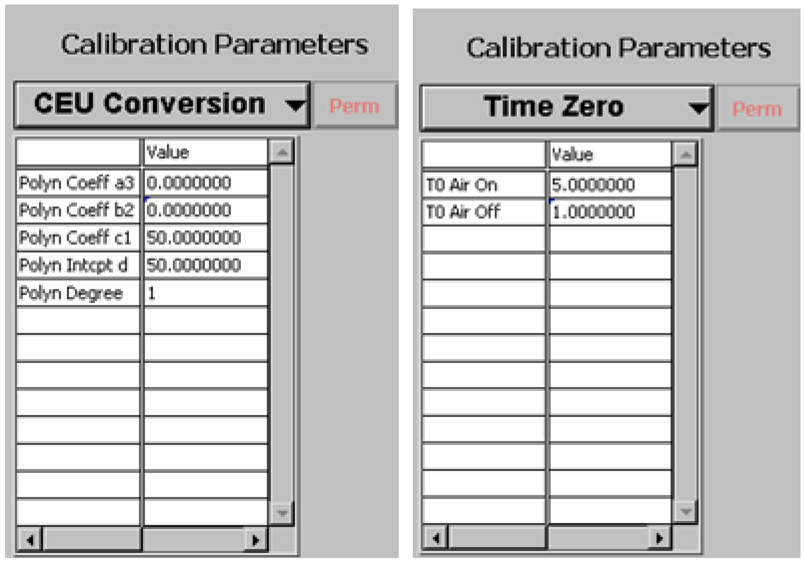


Figure 1-17 Calibration Parameters: CEU Conversion, and Time Zero

Figure 1-18 shows the parameters under **Limits**.

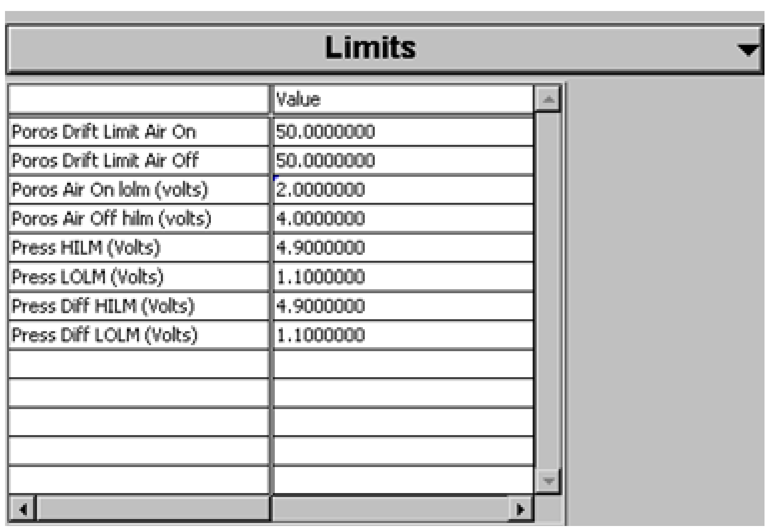


Figure 1-18 Limits

Table 1-6 describes the parameters under **CEU Conversion**.

Table 1-6 Parameters Under CEU Conversion

Parameter Name	Description	Default Value
Polynomial Coefficient a3	Third Polynomial transformation: $ax^3 + bx^2 + cx + d$	0.0
Polynomial Coefficient b2	Second Polynomial transformation: $bx^2 + cx + d$	0.0
Polynomial Coefficient c1	Linear transformation: cx + d	50.0
Polynomial Intercept d	Constant for all polynomial degrees: $ax^3 + bx^2 + cx + d$	50.0
Polynomial Degree	• 0 = No transformation • 1 = Linear transformation (cx + d) • 2 = Second Polynomial ($bx^2 + cx + d$) • 3 = Third Polynomial ($ax^3 + bx^2 + cx + d$)	1.0

It is recommended to change polynomial coefficients c and d:

- change c1 from 50 to 1
- change d1 from 50 to 0

Table 1-7 describes the parameters under **Time Zero**.

Table 1-7 Parameters Under Time Zero

Parameter Name	Description	Default Value
T0 Air On	*Time Zero Air On*. Porosity volts value change from this value is compared to *Porosity Drift Limit Air On* value during the reference/standardize phase 2.	5.0
T0 Air Off	*Time Zero Air Off*. Porosity volts value change from this value is compared to *Porosity Drift Limit Air Off* value during the reference/standardize phase 1.	1.0

Table 1-8 describes the parameters under **Limits**.

Table 1-8 Parameters Under Limits

Parameter Name	Description	Default Value
Poros Drift Limit Air On	Porosity volts value change limit. Compared to *Time Zero Air On* value during the reference/standardize phase. Generates *Poros Stdz Air Drift Too Big* alarm if change is bigger then this value.	50.0
Poros Drift Limit Air Off	Porosity volts value change limit. Compared to *Time Zero Air Off* value during the reference/standardize phase 1. Generates *Poros Stdz Air Drift Too Big* alarm if change is bigger then this value.	50.0
Poros Air On lolm (volts)	Porosity volts low limit during the reference/standardize Phase 2	2.0

Parameter Name	Description	Default Value
Poros Air Off hilm (volts)	Porosity volts high limit during the reference/standardize Phase 1	4.0
Press HILM (volts)	Pressure volts high limit. Checked during Single Point, EOS Forward, and EOS Reverse process.	4.9
Press LOLM (volts)	Pressure volts low limit. Checked during Single Point, EOS Forward, and EOS Reverse process.	1.1
Press Diff HILM (volts)	Pressure difference volts high limit. Checked during Single Point, EOS Forward, and EOS Reverse process.	4.9
Press Diff LOLM (volts)	Pressure difference volts low limit. Checked during Single Point, EOS Forward, and EOS Reverse process.	1.1

1.3. Sensor internal structure

This section provides a detailed description of the porosity sensors internal operation.

1.3.1. Electronics

1.3.1.1. Fuses, LEDs, and test points

Figure 1-19 shows the location of the DIP switches, LEDs, fuses, and test points.

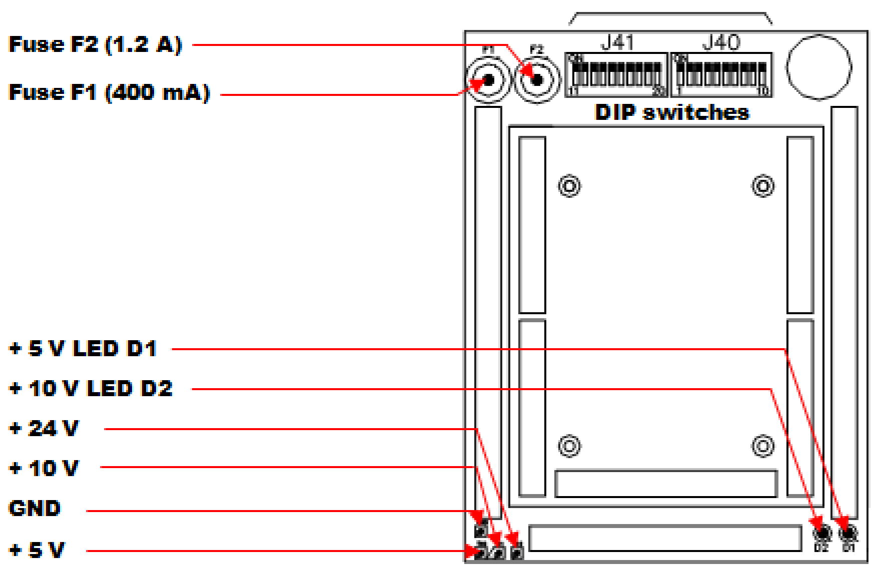


Figure 1-19 Fuses, LEDs, and Test Points

The sensor has two internal green LEDs for diagnostic purposes. When the status is *OK*, the LEDs light up.

Table 1-9 lists the fuses, LEDs, and test points.

Table 1-9 Fuses, LEDs, and Test Points

Fuses	**Value**
F1	400 mA
F2	2 A
LEDs	
D1	10 V
D2	5 V
Test Points	
T10	5 V
T11	10 V
T12	24 V
T13	GND

1.3.2. Pneumatics

For images of the Porosity sensor pneumatics, see Figure 1-20 , and Figure 1-21.

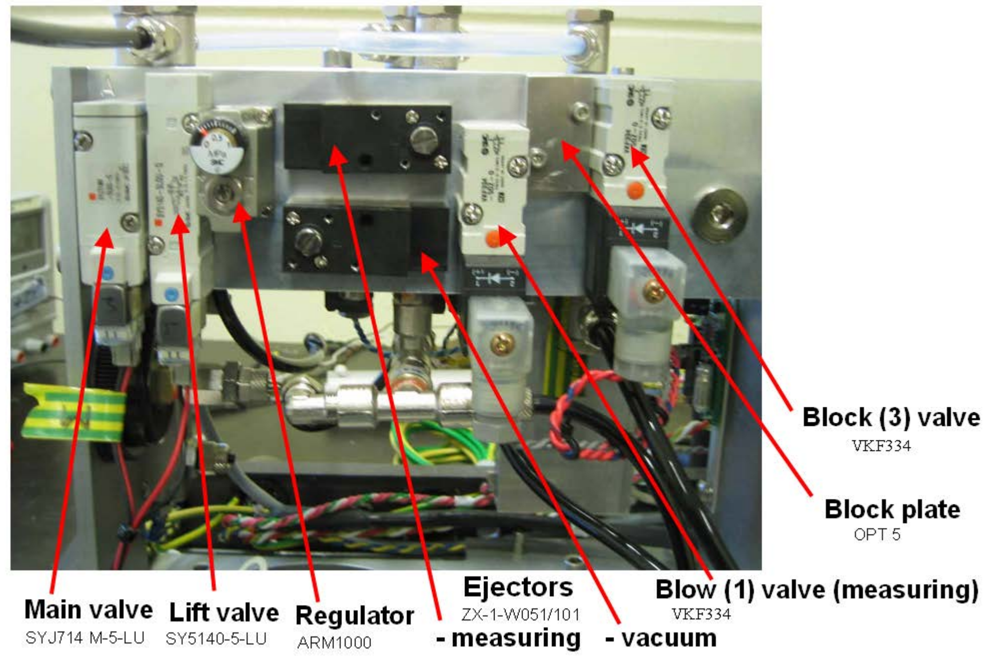


Figure 1-20 Sensor Pneumatics (1 of 2)

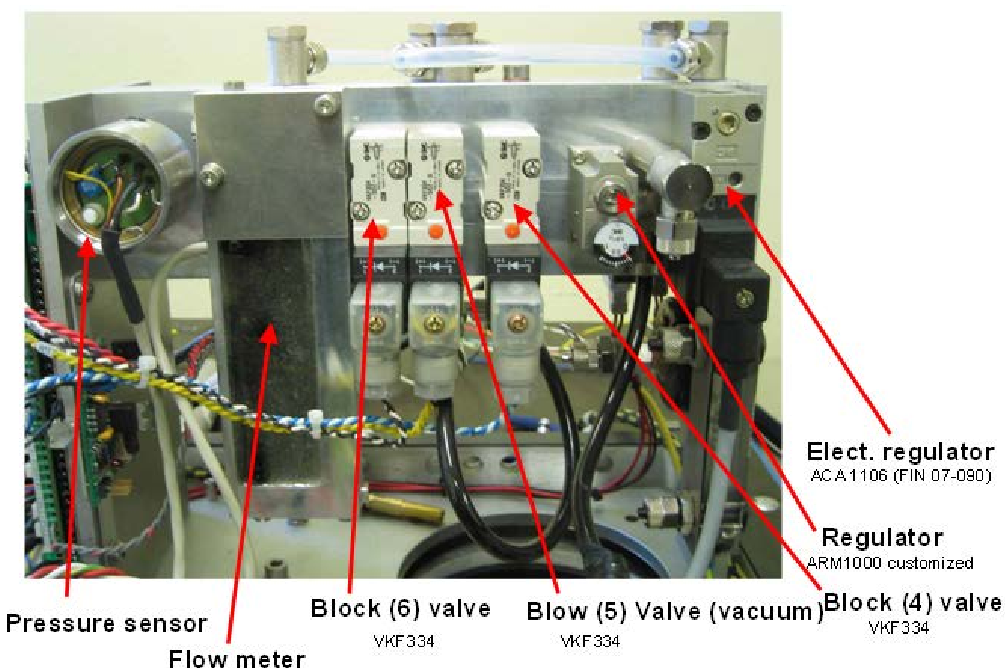


Figure 1-21 Sensor Pneumatics (2 of 2)

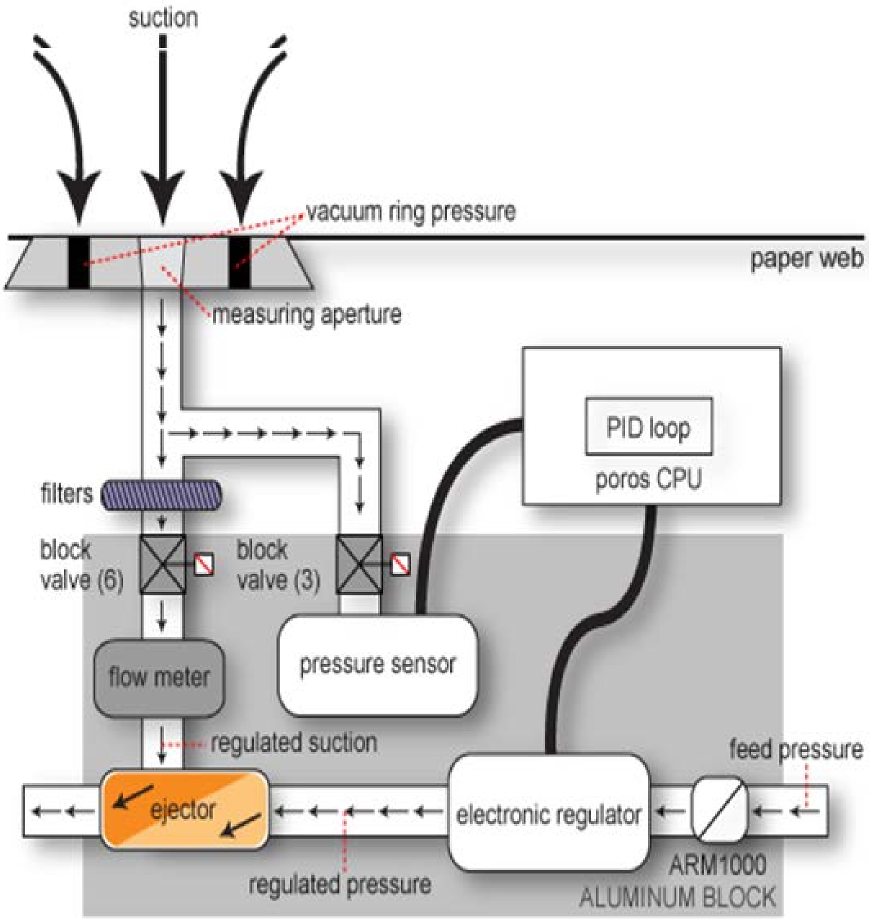


Figure 1-22 Pneumatic measurement loop

1.3.2.1. Manual pneumatic adjustments

There are two manual adjustments inside the sensor:

- set the supply pressure
- set the hold vacuum

Supply pressure

Supply pressure must be high enough. The recommended value is > 3.5 bar.

This is the supply pressure used by measurement pressure control. The closed loop control takes care of measurement pressure stabilizing. The exact value of measurement pressure (vacuum) is selected by configuration DIP switches.

Hold vacuum

The recommended values for the hold vacuum are:

- pressure 0.2–0.6 bar
- flow rate > 10 L/min

The hold vacuum determines how strongly paper is being sucked against the measuring element. If the vacuum is too low, the paper sheet does maintain good contact with the measuring element, leading to erroneous measurements due to air leakage. However, if the vacuum is too high, it can create excessive dusting, can mark or, in the worse case, can break the sheet.

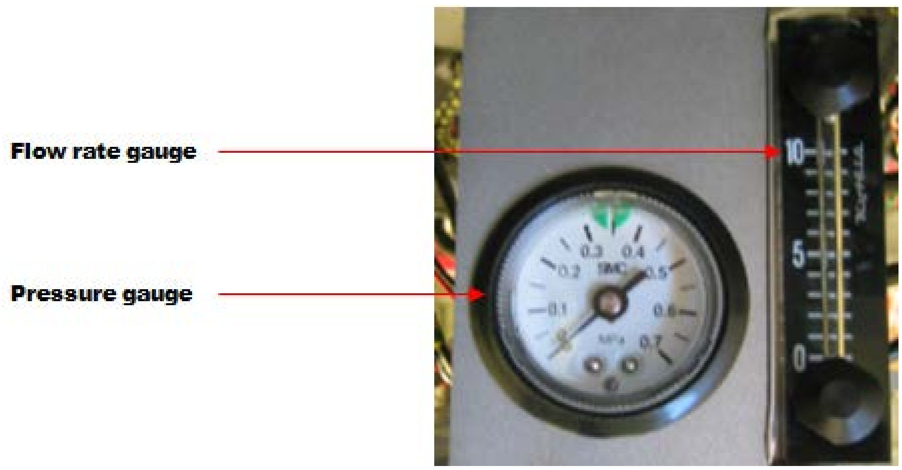


Figure 1-23 Pressure and Flow Rate Gauges

1.3.3. Software

The sensor internal software flow diagram is shown in Figure 1-24. The main tasks the software performs are:

- cleaning phase logic
- stabilizing of measurement pressure (vacuum)
- reading the flow and pressure gauges, running the calculation and control algorithms, and writing the output data to the Honeywell system

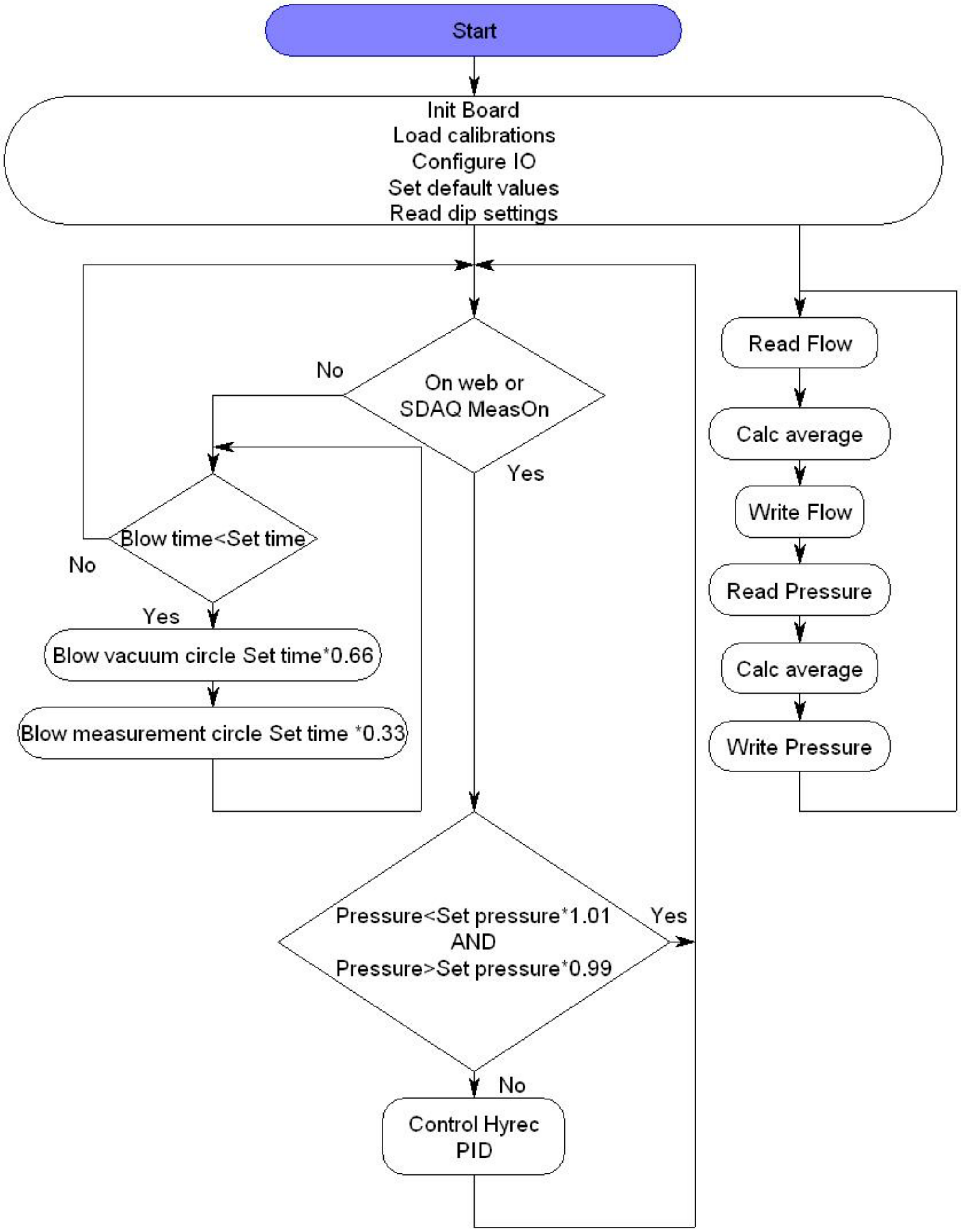


Figure 1-24 Software Flow Diagram

1.3.4. Configuration

The porosity sensor can be internally configured using the DIP switches. These settings cannot be changed from the Experion MX system.

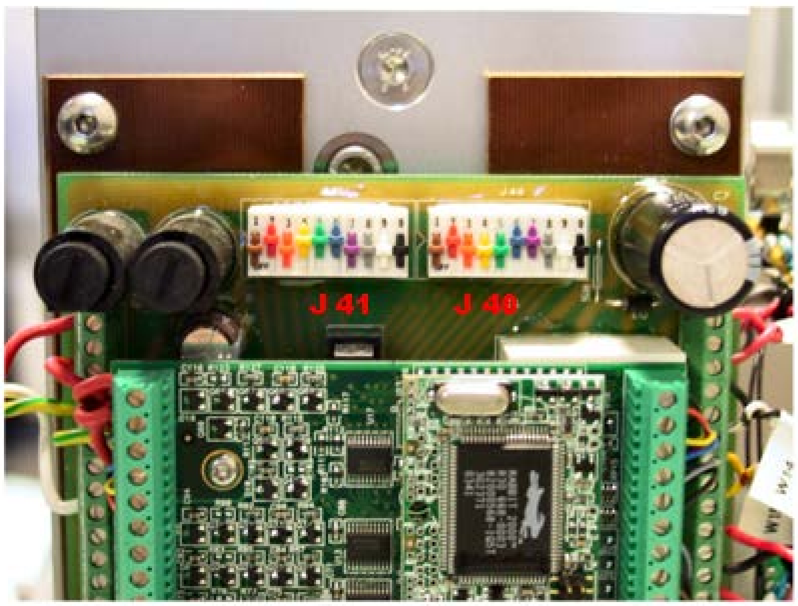


Figure 1-25 DIP Switches J41 and J40

The DIP switch settings are read by the sensor internal software always when offsheet and the cleaning phase is inactive. In practise, this means that after changing the DIP switch settings, you can put the sensor to scanning, and the new DIP switch settings are immediately active. A sensor reset is not needed after changing the DIP switches.

The calibration report shows the original settings of DIP switches.

Two parameters, flow sensor selection and Experion MX flag, must reflect the true porosity sensor hardware construction. If these settings are not correct, the sensor cannot work properly. For other selections, see the comments in Table 1-10, Table 1-11, and Table 1-12.

Table 1-10 lists DIP switches J40: **Flow Smoothen**.

Table 1-10 DIP Switches J40: Flow Smoothen

J40			2	1	Flow Smoothen	Comment
			0	0	No average	Default
			0	1	Average of 50	Do not use

J40			2	1	Flow Smoothen	Comment
			1	0	Average of 100	Do not use
			1	1	Average of 200	Do not use

Table 1-11 lists DIP switches J40: **Pressure Adjustment**.

Table 1-11 DIP Switches J40: Pressure Adjustment

0	6	5	4	3	Pressure Adjustment kPa	Comment
	0	0	0	0	-2,56	
	0	0	0	1	-2,34	
	0	0	1	0	-2,19	
	0	0	1	1	-2,03125	
	0	1	0	0	-1,875	
	0	1	0	1	-1,5625	
	0	1	1	0	-1,40625	
	0	1	1	1	-1,25	
	1	0	0	0	-1,09375	Default
	1	0	0	1	-0,9375	
	1	0	1	0	-0,78125	
	1	0	1	1	-0,63	
	1	1	0	0	-0,47	
	1	1	0	1	-0,31	
	1	1	1	0	-0,16	
	1	1	1	1	0	

ATTENTION

Diagnostic signal measurement pressure indicates measurement pressure selected. See Figure 1-9 for the conversion from measurement pressure in kPa units to measurement pressure in volts.

Measurement pressure affects sensor response and calibration. If measurement pressure is changed, normally a new calibration must be made.

Table 1-12 lists DIP switches J40: **Flow Meter Selection**.

Table 1-12 DIP Switches J40: Flow Meter Selection

J40		9	8	7	Flow Meter Selection	Comment
		0	0	0	HW200	Not used
		0	0	1	HW1000	Default

Table 1-13 lists DIP switches J40: **Pressure Adjustment kPa**.

Table 1-13 DIP Switches J40: Pressure Adjustment kPa

J41		**0**	**Noise filter**	
		0	Not in use	Default
		1	Used	Do not use
J41		**1**	**Sample mode**	
		0	Normal mode	Default
		1	Sample mode	
J41	**3**	**2**	**Hyreg Control Speed**	
	0	0	Super fast	
	0	1	Fast	
	1	0	Slow	Default
	1	1	Super low	
J41		**4**	**Lift measuring Element**	
		0	Always up	Default
		1	Lift up/down	
J41		**5**	**Experion MX**	
		0	No	
		1	Experion MX	Default
J41	**7**	**6**	**Cleaning phase**	
	0	0	No cleaning	
	0	1	2 s	
	1	0	20 s	
	1	1	120 s	Default

ATTENTION

Sample mode should be used only temporarily, for example when measuring samples, or when testing the sensor off the scanner. During normal operation, the switch must be in normal mode. Otherwise a sheet break may occur.

J41: electronic regulator (Hyreg) control speed

The duty of the electric regulator is to continuously produce the stable measurement pressure. This internal function of the sensor is very important for reliable porosity measurements.

Regulator control speed can be set with DIP switches to:

- super fast
- fast
- slow
- super slow

The control speed affects the way the measurement pressure stabilizes after the sensor comes to the sheet. Because there is no single good global value for the speed setting, the best value must be found case by case during sensor installation. The effect of regulator control speed is described in Chapter 4.

2. Introduction to Paper Porosity

When air is passed, under pressure, from one side of a paper sheet to the other side, it has to navigate through the capillary air passages between the fibers and fillers. Paper porosity (air permeance, air permeability), and its inverse property, air resistance, reflect the internal structure of the paper. Generally, a material can be porous without any air permeability, but in papermaking terminology, the term *porosity* is usually used as a synonym for the term *air permeability*.

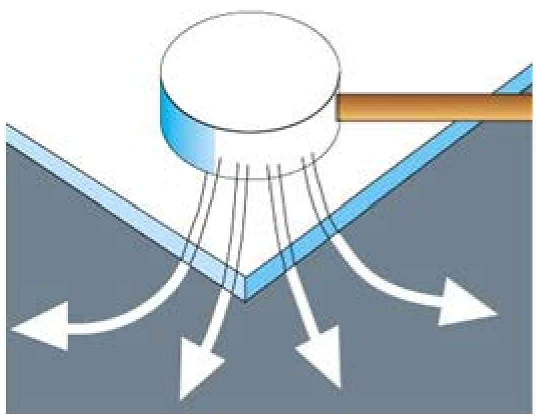


Figure 2-1 Laboratory Measurement Principle

2.1. Porosity formation

Paper is formed from small particles of fibers and fillers. During drainage from the paper machine headbox, fibers form a filtered network on the wire. If mineral fillers are used, they attach between fiber surfaces (increasing specific paper volume), or in the voids of the fiber network (decreasing specific paper volume). When the fibers or fillers are small, the fiber network is more closed and porosity is low. If fibers are very small, meaning freeness is low, drainage can be too slow, and more water must be removed in the press section. This is the limiting factor to control porosity by fiber and filler fineness. If the retention of fines is low, it has an opening effect on the web, increasing paper porosity. The conditions of wet end chemistry have a major effect on the retention of fiber fines and fillers, and on the porosity in the machine direction.

After the wire section, the wet fiber network is still quite open, because approximately 98% of the water in the suspension must be removed in the wire section. Main consolidation of the paper network starts in the press section where water must be pressed out of the network. In this stage, the paper network is very plastic, meaning less elastic than in the dry condition. This means that after the press section, paper easily stays in the compressed form. It is clear that more pressing means more consolidation, meaning lower paper porosity and bulk.

The pressure against the paper is quite small in the drying section, but some densification occurs due to fiber bonding and lumen collapse during drying. Paper is strained in the machine direction, but shrinkage occurs in the cross machine direction, especially close to the web edges. Higher machine direction draw (strain), and higher cross direction shrinkage increase porosity and decrease fiber bonding. This effect can be greater than normally supposed.

Wetting of dry paper, such as in the surface sizing and water spraying, has a swelling effect on the fiber network so that it can increase paper porosity. Surface size itself decreases porosity. It depends on the size of the solids and chemicals used how great the film forming effect and porosity decrease in the surface sizing. Also the surface sizing method has a great effect on porosity. Old size presses have less effect than modern film metering sizers, where the size solution stays more on the paper surface.

The final control of paper porosity is made with calendering. The effect depends on the calender type so that softer rolls give lower porosity. Increasing linear load and decreasing calender speed decreases porosity. Higher temperature and moisture enhance the calendaring effect. If the calender rolls are hard, and temperature as well as moisture is low, porosity can be even higher in spite of lower caliper after calendering.

2.2. Effects and benefits

Porosity measurement can be used to control refining, wet pressing, filler addition, wet end chemistry, vacuums of suction rolls or boxes, calendering, and to speed up grade change.

Increased refining results in a denser, less porous sheet. By contrast, high porosity can be expected, especially if the furnish consists mainly of relatively coarse fibers and a relatively low level of fiber fines. This is the same combination that yields high freeness, and one can expect there to be a fairly strong correlation between water-permeability during formation and air-permeability of the final sheet.

Porosity indicates the penetration and absorption of a base paper of a coating color or impregnant, the ease of filling a paper sack with cement as well as the performance of filter or cigarette papers.

Porosity correlates with basis weight, oil absorption, formation and pin holes, bulk (or density), bonding strength, light scattering/opacity, coating hold-out or coating coverage, print density, printed gloss, delta gloss, print-through, ink consumption, and several other properties.

The paper which is extremely non-uniform is likely to have excessively high porosity, because air is expected to move preferentially through the thin areas or pin holes in the paper.

Some of the practical measures to decrease porosity include:

- increased refining
- increased wet-press loading
- increased calendering
- reduced internal sizing to allow more uptake of size-press starch
- increased size-press starch viscosity/solids to achieve a better film

If the porosity of paper is too high, the first thing to be done is to increase refining.

The most effective wet end additives that can be used to reduce high porosity are delaminated clay and talc fillers. These additives have a highly plate-like structure that has the potential either to block air passages, or increase the length of the air flow path through the paper. Alternatively, special PCC fillers can increase porosity.

Some of the most effective ways to decrease porosity involve surface applications. To increase the effect of size-press starch, with respect to sealing the paper, ensure that you take measures that tend to hold the starch out on the paper surface. Such measures include internal sizing, increasing the solids content or viscosity of the starch solution, and use of film-applicator types of size press. In addition, you can add certain copolymers to the formulation. Latexes, polyvinyl alcohol, CMC, styrene maleic anhydride (SMA), and similar copolymers are often found to decrease the porosity of paper to a greater degree than starch alone.

Delaminated clay added at the size press can be expected to make the paper less permeable, though the use of minerals at the size press depends on having suitable equipment and procedures.

Coated paper is less porous than typical grades of uncoated papers. So, in a broader sense, the coating process can be seen as a solution to high air-permeability. An even more aggressive approach is to laminate the paper with polyethylene or other films, as in the case of milk cartons.

If the porosity is too low, it is possible to make paper more air-permeable by fractionating the fibers to remove the fines. However, you need to think of alternatives to make use of the fines fraction.

2.3. Laboratory methods and standards

The porosity of paper is normally measured using air leakage instruments of different types. Five of the common laboratory testers for paper smoothness, for example, Bekk, Gurley, Bendtsen, Parker Print-Surf, and Sheffield, also measure porosity. During this test, the backing for smoothness measurement is removed and the sample is clamped tighter. Porosity of cigarette papers is usually measured in Coresta units.

The term *densometer* is sometimes applied to the tests where the value increases with the air resistance (Gurley and Bekk).

These instruments measure the flow of air through a defined area of the paper, which is caused by a difference in pressure between the different sides of the paper sample. The measuring conditions, for example, the pressure difference and the measuring aperture, are arranged to suit the type of paper measured. In that way, the porosity of conventional paper grades, such as printing and writing papers, or low density papers such as tissue and cigarette papers, can be measured.

A general porosity method is available as ISO 5636-1. This method describes only the general physical features of the porosity measurement in a way such that instruments of different types can apply. The readings obtained with different instruments are calculated to a general porosity value using the physical dimensions of the particular instrument. The intent is to find a porosity value that does not depend on the instrument used. The units for this general porosity value are mm/Pas.

The most common porosity testers in use today for conventional paper grades are:

- Bendtsen, ISO 5636-3, and the Sheffield, ISO 5636-4, which measure the air flow in milliliters per minute

- Gurley tester, ISO 5636-5, which measures the time required for 100 mL of air to flow through the paper sample

In the case of very porous papers with low density, the pressure difference must be smaller than that used for conventional printing and writing papers. The measuring aperture is also often smaller. Methods based on these principles use:

- Gurley permeometer as described in TAPPI T 251
- normal Gurley tester equipped with a light inner cylinder and a smaller measuring aperture (this is not described in any standardized method)

In addition, companies making this type of paper product use various non-standardized methods for porosity measurement.

2.4. Porosity units

Table 2-1 lists elements involved in measuring porosity. The theoretical converting coefficients (TCC) given in the table are not precise. They are meant to give a rough idea of what a certain porosity value is when expressed in other porosity units.

Table 2-1 Porosity Measurement Elements

Unit	Area	Pressure	Expressed as	Range	TCC
ISO (Si)	10 cm^2	1.0 kPa	µm/Pas	0.01–100	
Schopper (DIN)	10 cm^2	0.981 kPa	ml/min	50–10000	Si=Sch/59
Schopper (ISO)	10 cm^2	1.0 kPa	ml/s	1–167	Si=Sch
Gurley	6.499 cm^2	1.21 kPa	s/100 ml	1.1–230	Si=128/Gs
Bendtsen	10 cm^2	1.47 kPa	ml/min	50–10000	Si=B/88,5
Bekk	1 cm^2	50 kPa	s/100 ml		Si=20/Bekk
Filtrona	10 cm^2	0.981 kPa	ml/min	50–10000	Si=F/59
Borgwaldt	40 cm^2	0.981 kPa	ml/min	10–50000	Si=Borg/235
Coresta	1 cm^2	1.0 kPa	ml/min	10–1000	Si=Coresta/6

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.

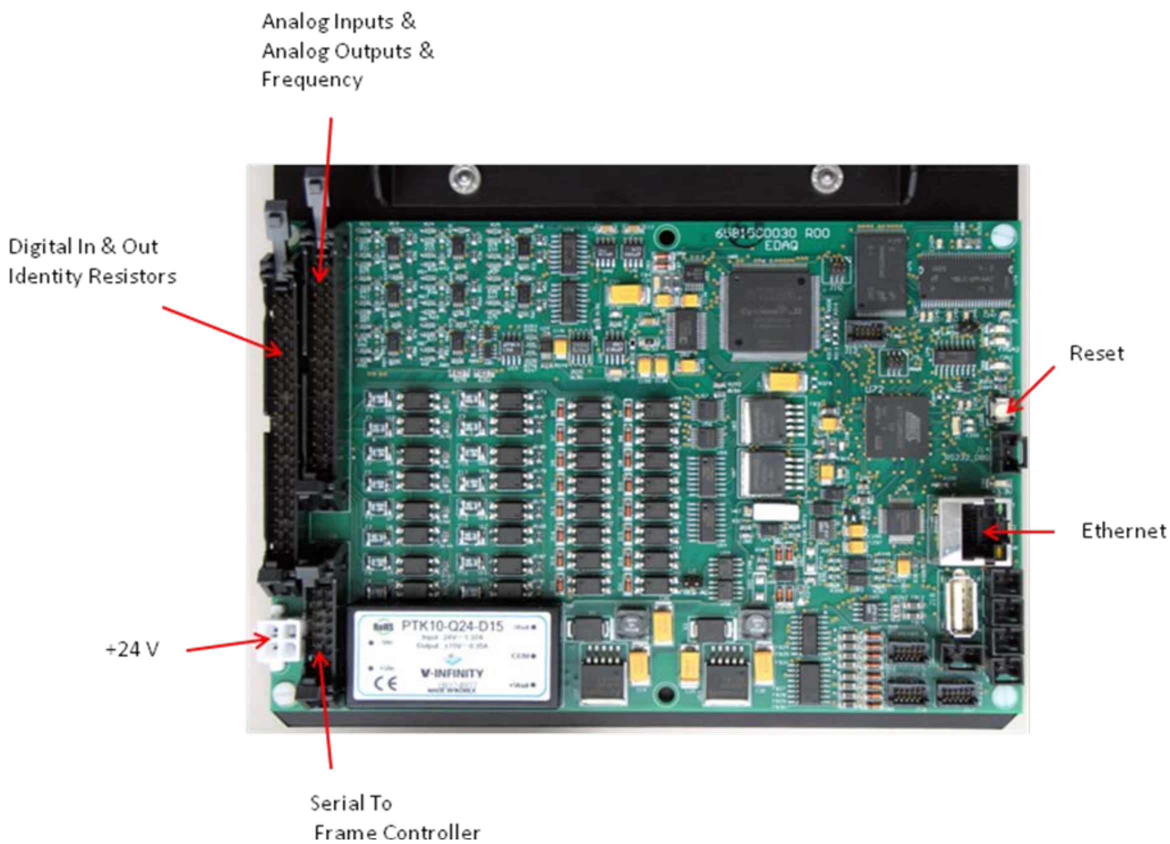


Figure 3-1 EDAQ Board

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.

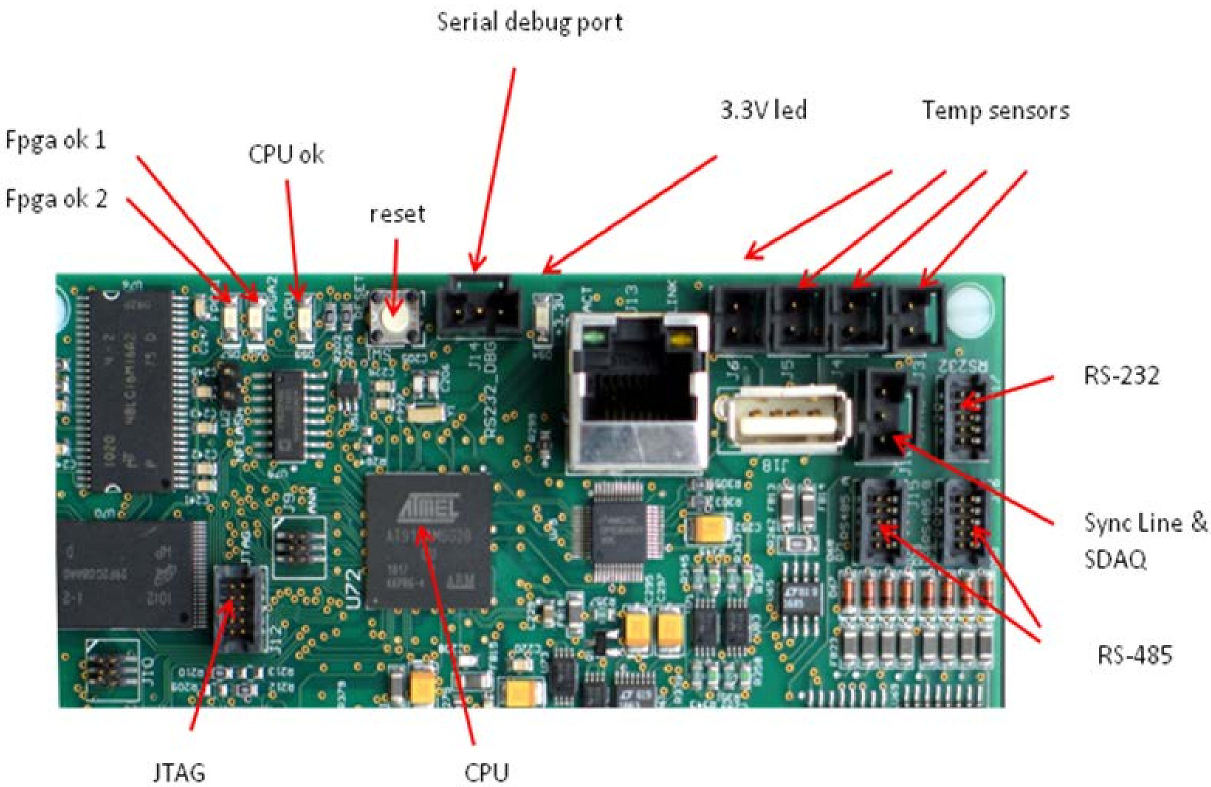


Figure 3-2 EDAQ Board: Ports and Diagnostic LEDs

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).

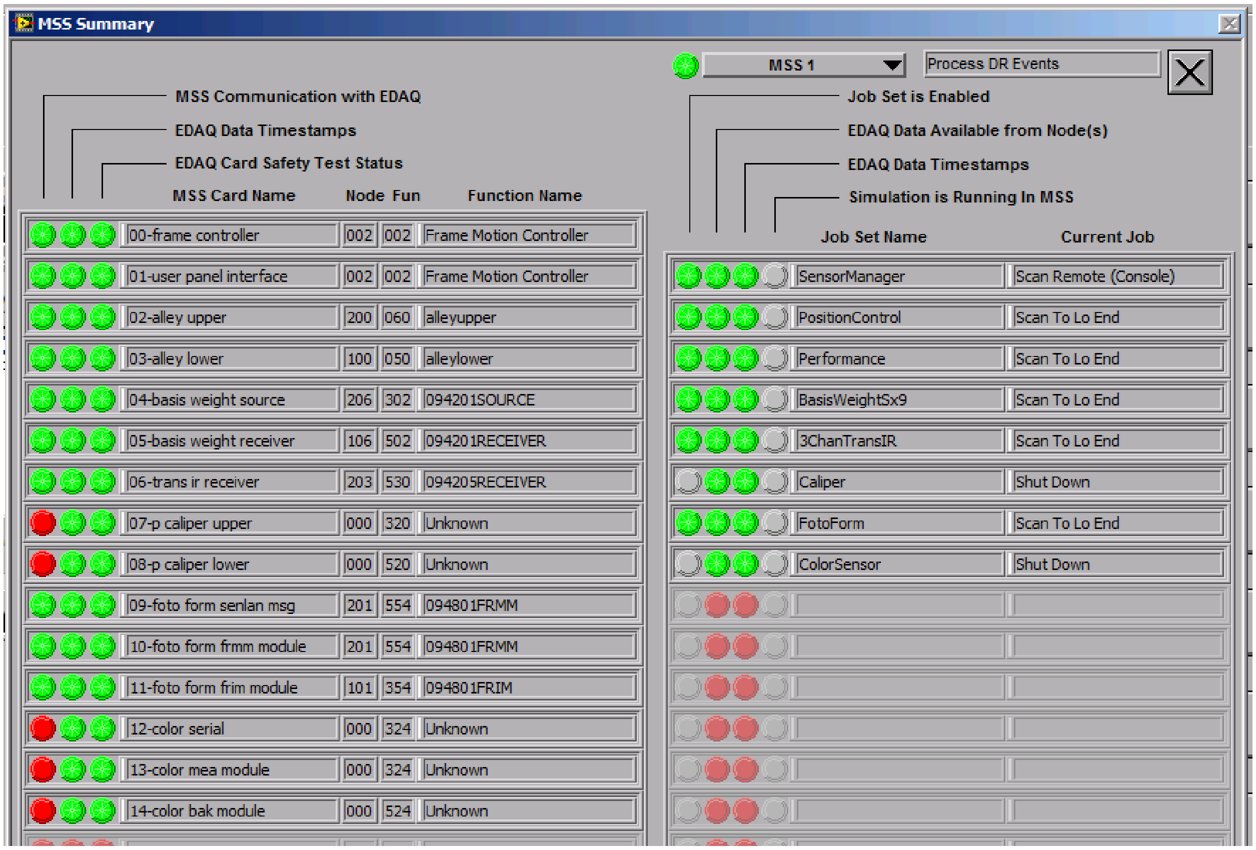


Figure 3-3 MSS Summary

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).

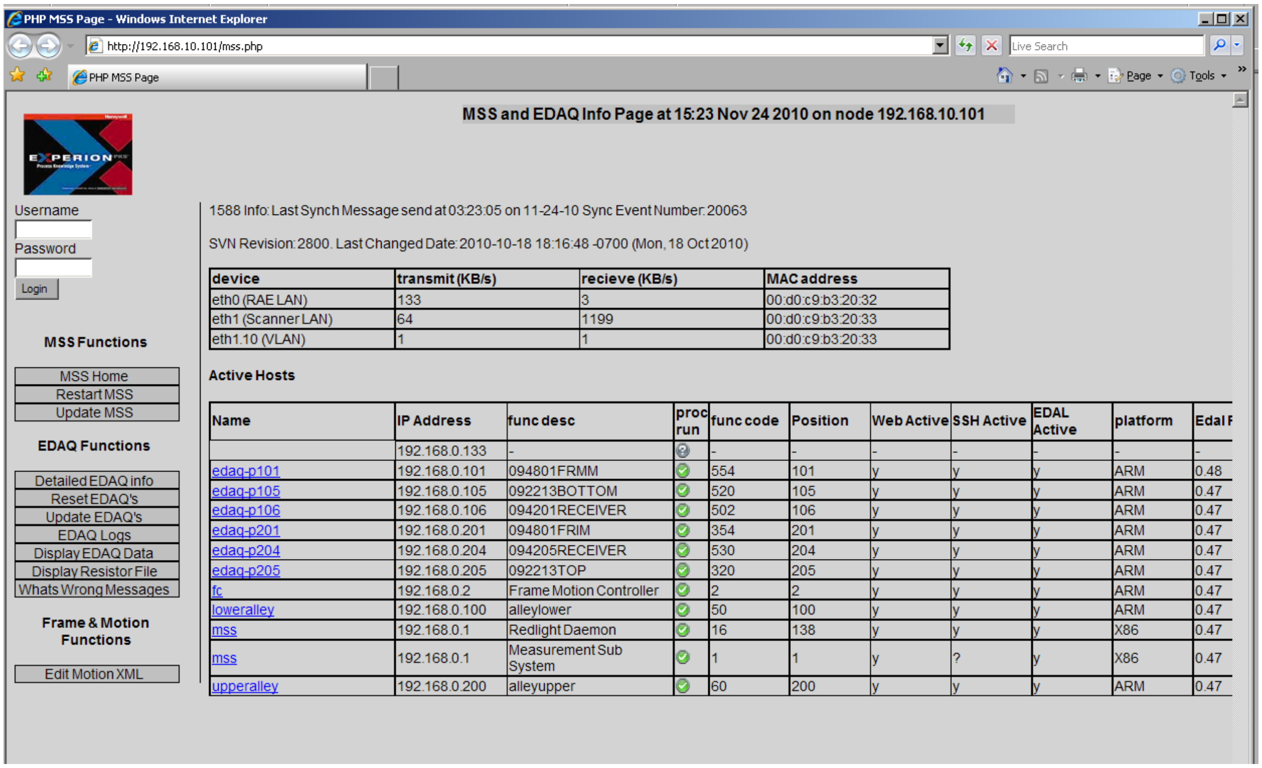


Figure 3-4 PHP MSS Page

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.

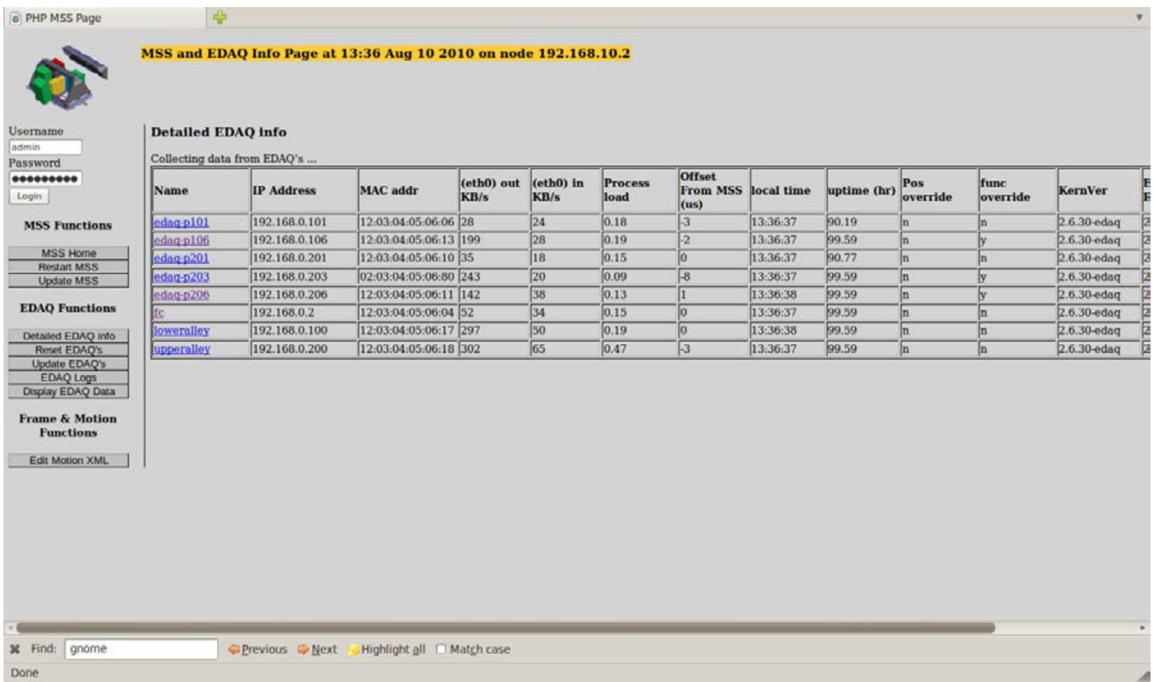
The second table lists all EDAQs discovered on the scanner LAN, their IP numbers, a brief description (related to model number), a program status column, the associated function code and position code, and whether the communication protocols are running (http, SSH, and Edal, the proprietary sensor data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

4.1. Overview

This chapter describes steps and procedures for installing the Porosity sensor. The chapter also includes installation requirements and a startup checklist to ensure that the porosity sensor has been installed correctly and is operating properly.

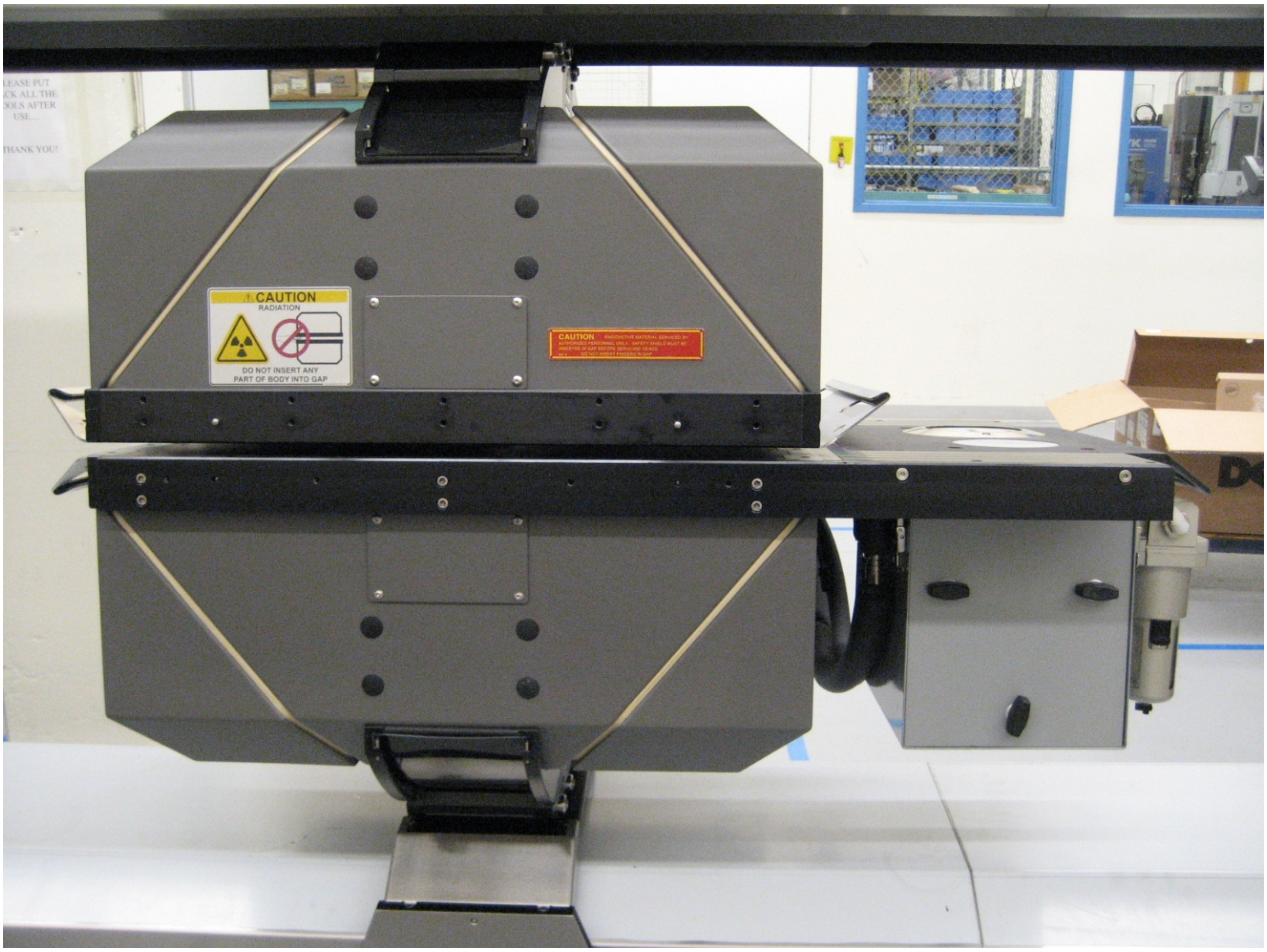


Figure 4-1 Porosity Sensor Outboard Installation

The Porosity sensor is always an outboard sensor. It is installed on the lower sensor head, because the sensor is always below the paper sheet.

4.2. Requirements

Before installing the porosity sensor, ensure that your system meets the following requirements:

- Pure, clean air: Your system must have pure, clean air. The sensor cannot operate properly if the air pressure is less than 3.5 bar (50 lb/in^2). Air consumption during normal measuring is below 50 L/min, but during cleaning phase it can be up to 250 L/min.

- Cooling water: Water must be available at a flow of up to 4 liters (1 US gallon) per hour. The internal temperature of the Porosity sensor should not exceed 55 °C (108 °F) for optimum performance.

4.2.1. Sensor location

The Porosity sensor is always located outboard. Before installing the sensor, you must ensure that there is enough space for the sensor to be correctly located (see Figure 4-2).

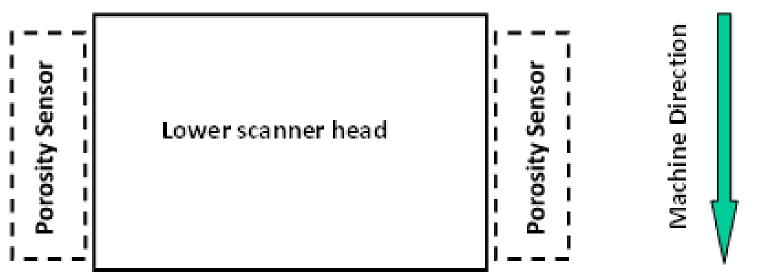


Figure 4-2 Porosity Sensor Recommended Locations

4.2.2. Measuring element direction

Measuring element direction must be selected to fulfill following requirements (see Figure 4-3):

- the measurement aperture must be in the machine direction in order to give high cross direction resolution
- the suction hole of the measurement aperture must be in the upstream position

4.2.3. Edge detectors

Edge detector installation is shown in Figure 4-3. The installation location depends on the sensor installation quadrant. For reliable sheet detection, edge detectors must be quite close to the paper web. The recommended level for the edge detectors is 2 mm below sensor head platform level.

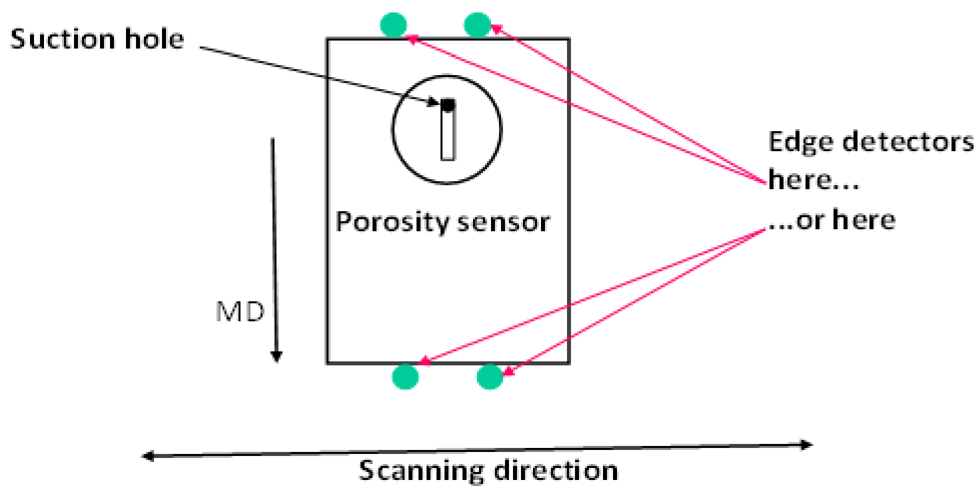


Figure 4-3 Edge Detector Installation

4.3. Mounting the Sensor

The Porosity sensor is mounted to lower scanner head using porosity sensor mounting bracket.

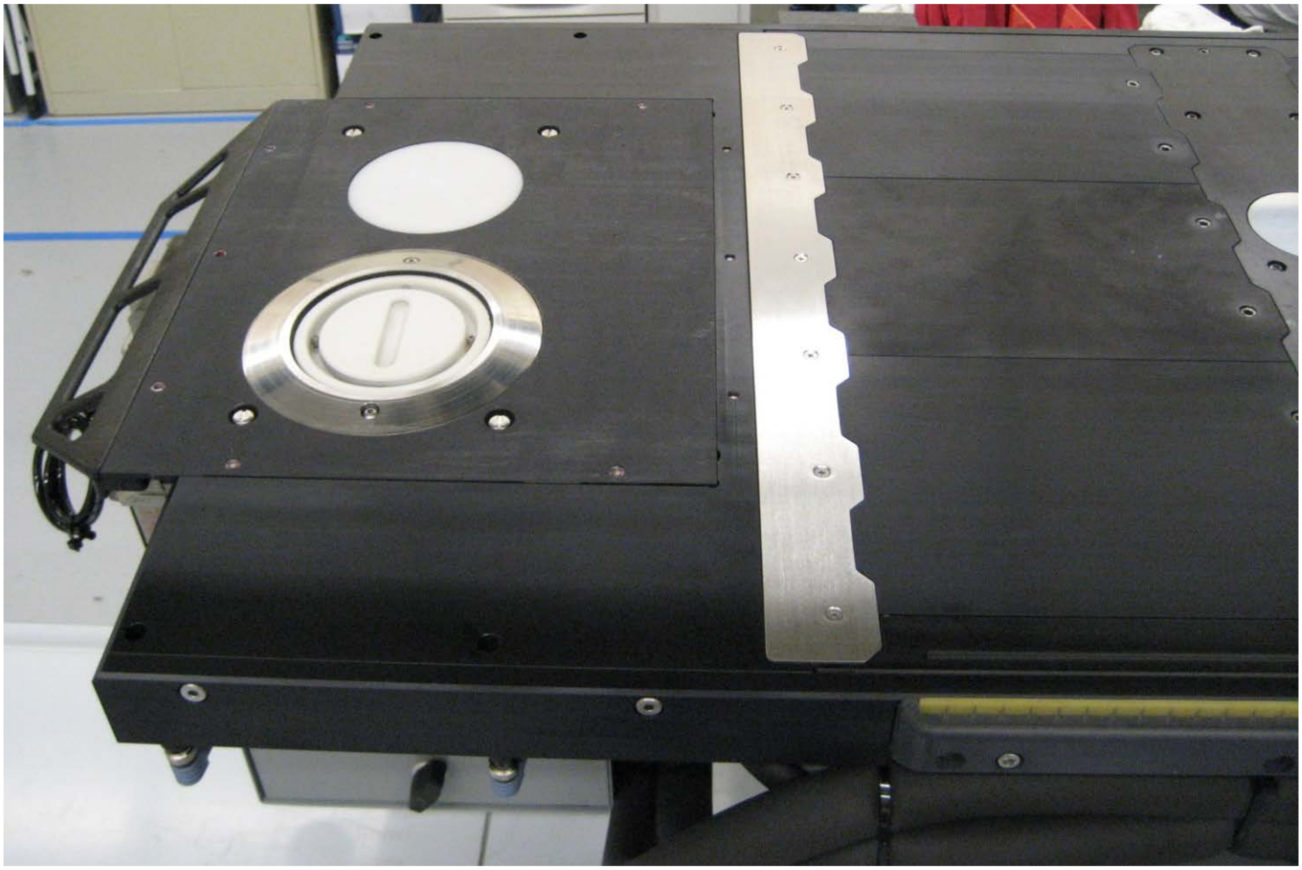


Figure 4-4 Sensor Mounting Bracket

4.4. Electrical connection

4.4.1. Wiring harness

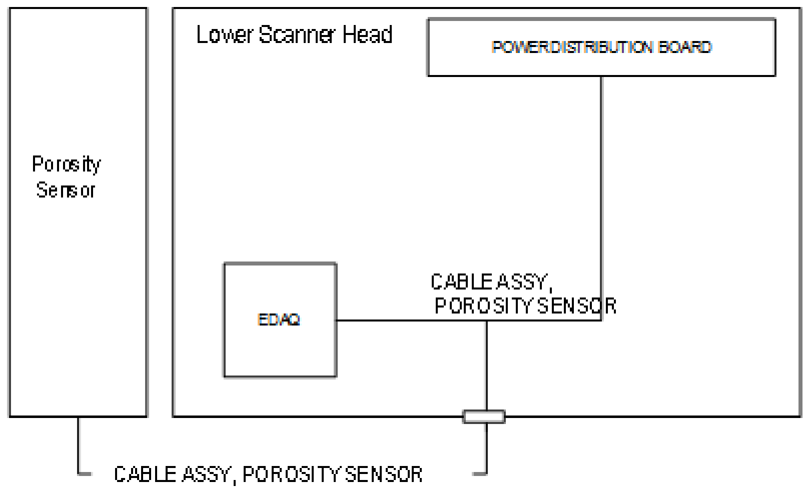


Figure 4-5 Sensor Wiring Schematic

The porosity sensor wiring harness (CABLE ASSY, POROSITY SENSOR) connects to the round 41-pin military connector on the porosity sensor.

4.5. Air Connection

Proper air supply is most important to the operation of the porosity sensor. Air flow provides the measurement vacuum, and the vacuum needed to hold the sheet against the measuring element.

The porosity sensor air connection is a quick-disconnect fitting mounted on to the sheet guide of the sensor.

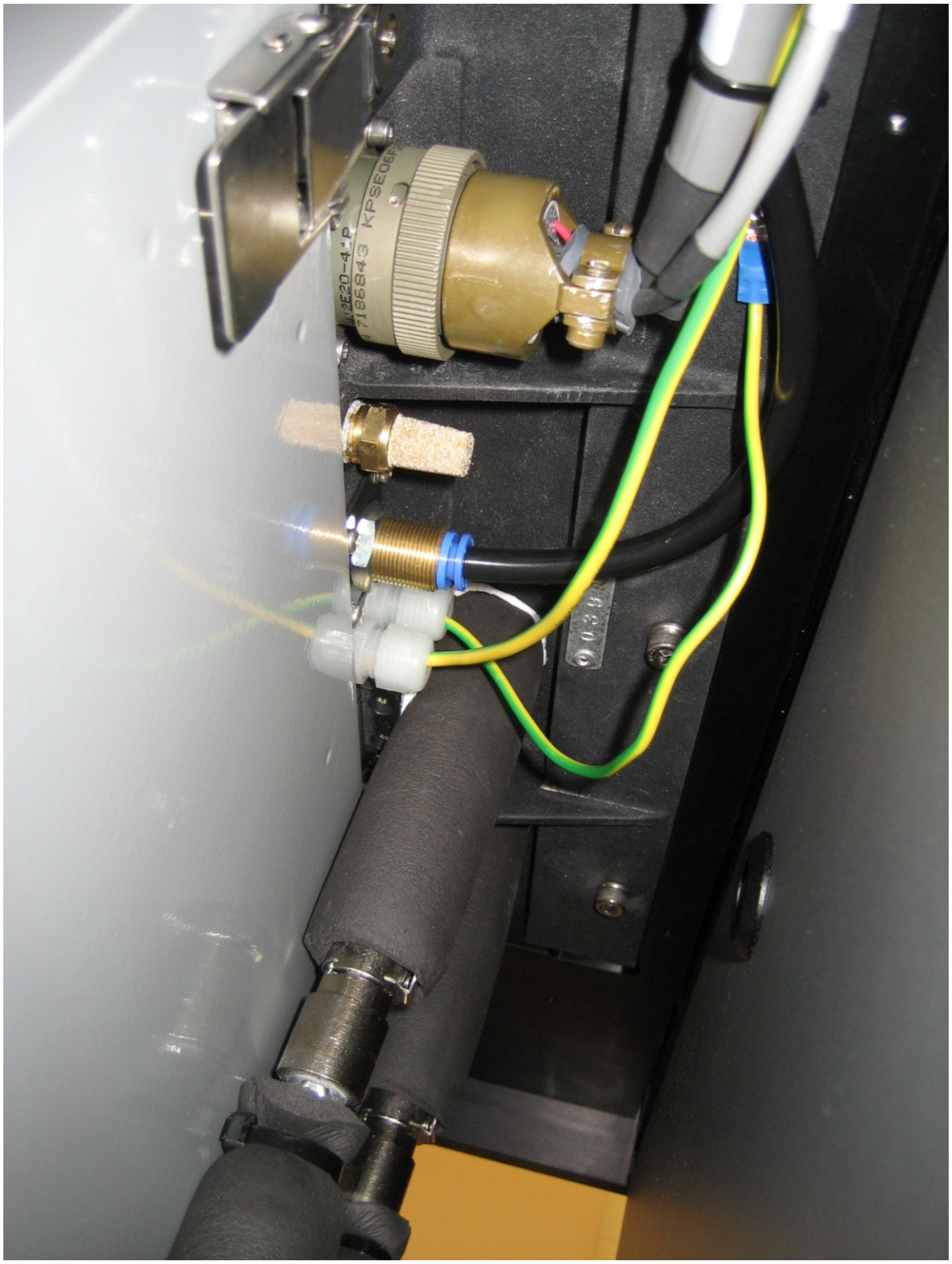


Figure 4-6 Electrical and Air Connections

Some practical considerations when connecting the air supply are:

- Target pressure at the mounting place is at five bars.
- Use the spare pressure line from the power track only for the Porosity sensor.

If some other device, for example, the air wipe, is using the same air, there could be disturbances in the Porosity sensor operation.

ATTENTION

The flow meter inside the sensor might get damaged when experiencing a high air pressure pulse. This can happen especially when the measuring aperture is blocked, and when the sensor cleaning phase is activated. Before connecting the air supply, ensure that the measuring aperture is not blocked.

4.6. Water connection

4.6.1. Model Q4219-51

Water cooling is needed if the sensor internal temperature exceeds 55 °C (131 °F).

1. Connect water circulation from the sensor head to the Porosity sensor so that water leaving the sensor head goes through POROS.
2. Connect water circulation first only to the sensor platform.
3. If sufficient cooling cannot be achieved, connect water circulation to DuoPack enclosure also.
4. Do not use DuoPack temperature control, because it might disturb the sensor head water circulation.

4.6.2. Model Q4219-52

Water cooling should not be used with this sensor model. If used, water may condensate inside the sensor.

4.7. Sheet contact adjustment

Sheet contact is one of the most important factors affecting the reliable operation of the Porosity sensor. Porosity measurement operation requires good contact with the sheet. Bad contact with the sheet might cause air leakage, resulting in erroneous measurements.

Some of the practical considerations to be aware of while making adjustments to the sheet contact are:

- Use the stiffener bar to prevent the sensor from hanging.
- Porosity sensor measuring element surface must be parallel with the paper web.

To adjust sheet contact, follow one of these options:

- Measuring element movement
- Measuring element level
- Hold vacuum level
- Measurement pressure

4.7.1. Measuring element movement

Figure 4-7 shows the measuring element controls.

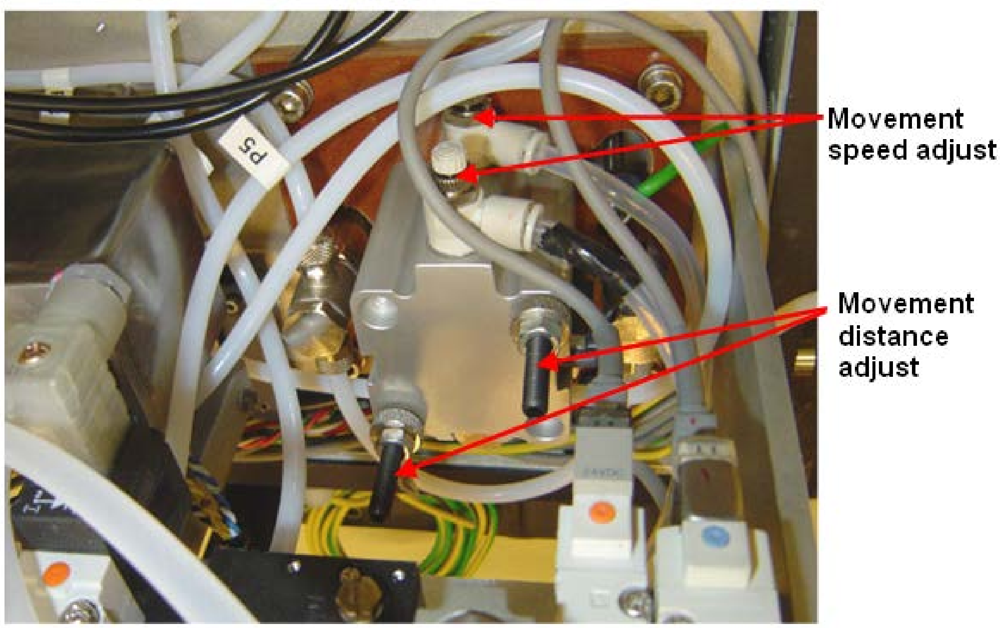


Figure 4-7 Measuring Element Controls

4.7.1.1. Movement / no movement selection

The measuring element up/down movement can be enabled and disabled by configuration. By default, it is disabled. If not needed, disable the movement to avoid extra shocks and wearing of the sensor mechanical components.

4.7.1.2. Movement speed adjustment

Movement speed can be adjusted using two screws inside the sensor. If the up/down movement is needed, the movement must be adjusted to minimize the shock and vibrations caused. For the procedure to adjust the measurement element movement speed, see Honeywell technical bulletin p/n 6510493015, Appendix B.

4.7.2. Measuring element level

If the movement is enabled, the sensor measuring element is in the down position, when the sensor is in **Meas OFF** state. The sensor measuring element is in the up position, when the sensor is in **Meas ON** state. The measuring element down position is fixed. *Level* means the distance between the measuring element up and down positions. That distance can be manually adjusted.

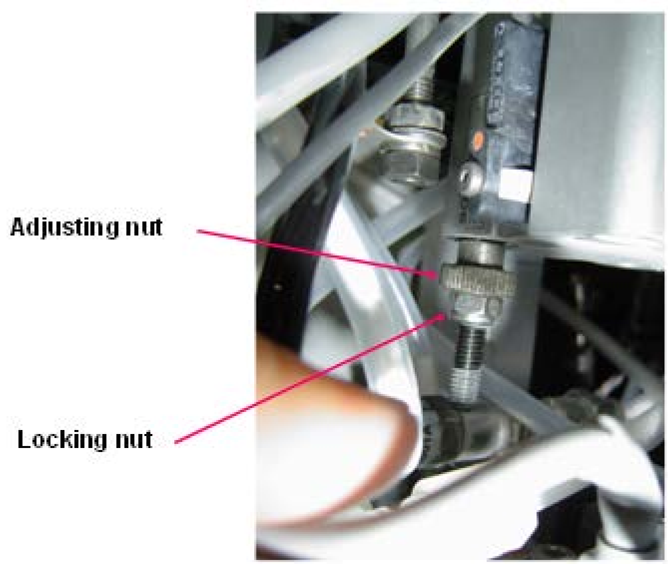


Figure 4-8 Measuring Element Level Adjustment

Select the level with the adjusting nut, and test the behavior. After acceptable sheet contact has been set, lock the level setting using the locking nut.

Optimal level adjustment depends on whether or not the backing plate has been installed.

4.7.3. Good sheet contact

To ensure good sheet contact:

1. Check that the measuring element has a visible contact to the sheet. The vacuum ring and the measuring aperture must make visible dents to the sheet. In Figure 4-9, the sheet is supported with a guide bar.

Figure 4-9 Good Visible Sheet Contact

2. To ensure visible contact, make sure that vacuum suction pressure has been adjusted properly (see Subsection 4.7.4).

3. Finally, you can analyze the quality of the sheet contact with the help of the diagnostic profiles tool. For more information about the diagnostic profiles tool, see Subsection 4.7.3.1.

4.7.3.1. Use of the diagnostic profiles tool

Figure 4-10 shows the **Diagnostic Profile** display set to show forward and reverse profiles of porosity measurement, diagnostic signal pressure (**poros Pressure xx**), and raw porosity value (**Flow meter xx volts**).

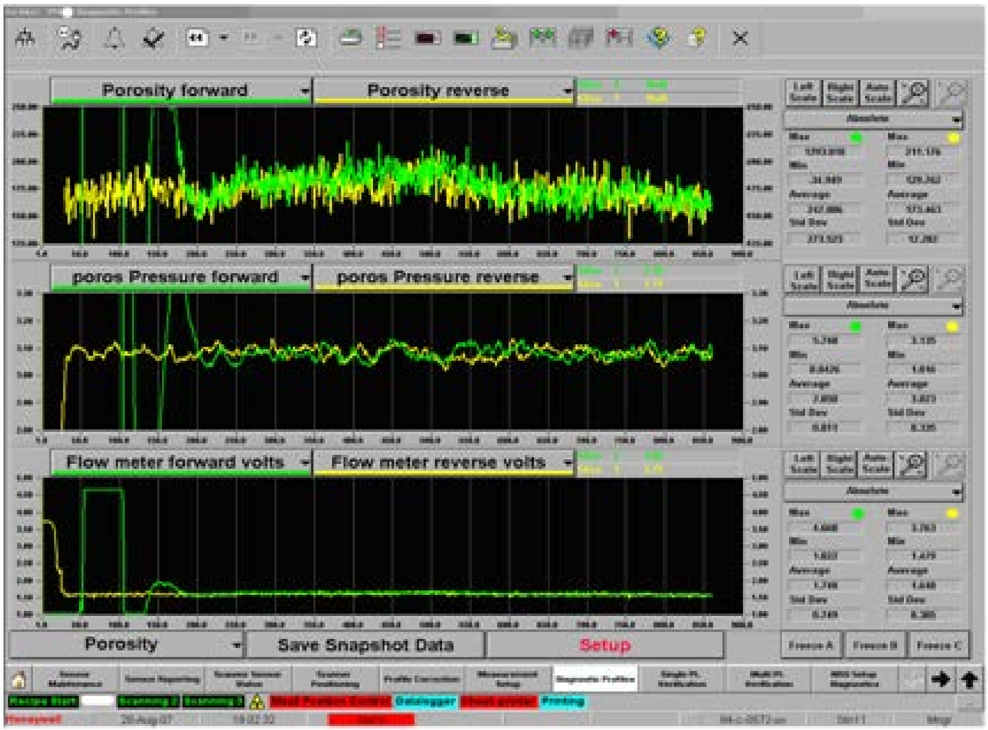


Figure 4-10 Diagnostic Profile Display [Tool]

The Porosity sensor builds a target measuring pressure while entering the sheet. The diagnostic signal pressure indicates the measuring pressure as shown in the middle of the display. The pressure first overshoots, and then comes back, and finally it reaches the correct level and stabilizes.

Porosity measurement is valid only when the measurement pressure is on the correct level and is stable.

The better the sheet contact, the sooner the pressure signal stabilizes, and the smoother the measurement pressure profile.

4.7.4. Hold vacuum level

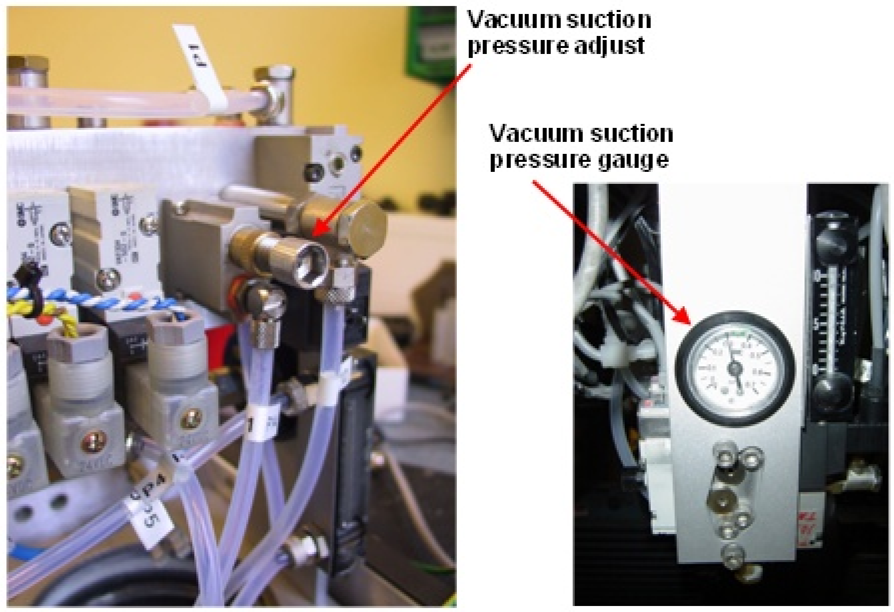


Figure 4-11 Hold Vacuum Level Adjustment

After establishing the contact with the sheet by the whole scan, you can select the vacuum suction level.

- If the hold vacuum level is too low, no contact can be achieved, or the contact is valid only occasionally during a scan.
- If the vacuum is too low, by increasing the vacuum you can establish the sheet contact sooner and a smoother measuring pressure profile can be obtained.
- If the vacuum level is too high, it can cause marking or web breaks.
- Determine the correct hold vacuum level by first inspecting sheet contact visually, and then using the diagnostic profiles tool.

4.7.5. Measurement pressure

Do not change or alter the measurement pressure, because it is set to the correct level during manufacturing and when calibrating the sensor with customer samples. Measurement pressure can be selected with the DIP switches, as described in Subsection 1.3.4. Changing measurement pressure means that the sensor must be re-calibrated.

Porosity sensor internal flow meter output is 1–5 V (raw porosity value). Optimum range for flow meter output is 1.5–3.5 V.

All grades that are to be measured must produce a valid flow meter value. You can consider changing the measurement pressure if:

- flow meter volts are near 1 V, measurement pressure must be increased
- flow meter volts are near 5 V, measurement pressure must be decreased

4.8. Sensor tuning

Porosity sensor tuning is described by an example.

4.8.1. Example

The example is a high speed Paper Machine where high speed scan was also used, making porosity sensor tuning more challenging.

Case specifics:

- Porosity sensor goes off the sheet on one side only
- High speed paper machine
- High speed scan

Before tuning the measurement pressure, shown in the diagnostic profiles tool middle window (see Figure 4-12), has large disturbances in forward scan (when entering the sheet from offsheet), but also the reverse scan is unreliable. In this situation, the Porosity sensor cannot produce correct measurements.

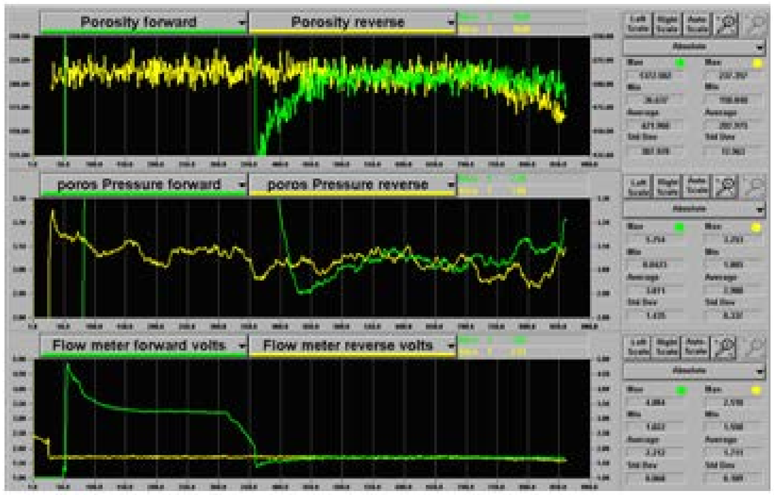


Figure 4-12 Situation in the Beginning of Tuning

The first corrective actions were:

- Raising the measuring element up.
- Increasing the hold vacuum level from 0.15 to 0.30 MPa.

As a result, measurement pressure profiles are slightly better. However, the Porosity sensor is still unable to give good measurement results (see Figure 4-13).

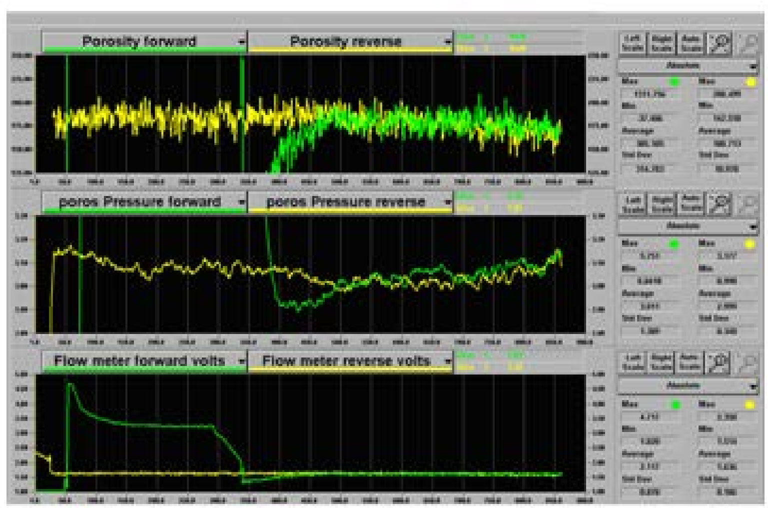


Figure 4-13 Profiles after First Corrective Actions

The secondary corrective actions are (see Figure 4-14):

- The regulator control speed was increased from super slow to fast. This gave a clear improvement.

- The regulator control speed was increased to super fast. This was the optimum control speed value.

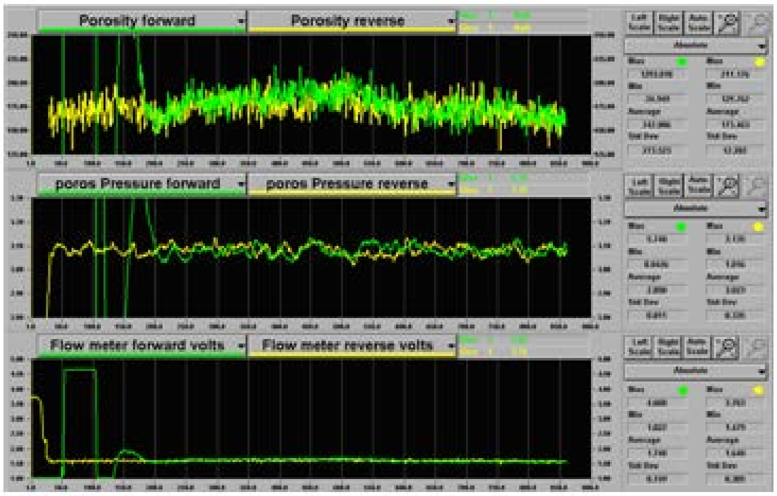


Figure 4-14 Secondary Corrective Actions Gave Good Results

Increasing the regulator control speed provides relatively even measurement pressure profiles which, in addition, are on the same level. In the beginning of the forward scan, when the sensor enters the sheet, the measurement pressure had disturbances that made the respective portion of porosity measurement profile unreliable. The unreliable part of a profile can be removed from a porosity measurement using the **Sensor Maintenance** display.

Summary

Getting a best sensor performance is case-dependent. In this case, the actions performed to obtain significant improvement in sensor performance were:

- Raising the measurement element for better sheet contact.
- Increase in the hold vacuum level for better sheet contact.
- Changing the electric regulator (HYREG) control speed from super slow to super fast for faster measurement pressure stabilization.

4.8.2. Tuning recommendations

These are the recommended steps to optimize Porosity sensor performance. Use the **Diagnostic Profile** display to monitor the effect of adjustments:

1. Decide whether the measuring element must be static, or whether element movement should be enabled. Enabling/disabling movement is done by configuring the DIP switches.

2. Adjust the correct level for the measuring element (see Subsection 4.7.2).

3. Select an appropriate hold vacuum level (see Subsection 4.7.4).

4. Determine if the measuring pressure must be changed. Note, that changing this setting requires a new sensor calibration. Measurement pressure is selected by configuring the DIP switches.

5. Find the optimum control speed for the electronic regulator (HYREG) by testing the effect of different control speeds.

6. Set a suitable cleaning phase by configuring the DIP switches. Set the cleaning time to maximum, if there are no installation-specific reasons not to do it.

5. Calibration

The Porosity sensor is calibrated during manufacturing, before shipping to the customer site, and the calibration report is shipped with the sensor.

The original calibration is made using customer samples. For procedures for selecting calibration samples, see Appendix A.

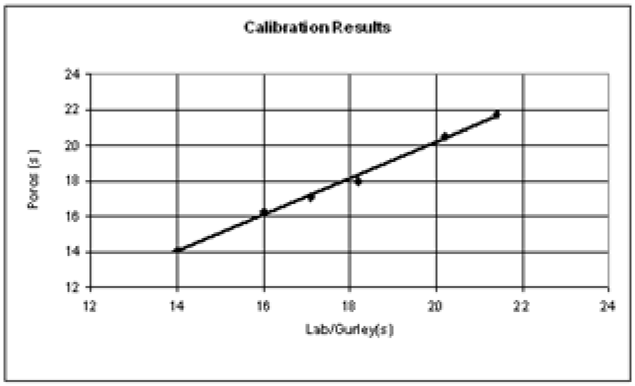
Figure 5-1 shows a sample calibration report from the sensor manufacturer. The laboratory method used to calibrate the sensor in this example is *Gurley*.

Honeywell

POROSITY SENSOR PERFORMANCE REPORT

Customer:	**xxx**
Application:	
System:	
Scanner:	
Sensor type:	**4219-1**
Serial number:	**0013**
Lab method:	**Gurley**
Analyst:	**xxx**
Date:	**11.3.2005**

A. CALIBRATION DATA



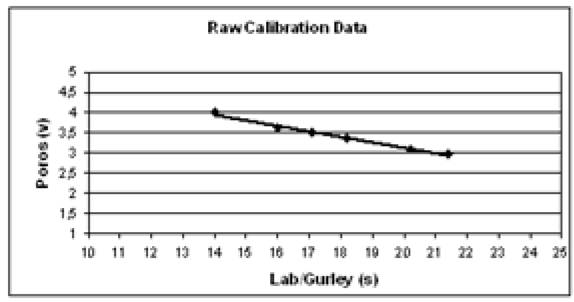
Calibration parameters

Slope:	144
Intercept:	-154

Sensor measures airflow (ml/min) and the Gurley (s) calculated using the conversion factor: 6000 /airflow.
Calibrated Poros = 6000 / (Poros (V)* Slope + Intercept)

Honeywell

Point/ Sample	Meas 1 / Poros(V)	Meas 2 / Poros(V)	Meas 3 / Poros(V)	Meas Avg / Poros(V)	Calibrated Poros	Customer Lab
1	4	4,15	3,92	4,02	14,1	14
2	3,72	3,64	3,53	3,63	16,3	16
3	3,52	3,45	3,55	3,51	17,1	17,1
4	3,39	3,38	3,37	3,38	18,0	18,2
5	3,14	3,09	3,08	3,10	20,5	20,2
6	3,01	2,92	3,05	2,99	21,7	21,4



Integration time: **16**

Figure 5-1 Sample Calibration Report

Page one of the calibration report provides data on the original sensor calibration at the manufacturer. In this instance, five samples are used. Each sample is measured three times, with the average used for calibration. The calibration result is parameters for slope and intercept, by which the raw porosity value from the sensor can be converted to the Bendtsen value.

Page two of the calibration report shows DIP switch setting used (see Figure 5-2). If measurement pressure is changed after the calibration is done, the sensor must be re-calibrated.

Honeywell

Dip settings

	J40	On/Off	
Flow smoothen	1	1	Average 200
	2	1	
Pressure adjustment	3	0	-0.78k
	4	1	
	5	0	
	6	1	
Flow meter selection	7	1	HW1000
	8	0	
	9	0	
Noise filter	0	0	Not in use

	J41	On/Off	
Sample mode	1	0	Normal
Control Speed	2	0	Slow
	3	1	
Lift contact head	4	1	Lift
SDAQ	5	0	Not in use
Blow time	6	0	0
	7	0	
Scaling	8	0	0
	9	0	
Method	0	0	Flow

Figure 5-2 DIP Switch Settings

Sensor calibration consists of two steps:

- static calibration
- dynamic calibration

A fast moving sheet produces some amount of air leakage, and it can happen when the static calibration gives wrong porosity values when measuring a moving web. This difference between a laboratory analyzer and an online sensor must be corrected by using dynamic calibration.

5.1. Static calibration

5.1.1. Selection of samples

For additional details on selecting samples, and to determine how to select customer samples, see Appendix B. Use the samples shipped with the sensor if they are available. If they are not, get these samples from the customer:

- samples representing highest porosity level
- samples representing lowest porosity level
- samples representing three intermediate porosity levels

5.1.2. Measuring samples with a laboratory analyzer

Carefully measure the porosity levels of the samples using a laboratory analyzer.

5.1.3. Measuring samples with an online sensor

To measure the samples with online sensor:

1. Before starting to measure the samples, disable the cleaning phase with the configuration. This is done to protect the flow meter from high air pressure pulses created by the cleaning phase air blow, which might damage the flow meter.
2. Use the tools available in the system to measure the Porosity sensor output voltage for each sample.
3. Use the sample pad with the samples. With sample pads, the samples will be tight enough to avoid air leakage, which often disturbs sample measurements.

Figure 5-3 shows a pair of sample pads.

Figure 5-3 Sample Pads

5.1.3.1. Using the sample tool

To measure samples with the sample tool:

1. Put the scanner into maintenance mode.
2. Set the cleaning phase configuration setting to *No cleaning*. This is a preventive measure to protect the flow meter inside the sensor.
3. Turn porosity sensor configuration setting sample switch to the *Sample* position, and cover both edge detectors. As a result, the measuring element is raised to the up position (if movement is enabled), and the hold vacuum and the measurement vacuum are activated.
4. Put the paper sheet flat against the sensor measuring element. Reliable measurement requires good contact with the vacuum ring, which can be seen as a round circle around the measurement aperture (see Figure 1–3). It may take some time to get the sample flat enough on the measuring element to create a good contact with the vacuum ring.
5. Use the sample tool to read sensor measurement voltage.
6. Repeat Step 4 and Step 5 until all samples have been measured.
7. Remember to return sample switch back to the *Normal* position, and to uncover the edge detectors (see Figure 1–2).
8. Return the cleaning phase configuration setting to the original value.
9. Return the scanner to the process mode.

5.1.4. Calibration parameters for flow-based measurement

Sensor response is linear. To convert the sensor signal to porosity units, a straight line must be fitted to the laboratory or online porosity sensor data sets.

Experion MX software is written to support flow-based measurement. Static calibration line coefficients *c1* and *d* must be entered into the system.

Dynamic calibration intercept and slope parameters can be used to fine tune online porosity sensor to agree with the laboratory analyzer.

5.1.5. Calibration parameters for time-based measurement

Sensor response correlates with flow, so it must be inverted in the Quality Control System (QCS) to get a reading in time based porosity units.

Experion MX porosity sensor software does not support time-based porosity measurement.

Use the **Virtual Sensor Wizard** to implement the calculation to time-based measurement. Good system software knowledge is required.

Dynamic calibration intercept and slope parameters can be used to fine tune online porosity sensor to agree with the laboratory analyzer.

5.2. Dynamic calibration

Paper samples are frequently taken from production for the mill laboratory analysis. Samples are normally machine direction samples, but sometimes cross direction profile samples are also used.

Dynamic calibration requires a comparison to be made between the laboratory result and the online sensor reading.

Depending on the sample type, machine direction or cross direction, representative online sensor data must be used in the comparison.

Practical considerations:

- the comparison time period should be long enough
- several grades must be included to the comparison
- monitoring of dynamic correlation is a task that must done continuously
- worsening dynamic correlation is often a symptom of a sensor problem

Figure 5-4 shows a graph describing a good dynamic correlation.

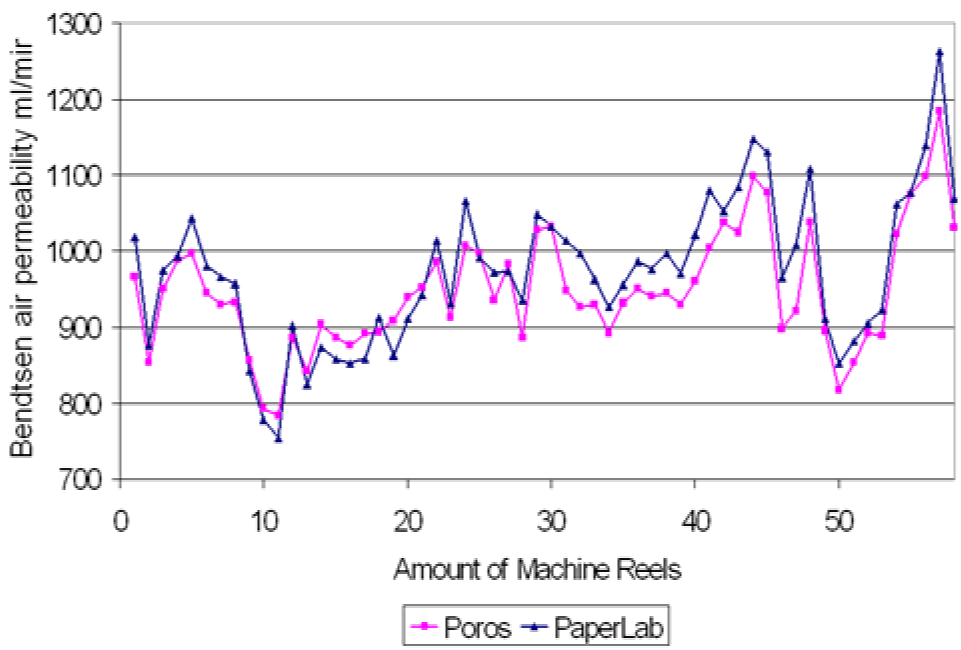


Figure 5-4 Good Dynamic Correlation

Figure 5-4 shows a graph describing a bad dynamic correlation.

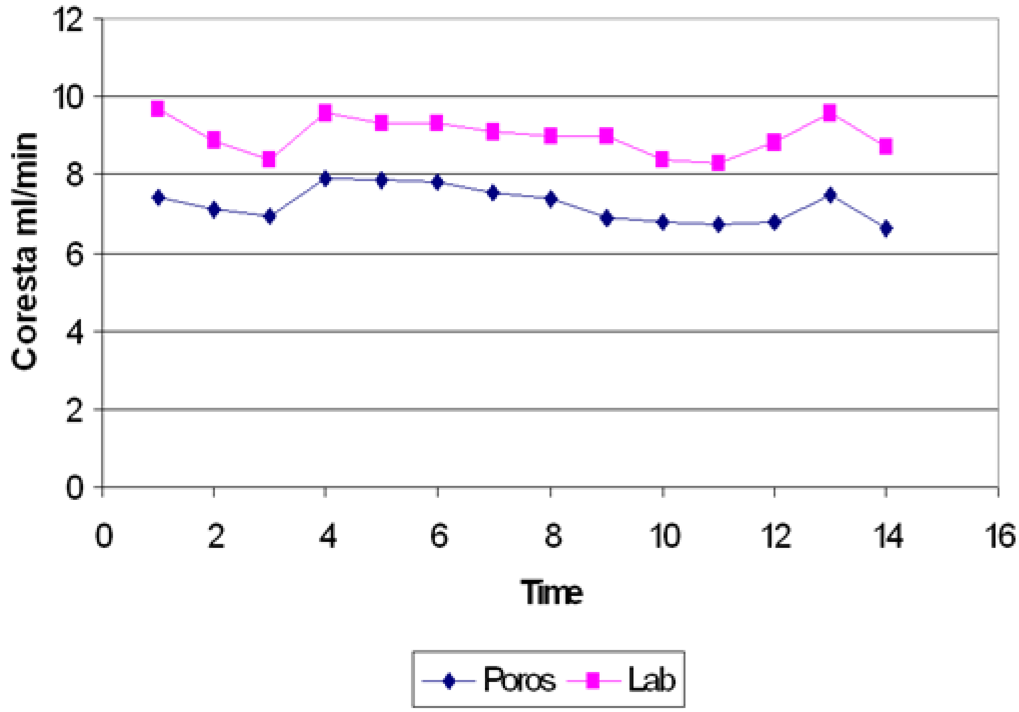


Figure 5-5 Bad Dynamic Correlation

In the bad dynamic correlation graph, the online sensor gives systematically lower values than the laboratory analyzer. If only the intercept value must be changed, or if there is a need for slope adjustment, these can be seen only by calculating, for example, with Microsoft™ Excel, correct values for the parameters.

5.3. Example calibration

Table 5-1 shows an example where four samples have been used to check the Porosity sensor dynamic correlation. The Porosity sensor calibration is very poor. Raw porosity voltages, calculated using known sensor calibration parameter values (slope=54.403, intercept=-63.871), are also shown in the table. Raw porosity voltages can be calculated as:

Raw porosity in Volts = (Porosity in Engineering Units - Intercept)/Slope

Table 5-1 Bad Calibration

Laboratory (Coresta)	Porosity Sensor (Coresta)	Calculated Raw Porosity Value (V)
175	106.44	3.13
78	44.94	2.00

Laboratory (Coresta)	Porosity Sensor (Coresta)	Calculated Raw Porosity Value (V)
29.1	14.79	1.45
9.8	-0.88	1.16

Figure 5-6 shows a graphical presentation of dynamic correlation. The Porosity sensor gives wrong measurement results, but the good point is that correlation between the laboratory and the online sensor reading is almost linear, indicating that a good calibration can be made.

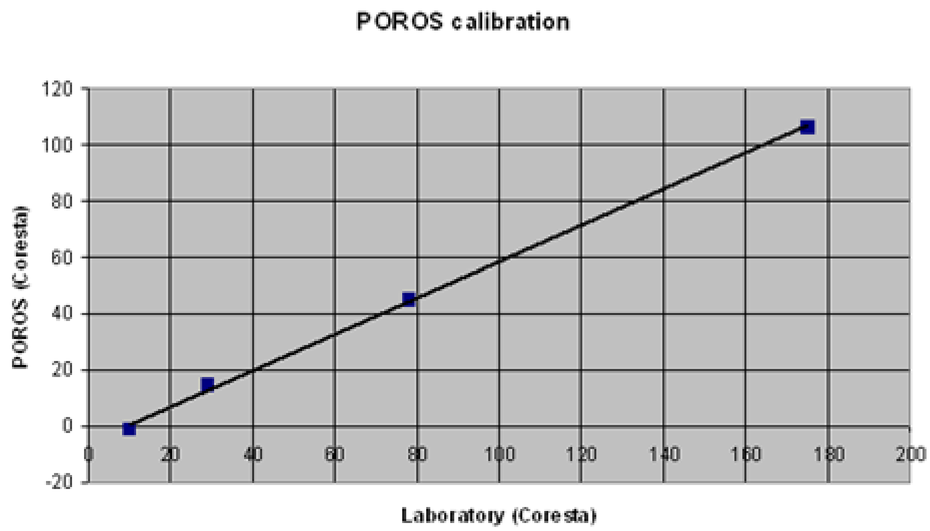


Figure 5-6 Bad Dynamic Correlation

A new calibration must be calculated so that linear transformation using new slope and intercept (or offset) parameters convert raw porosity voltages to laboratory analyzer values. That can be done quite easily with Excel, which calculates the linear transformation from raw porosity value to laboratory value. Figure 5-7 shows the results.

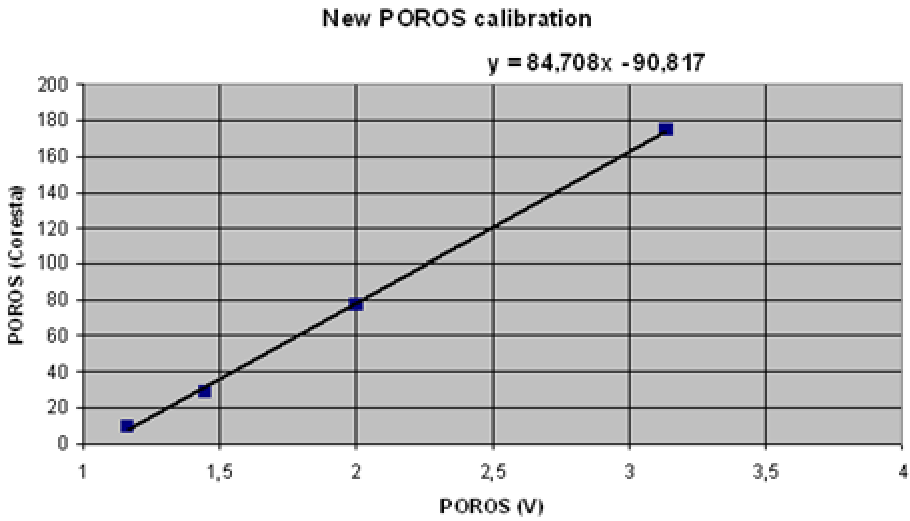


Figure 5-7 Improved Calibration

New calibration parameters are:

- slope = 84.708
- intercept = -90.817

Table 5-2 shows the results. The difference between the laboratory and online sensor results is added to the table.

Table 5-2 Calibration Results

Laboratory (Coresta)	Porosity Sensor (Coresta)	Difference Laboratory–POROS
175	174.37	0.63
78	78.61	-0.61
29.1	31.66	-2.56
9.8	7.26	2.54

6. Preventive Maintenance

Preventive maintenance requirements for the Porosity sensor depend primarily on the environment, because it touches the paper web, and also because the air it sucks in from the process environment goes inside the sensor.

The frequency of preventive maintenance procedures might need to be adjusted depending on your operating environment. It is not possible to give a global preventive maintenance schedule for the Porosity sensor, so, three different process environments are described in this chapter. For each instance, preventive maintenance requirements are described, and a preventive maintenance schedule is suggested. By using these instances as an example, it is possible to build a preventive maintenance schedule for each one. With experience, you can fine tune the schedule for optimum performance.

6.1. Maintenance environments

6.1.1. Friendly environment

This environment is relatively easy from a sensor maintenance perspective. This environment can best be described by what it does not have:

- no dust or fibers that accumulate on sensor surfaces or that could go inside the sensor pneumatic sub-system
- sheet moisture content relatively low, that is below 5% moisture
- no stickies in the paper that can attach to the sensor measuring element

The need to verify dynamic correlation is not environment-dependent. Correlation to the laboratory should be verified every week. Because there is not very much dust or fibers, cleaning of the sensor surfaces can be done every other week or so.

The same is true for cleaning air filters and caps. Sheet contact must be checked visually, and by using the diagnostic profiles tool on a weekly basis no matter what the sensor environment is. The preventive maintenance schedule is provided in Table 6-1.

6.1.2. Medium environment

The medium environment is similar to the friendly environment, except that it has dust and fibers.

Dust and fibers must be cleaned from sensor surfaces and air filters and filter caps more frequently. Filter cleaning must be done several times per week for following very demanding grades:

- super calandered paper (SC)
- high filler content
- fluting
- sack paper

The preventive maintenance schedule is provided in Table 6-1.

6.1.3. Hostile environment

This environment has all the features that make the maintenance of Porosity sensor demanding. The environment can be described as:

- dust and fibers
- sheet moisture content high: > 5% moisture
- stickies
- recycled stock

High sheet moisture content, and the presence of stickies, indicate that dirt accumulation on the sensor surfaces will be a maintenance challenge, so sensor surfaces must be cleaned several times a week.

Dirt accumulated on the sensor surfaces may disturb sheet contact. The preventive maintenance schedule is provided in Table 6-1.

6.2. Preventive maintenance checklist

In Table 6-1, *X* indicates recommended maintenance intervals (*AR* indicates As Required, or multiple times during the interval).

Table 6-1 Preventive Maintenance Internal Checklist

Procedure	Daily	Weekly	Months		Years			Task Details
			1	6	1	2	5	
Friendly Environment								
Clean measuring element		X						See Subsection 7.1
Clean and check edge detectors		X						See Subsection 7.2
Clean air filters and caps			X					See Subsection 7.3
Check measurement pressure profile		X						See Subsection 7.4
Medium Environment								
Clean measuring element		X						See Subsection 7.1
Clean and check edge detectors		X						See Subsection 7.2
Clean air filters and caps		AR						See Subsection 7.3
Check measurement pressure profile		X						See Subsection 7.4
Hostile Environment								
Clean measuring element	X							See Subsection 7.1
Clean and check edge detectors	X							See Subsection 7.2
Clean air filters and caps		AR						See Subsection 7.3
Check measurement pressure profile		X						See Subsection 7.4

7. Tasks

This chapter provides procedures for maintaining optimal Porosity Measurement function, and troubleshooting issues with the sensor.

7.1. Clean measuring element

This procedure is especially important if using recycled stock.

Activity Number:	Q4219-52-ACT-001		**Applicable Models:**	Q4219-51; Q4219-52
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):	10 minutes		**# of People Required:**	1
Prerequisite Procedures:				
Post Procedures:				
Required Parts:	Part Number	Quantity	Description	
Required Tools:	• brush • cleaning tissue • isopropanol			

You can use compressed air to clean the vacuum ring, but ensure that the vacuum filter is installed (see Figure 7-1).

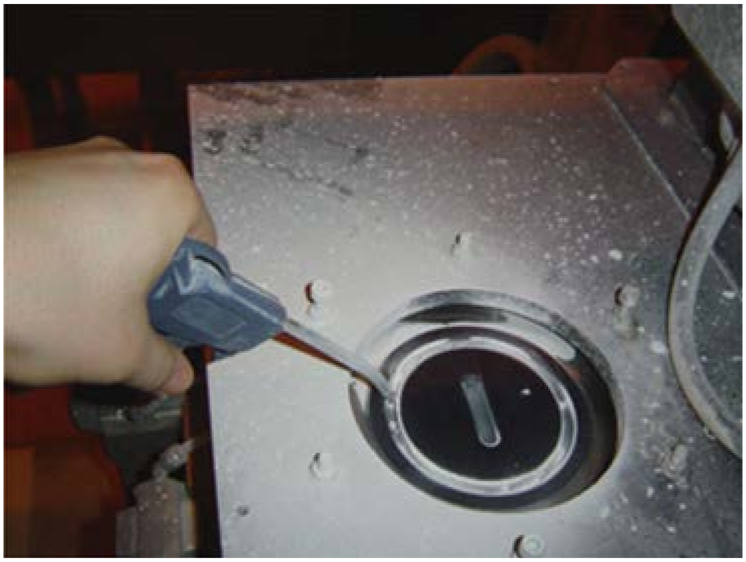


Figure 7-1 Clean the Vacuum Ring with Compressed Air

ATTENTION

Do not use compressed air to clean the measuring aperture. Using compressed air might break the flow meter inside the Porosity sensor.

To clean the measuring element:

1. Cover the edge detectors to activate the sensor cleaning phase. Use a brush to clean the vacuum ring (see Figure 7-2).

Figure 7-2 Clean the Vacuum Ring with a Brush

2. Wet a cleaning tissue with isopropanol.
3. Use the cleaning tissue with force to clean the measuring element surface of stickies (see Figure 7-3). Continue until the surface is clean.

Figure 7-3 Clean the Measuring Element with Isopropanol

7.2. Clean and check edge detectors

Activity Number:	Q4219-52-ACT-002	**Applicable Models:**	Q4219-51; Q4219-52
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):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
Required Parts:	Part Number	Quantity	Description
Required Tools:	• paper towel or rag		

Two possible causes of problems for the Porosity Measurement:

- dust build up on the detectors
- detectors are too far away from the paper web

Actions to take:

1. Clean the edge detectors.
2. Check the distance from the detectors to the paper web. The recommended position for the edge detectors is 2 mm below the sensor head platform level.

7.3. Clean air filters and filter caps

Activity Number:	Q4219-52-ACT-003	**Applicable Models:**	Q4219-51; Q4219-52
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 month
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
Required Parts:	Part Number	Quantity	Description
Required Tools:			

For examples of cleaning actions, see Figure 7-4 and Figure 7-5.

1. Remove filter caps.
2. Remove the filters.
3. Clean the filters with pressurized air.
4. Clean the filter caps.

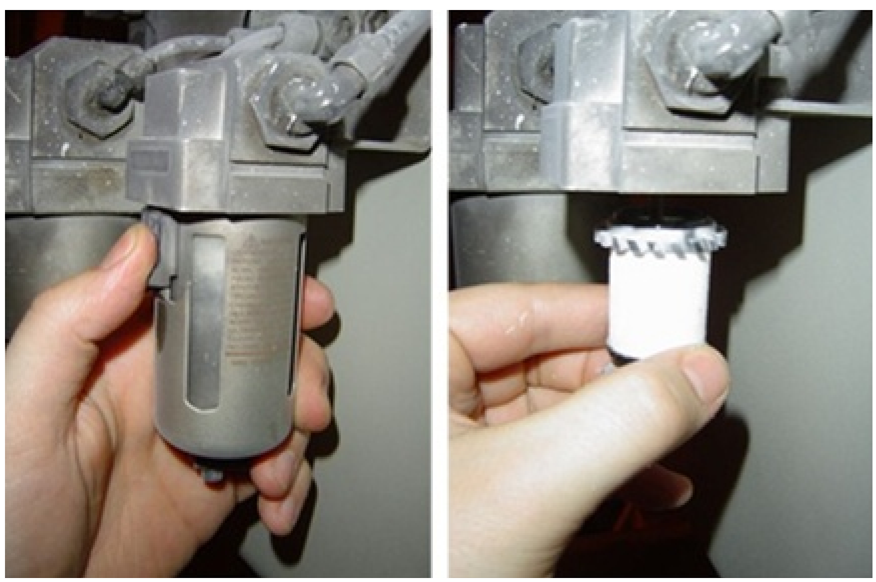


Figure 7-4 Remove Filter Caps and Filters

Figure 7-5 Clean Filters and Remove Dust

ATTENTION

Do not clean the upper part of the filter caps when the filter is not attached.

After cleaning the air filters, ensure that the filter caps are installed firmly. If they are not installed firmly, air leakage occurs for the hold vacuum or measurement pressure, which shows up as a disturbance in the porosity measurement.

7.4. Check measurement pressure profile

Activity Number:	Q4219-52-ACT-004	**Applicable Models:**	Q4219-51; Q4219-52
Type of Procedure:	Maintain	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	None	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 week
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
Required Parts:	Part Number	Quantity	Description

Required Tools:	diagnostic profiles tool

The profile of diagnostic signal measurement pressure indicates how well the sensor is tuned. Measurement pressure should ideally be flat during the scan in both directions. In practice, there are disturbances at the sheet edge where the sensor goes off the sheet (see Figure 7-6).

The diagnostic profiles tool must be set to display:

- measurement pressure
- raw porosity value

Figure 7-6 shows a relatively well tuned porosity measurement. Porosity measurement raw value and measurement pressure are shown in the two upper windows. The bottom window shows the porosity value in engineering units.

Figure 7-6 Well Tuned Porosity Measurement

Figure 7-8 and Figure 7-9 show a badly tuned porosity measurement.

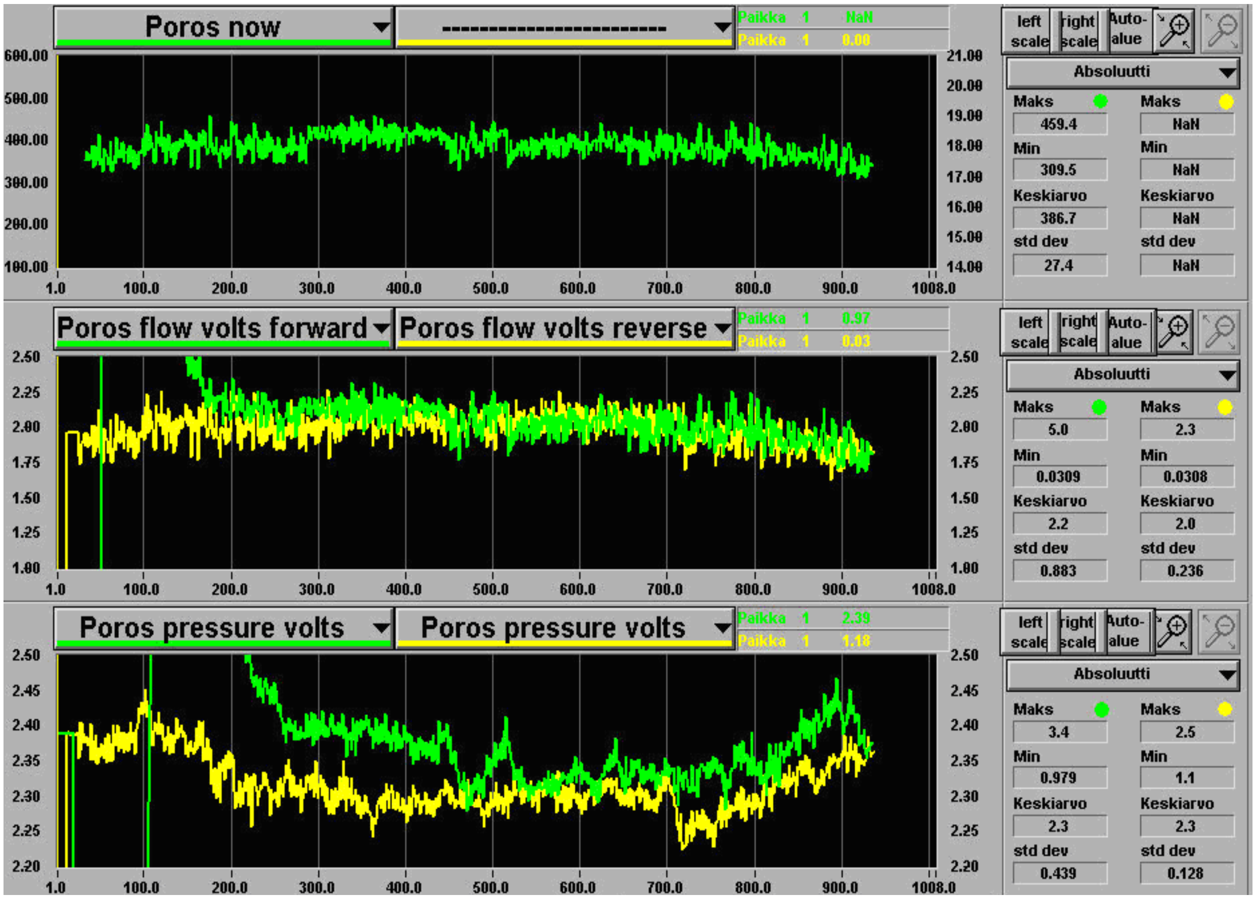


Figure 7-7 Badly Tuned Porosity Measurement (1 of 2)

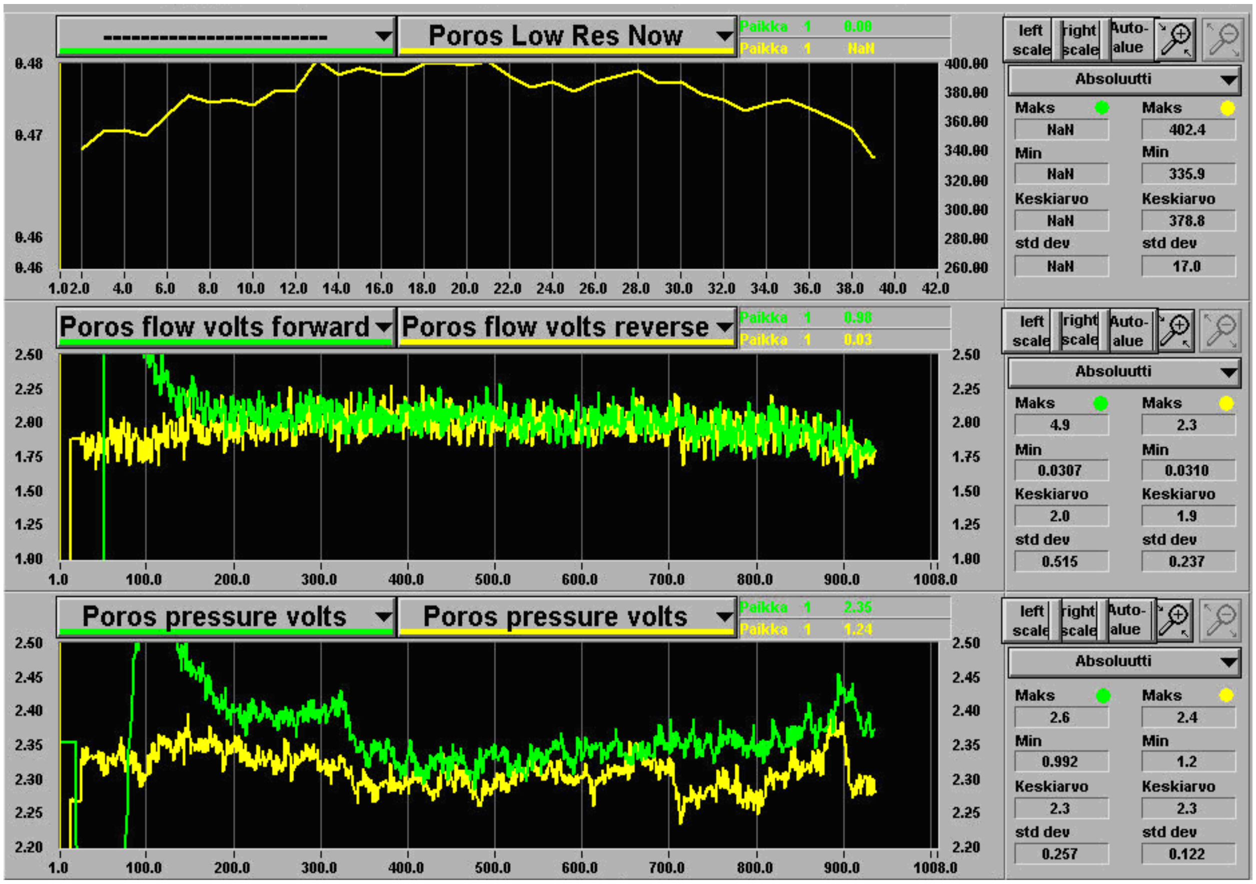


Figure 7-8 Badly Tuned Porosity Measurement (2 of 2)

To improve porosity measurement tuning using Diagnostic Profile Tool:

1. Find optimum Measurement Element Level, see Subsection 4.7.2.
2. Consider if Hold Vacuum Level should be adjusted, see Subsection 4.7.4.
3. Find the optimum control speed for the electronic regulator (Hyreg) by testing the effect of different control speeds.

For an example of a sensor tuning process, see Section 4.8.

7.5. Test sensor with digital volt meter

Activity Number:	Q4219-52-ACT-005	**Applicable Models:**	Q4219-51; Q4219-52
Type of Procedure:	Inspect	**Expertise Level:**	Technician

Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
Required Parts:	Part Number	Quantity	Description
Required Tools:	• digital volt meter (DVM) • piece of paper • packing tape		

Use a DVM and a piece of paper to check if the sensor responds correctly. Figure 7-9 shows the test points.

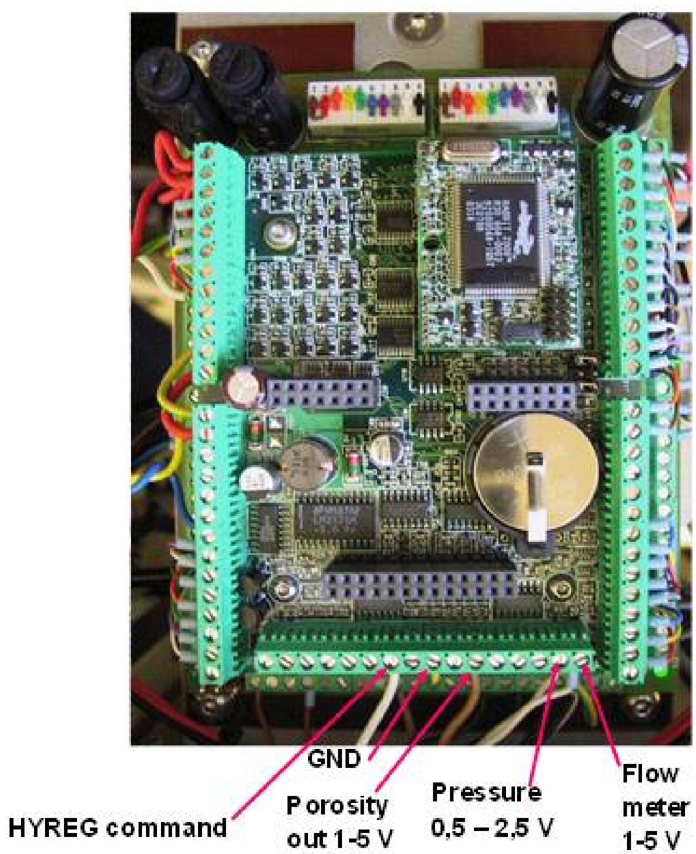


Figure 7-9 Test Points for Testing the Sensor

Test procedure:

1. Without any paper the raw porosity voltage must be near 5 V.
2. With a paper tightly attached to the measuring element, the raw porosity must go down to 1.5–3.0 V.
3. Seal the measuring aperture tightly with packing tape. That should totally stop air flow through the aperture. As a result, raw porosity voltage should be near 1 V.

7.6. Test sensor with Experion MX tools

Activity Number:	Q4219-52-ACT-006	**Applicable Models:**	Q4219-51; Q4219-52
Type of Procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	None	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
Required Parts:	Part Number	Quantity	Description
Required Tools:			

The Porosity sensor raw input/output signals can be monitored with Experion MX tools, by selecting the:

- **Sensor/Scanner** display
- **MSS Setup Diagnostics** display
- **MSS Card IO Point Monitor** display

By selecting the correct MSS and card, it is possible to monitor sensor signals.

When the sensor is measuring the sheet:

- Porosity value should be 1.5 – 3.0 V.
- Measurement pressure voltage depends on the DIP configuration, see Figure 1-9.

If the sensor is taken off the sheet, same tests can be done as when testing the sensor with a DVM:

- Without any paper the raw porosity voltage must be near 5 V.
- With a paper tightly attached to the measuring element, the raw porosity must go down to 1.5–3.0 V.

  Seal the measuring aperture tightly with packing tape. That should totally stop air flow through the aperture. As a result, raw porosity voltage should be near 1 V.

7.7. Check supply pressure

Activity Number:	Q4219-52-ACT-007		**Applicable Models:**	Q4219-51; Q4219-52
Type of Procedure:	Inspect		**Expertise Level:**	Technician
Priority Level:	Average		**Cautions:**	None
Availability Required:	Scanner offsheet		**Reminder Lead Time:**	
Overdue Grace Period:			**Frequency (time period):**	
Duration (time period):	5 minutes		**# of People Required:**	1
Prerequisite Procedures:				
Post Procedures:				
Required Parts:	Part Number	Quantity	Description	
Required Tools:				

Proper supply pressure is most important for reliable sensor operation.

Check:

1. The pressure must be > 3.5 bars.
2. The target pressure at the mounting location is 5 bars.

7.8. Check measuring element level

Activity Number:	Q4219-52-ACT-008		**Applicable Models:**	Q4219-51; Q4219-52
Type of Procedure:	Inspect		**Expertise Level:**	Technician
Priority Level:	Average		**Cautions:**	None
Availability Required:	Scanner offsheet		**Reminder Lead Time:**	
Overdue Grace Period:			**Frequency (time period):**	
Duration (time period):	20 minutes		**# of People Required:**	1
Prerequisite Procedures:				
Post Procedures:				
Required Parts:	Part Number	Quantity	Description	
Required Tools:				

The measuring element down position is fixed. Level means the distance between measuring element up and down positions. This distance can be manually adjusted.

Figure 7-10 Good Visible Sheet Contact

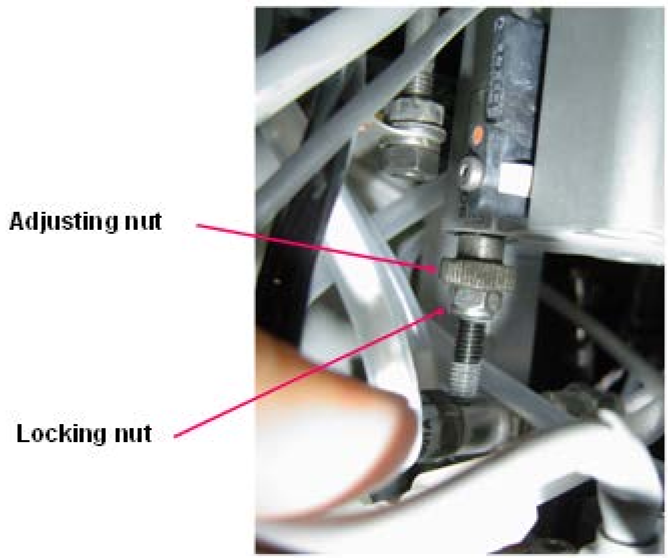


Figure 7-11 Measuring Element Level Adjustment

To check measuring element level:

1. Check visually, and/or with the diagnostic profiles tool, if the sheet contact is good.

2. If the sheet contact is not good, raising the measuring element might help.

7.9. Check hold vacuum level

Activity Number:	Q4219-52-ACT-009		**Applicable Models:**	Q4219-51; Q4219-52
Type of Procedure:	Inspect		**Expertise Level:**	Technician
Priority Level:	Average		**Cautions:**	None
Availability Required:	Scanner offsheet		**Reminder Lead Time:**	
Overdue Grace Period:			**Frequency (time period):**	
Duration (time period):	10 minutes		**# of People Required:**	1
Prerequisite Procedures:				
Post Procedures:				
Required Parts:	Part Number	Quantity	Description	
Required Tools:				

Check the hold vacuum level:

- If the vacuum is too low, increase the vacuum to establish the sheet contact sooner; a smoother measuring pressure profile can be obtained.
- If the vacuum level is too high, it can cause marking or web breaks.

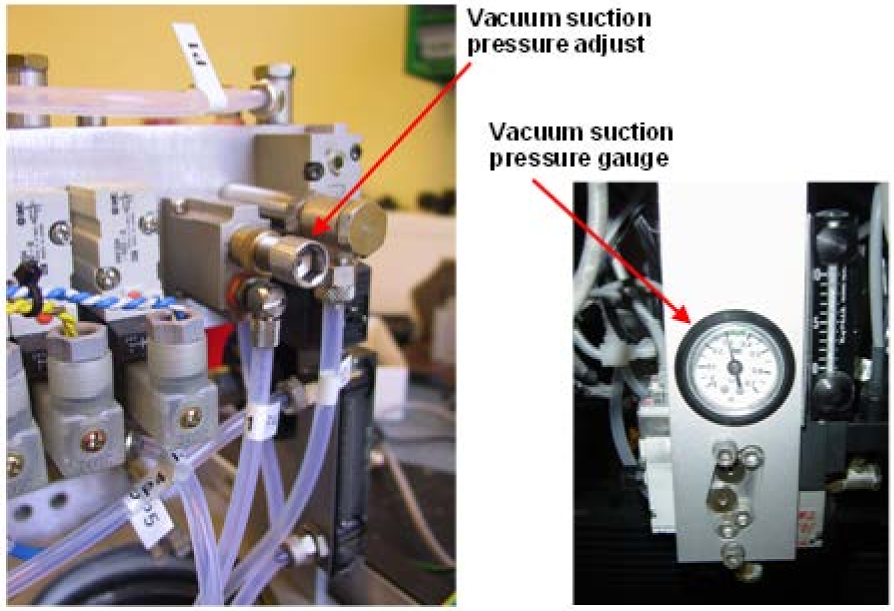


Figure 7-12 Hold Vacuum Level Adjustment

7.10. Check measurement pressure DIP setting

Activity Number:	Q4219-52-ACT-010	**Applicable Models:**	Q4219-51; Q4219-52
Type of Procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
Required Parts:	Part Number	Quantity	Description
Required Tools:			

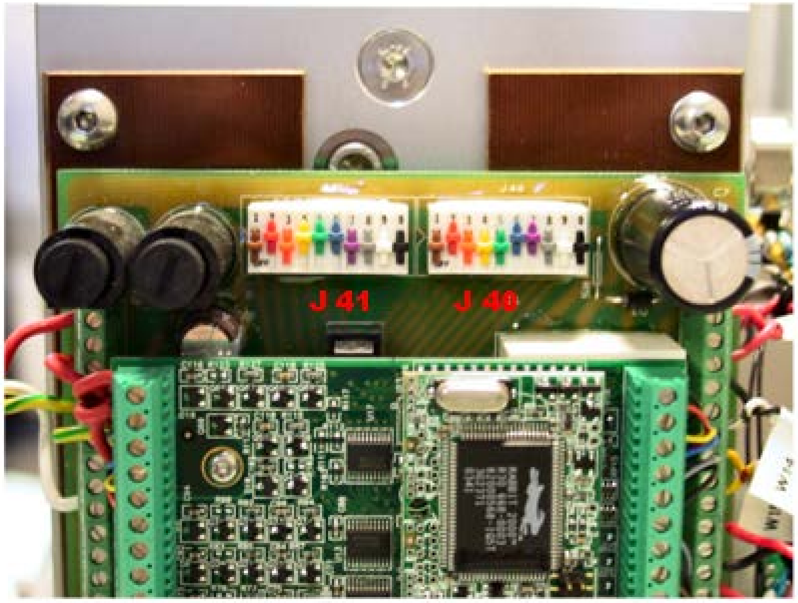


Figure 7-13 Configuration DIP switches

Measurement pressure DIP setting used during sensor calibration is documented in the Calibration Report. See Table 7-1 for available measurement pressures.

Check that the measurement pressure setting in switches 6 to 3 of bank J40 is the same as in the Calibration Report.

Table 7-1 Available Measurement Pressures

0	6	5	4	3	Pressure Adjustment kPa	Comment
	0	0	0	0	-2,56	
	0	0	0	1	-2,34	
	0	0	1	0	-2,19	
	0	0	1	1	-2,03125	
	0	1	0	0	-1,875	
	0	1	0	1	-1,5625	
	0	1	1	0	-1,40625	
	0	1	1	1	-1,25	
	1	0	0	0	-1,09375	Default
	1	0	0	1	-0,9375	
	1	0	1	0	-0,78125	
	1	0	1	1	-0,63	
	1	1	0	0	-0,47	
	1	1	0	1	-0,31	
	1	1	1	0	-0,16	
	1	1	1	1	0	

8. Troubleshooting

This chapter is divided into two sections listing possible issues with the Porosity Measurement:

- Section 8.1 Alarm based troubleshooting, listing steps to be taken in response to a specific alarm.
- Section 8.2 Non-alarm based troubleshooting, listing steps that may not be related to a specific alarm.

8.1. Alarm based troubleshooting

8.1.1. Stdz Air Drift Too Big

Symptom	Possible Cause(s)	Solution (Tasks)
Sensor fails to standardize	Sensor failure	Test sensor with digital volt meter
		Test sensor with Experion MX tools
	Supply pressure low	Check supply pressure
	Dirt build-up in the sensor	Clean air filters and filter caps
		Clean measuring element
		Clean and check edge detectors

8.1.2. Porosity Too High

Symptom	Possible Cause(s)	Solution (Tasks)
Sensor now value too high	Measurement pressure too high	Check measurement pressure DIP setting
		Check supply pressure
	Sheet contact problem	Check measurement pressure profile
		Check measuring element level
		Check hold vacuum level

8.1.3. Porosity Too Low

Symptom	Possible Cause(s)	Solution (Tasks)
Sensor now value too low	Measurement pressure too low	Check measurement pressure DIP setting
		Check supply pressure
	Sheet contact problem	Check measurement pressure profile
		Check measuring element level
		Check hold vacuum level
	Dirt build-up in the sensor	Clean air filters and filter caps
		Clean measuring element
		Clean and check edge detectors

8.1.4. Measurement Pressure Too High

Symptom	Possible Cause(s)	Solution (Tasks)
Sensor measurement pressure too high	DIP configuration error	Check measurement pressure DIP setting
	Sensor failure	Test sensor with digital volt meter
		Test sensor with Experion MX tools

8.1.5. Measurement Pressure Too Low

Symptom	Possible Cause(s)	Solution (Tasks)
Sensor measurement pressure too low	DIP configuration error	Check measurement pressure DIP setting
	Sensor failure	Test sensor with digital volt meter
		Test sensor with Experion MX tools

8.1.6. Pressure Difference Too High

Symptom	Possible Cause(s)	Solution (Tasks)
Sensor measurement pressure difference value too high	Sensor failure	Test sensor with digital volt meter
		Test sensor with Experion MX tools
	Dirt build-up in the sensor	Clean air filters and filter caps
		Clean measuring element
		Clean and check edge detectors
	DIP configuration error	Check measurement pressure DIP setting

8.1.7. Pressure Difference Too Low

Symptom	Possible Cause(s)	Solution (Tasks)
Sensor measurement pressure difference value too low	Sensor failure	Test sensor with digital volt meter
		Test sensor with Experion MX tools
	Dirt build-up in the sensor	Clean air filters and filter caps
		Clean measuring element
		Clean and check edge detectors
	DIP configuration error	Check measurement pressure DIP Setting

8.2. Non-alarm based troubleshooting

8.2.1. Bad measurement profile

Symptom	Possible Cause(s)	Solution (Tasks)
Bad measurement profile	Supply pressure low	Check supply pressure
	Sheet contact problem	Check measurement pressure profile
		Check measuring element level
		Check hold vacuum level
	Dirt build-up in the sensor	Clean air filters and filter caps
		Clean measuring element
		Clean and check edge detectors

8.2.2. Unstable measurement

Symptom	Possible Cause(s)	Solution (Tasks)
Unstable measurement	Supply pressure low	Check supply pressure
	Sheet contact problem	Check measurement pressure profile
		Check measuring element level
		Check hold vacuum level
	Dirt build-up in the sensor	Clean air filters and filter caps
		Clean measuring element
		Clean and check edge detectors

8.2.3. Sensor marks the sheet

Symptom	Possible Cause(s)	Solution (Tasks)
Sensor marks the sheet	Hold vacuum level too high	Check hold vacuum level
	Sheet contact problem	Check measuring element level
		Check hold vacuum level

9. Storage, Transportation, and End of Life

This chapter summarizes Honeywell policy regarding the storage and disposal of the Porosity Measurement system components.

9.1. Storage and transportation environment

In order to maintain the integrity of system components, the storage and transportation of all equipment must be within the parameters shown in Table 9-1.

Table 9-1 Storage and Transportation Parameters

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

9.2. 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.

Except where identified within this section, the sensor does not contain hazardous or restricted materials.

Guidelines for disposal of equipment by Honeywell or the customer for materials are:

9.2.1. Solid materials

- Remove all non-metallic parts (except plastic) from the sensor and dispose through the local refuse system. Recycle plastic parts.
- Wire and cabling should be removed and recycled; the copper may have value as scrap.
- Electrical and electronic components (for example, solder, circuit boards, batteries, and oil-filled capacitors) should be recycled or handled as special waste to prevent them from being put in a landfill, as there is potential for lead and other metals leaching into the ground and water.
- Metals should be recycled, and in many cases will have value as scrap.

10. Glossary

Actuator	Mechanical or electronic device that performs the control action in a control loop
Back Side	See Drive Side
Bin	The smallest measurement zone on the frame. Also called Bucket or Slice.
Bucket	See Bin
Cable End	Location of the electronics and/or the entry point for communications and power on the scanner
Cross Direction (CD)	Used to refer to those properties of a process measurement or control device that are determined by its position along a line that runs across the paper machine. The cross direction is transverse to the machine, but usually relates to a position along the length of the paper machine.
Cross Direction Spread	Variation in the profile data equal to twice the standard deviation of the measured variable
Da Vinci	A quality control system (QCS)
Distant End	The end of the scanner opposite the cable end
Downstream	Towards the reel, or in the direction of travel of the sheet
Drive Side	The side of the paper machine where the main motor drives are located. Cabling is routed from this end. Also called Back Side.
Ethernet Data Acquisition Board (EDAQ)	Digitization and control board used on each sensor on the Experion MX platform
Experion MX	Honeywell's most recent Quality Control System.
Front Side	See Tending Side
Gauge Support Processor (GSP)	A software layer in the Experion MX host, which manages the status and measurements of a sensor as sent by the MSS

High End Calibrate Distance	The distance from a fixed point on the sensor head to the closest vertical member of the scanner when it is located at the High End Limit switch. This position is determined during scanner calibration.
Human Machine Interface (HMI)	Also referred to as UPI
LED	Light emitting diode
Light Emitting Diode	An illuminator with high speed response capable of short intense light pulses
Linux	Computer operating system running on the EDAQ CPU as well as the MSS computer
Low End Calibrate Distance	The value of the head position (in millimeters) when the sensor head reaches the low end calibrate position
Low End Calibrate Position	This position is only updated during a scanner calibration procedure
Low End Offset	The distance in millimeters from the cable end of the scanner to where bucket zero is located
Machine Direction (MD)	The direction in which paper travels down the paper machine
Management Information System (MIS)	System or subsystem that collects and manages information on the paper production
Measurement Sub System (MSS)	A node in the Experion MX which controls the Q4000 scanner and interfaces to the sensors in that scanner
Motor End	Location of the motor on the scanner
Motor End Support	Formed steel channel welded to the upper and lower box beams at the motor end
Passline	Distance from sensor window to paper web
Quality Control System (QCS)	A computer system that manages the quality of the paper produced
Real-Time Application Environment (RAE)	The system software used by Da Vinci and Experion MX QCS to manage data exchange between applications
Real-Time Data Repository (RTDR)	The database managed by RAE to store system data, and data for individual applications
Scan Position	A constant position (in millimeters) measured from the cable end
Sensor Set	The term used in the **Sensor Maintenance** display to describe a set of sensors working together on a scanner to perform one measurement

Slice	See Bin
Smoothing Width	A value that determines the amount of averaging that will be applied to a measurement bin
Standardize	An automatic periodic measurement of the primary and auxiliary sensors taken offsheet. The standardize measurements are used to adjust the primary sensor readings to ensure accuracy.
Streak	A narrow cross-directional section of paper where a measured quality deviates significantly from the average of the entire width of the paper. Also an area in an array of cross-directional measurements that deviates more than a certain amount from its surroundings. The amount of allowed deviation can be set up as an absolute number, or as a percentage.
Tending Side	The side of the paper machine where the operator has unobstructed access. Also called Front Side.
Tilt angle	Angle between sensor window and paper web in degrees. The sensor determines tilt angle in both the machine direction and the cross direction.
Trend	The display of data over time
Upstream	Towards the headbox, or in the opposite direction to the travel of the sheet

A. Collecting Paper Samples

Be aware of these details while collecting porosity samples:

- It is recommended that at least five grades of paper samples with various porosity levels be used. Samples need to be representative of the relevant porosity range of the process, from minimum to maximum porosities.
- Paper size of test samples is A4/letter (minimum 8.5 x 11 inches).
- Five to 10 sheets of each sample are required for test runs.
- Test run samples should be packed in plastic office pockets for delivery, with sheets of each grade in a separate pocket.
- Attached with the samples should be information on porosity values as determined by laboratory at the customer site and porosity determination method used (Gurley, Bendtsen, and so on).
- In case of special paper grades, of which both sides are not equal, you must indicate the side on which the lab analyses were performed.
- If samples are of board grade, they should be dried under compression between flat plates to minimize curl during drying. Excessive sample curl will make sample verification difficult.
- The sample package should be labeled with the system number (if any), customer name, location, and phone number.

B. Technical Bulletin

See Technical Bulletin 6510493015, linked to this document.