Surface Topography Measurement

System Manual

6510020423

Surface Topography Measurement

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Introduction

The purpose of this document is to enable Honeywell personnel to install, calibrate, and maintain the model Q4222-50 Surface Topography sensor for Experion MX.

ATTENTION

The terms *FotoSurf*, *FotoSurf sensor*, and *Surface Topography Measurement*, refer to the *Surface Topography sensor*. These terms may be used interchangeably in this manual.

Audience

This manual is intended for use by engineers or process engineers. The manual 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.

It also assumes that the reader is familiar with using the Experion MX QCS system to control the scanner, maintain the paper recipe database, and other basic operations, and that the reader is generally familiar with calibration and configuration procedures, and has completed surface topography measurement instruction that includes both classroom and practical training.

About this manual

This manual contains 11 chapters and one appendix.

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

Chapter 2, **EDAQ**, describes the principles and operation of the Ethernet Data Acquisition (EDAQ) board.

Chapter 3, **Installation**, describes installation and set up tasks for the system.

Chapter 4, **Operation**, describes operation of the system.

Chapter 5, **Configuration**, describes configuration parameters for the system.

Chapter 6, **Introduction to Measurement**, describes the principle of measurement.

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

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

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

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

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

Appendix A, **Part Numbers**, lists the component part numbers for this system.

Related reading

The following documents contain related reading material.

Honeywell Part Number	Document Title / Description
	Gnu Public License[1]
6510020381	Experion MX MSS and EDAQ Data Acquisition System Manual Rev 01

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.

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[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

FotoSurf is designed for on-line measurement of roughness, smoothness, and defects of the surface of a moving paper web.

The FotoSurf sensor consists of the FotoSurf measurement module (FSMM), and the FotoSurf backing module (FSBM). Figure 1-1 shows the FSMM.

Figure 1-1 The FotoSurf Measurement Module

Figure 1-2 shows the FSBM.

Figure 1-2 The FotoSurf Backing Module

Table 1-1 lists the main sensor components.

Table 1-1 Main Sensor Components

FotoSurf Measurement Module
Class I laser device
Master unit
Imaging of paper/board web with laser illumination
Computation of surface topography characters
Communication with the Measurement Sub System
FotoSurf Backing Module
Passive unit
Magnetic couple for FSMM safety interlock circuit

The FSMM contains the illumination, optics, camera and processor module, and the magnetic reed switch for the sensor removal safety interlock circuit, which also acts as redundant head separation safety circuit.

The FSBM contains the magnet for the sensor removal safety interlock circuit, and acts as a white background behind the web. Both the FSMM and the FSBM are mounted flush to the sensor faceplate, which makes this is a non-contacting sensor.

1.1. The FotoSurf measurement module

Figure 1-3 shows the electrical connections, switches, and LEDs of the FSMM. This module is the active module of the FotoSurf sensor. It communicates with the FSMM Ethernet Data Acquisition (EDAQ) board through the FSMM connector. The FSMM is powered through the 24 V DC connector that is connected to the EDAQ with the FotoSurf Evolution cable assembly. There is a switch to power the FSMM on and off. The FSMM is protected by a resettable PTC fuse rated to 4 A.

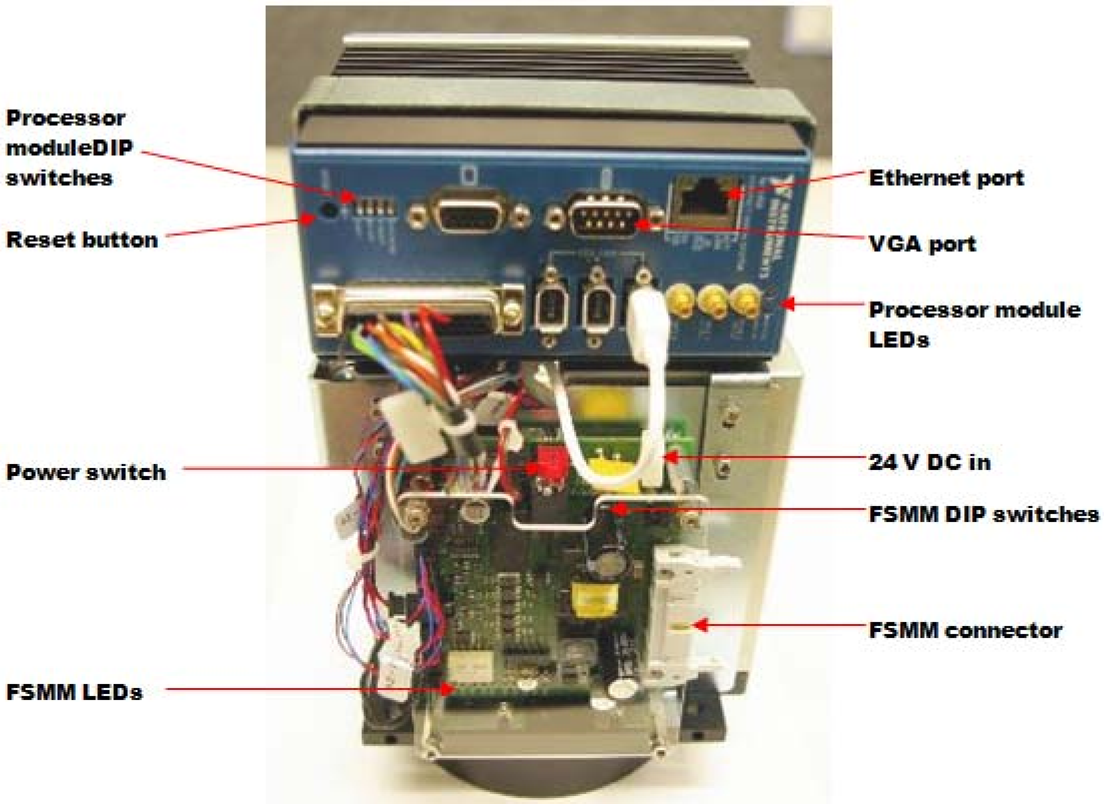


Figure 1-3 FSMM Connections, Switches, and LEDs

Pushing the **Reset** button for a few seconds performs a soft reboot of the FSMM. This button may be needed in firmware updates. The processor module DIP switches determine the operating mode of the FotoSurf sensor. The default operation, *measurement mode*, is achieved by setting all the switches to the OFF position.

The FSMM DIP switches determine additional settings. DIP 1 selects the scanner system into which the sensor is installed, and should be set to the ON position for the Experion MX scanner:

- OFF = PCI/PCDAQ connection
- ON = EDAQ connection

The VGA port provides diagnostic information during Experion MX measurement, for example, timestamp, last mode request and/or status, and internal parameters. This feature can be used in troubleshooting.

The Ethernet port is used to connect the FotoSurf sensor to the Measurement Sub System (MSS) through the sensor network. Firmware updates may be installed using a maintenance PC hooked up to the sensor network. The Ethernet port can be used in PC control mode where various functions of the sensor can be tested. For example, the quality control test performed by the factory uses this port.

The processor module LEDs indicate the various states of the FRMM processor module. They are helpful in troubleshooting.

The FSMM LEDs indicate power status and communication activity.

Figure 1-4 shows the sensor gap side of the FSMM. When the FSMM is installed on the sensor baseplate, the 10 mm (0.39 in.) thick borosilicate protective glass window is flush to the sensor baseplate, and does not create a bump or pit on the faceplate level in the sensor gap. This provides two benefits:

- the FotoSurf sensor is non-contacting
- the window stays clean

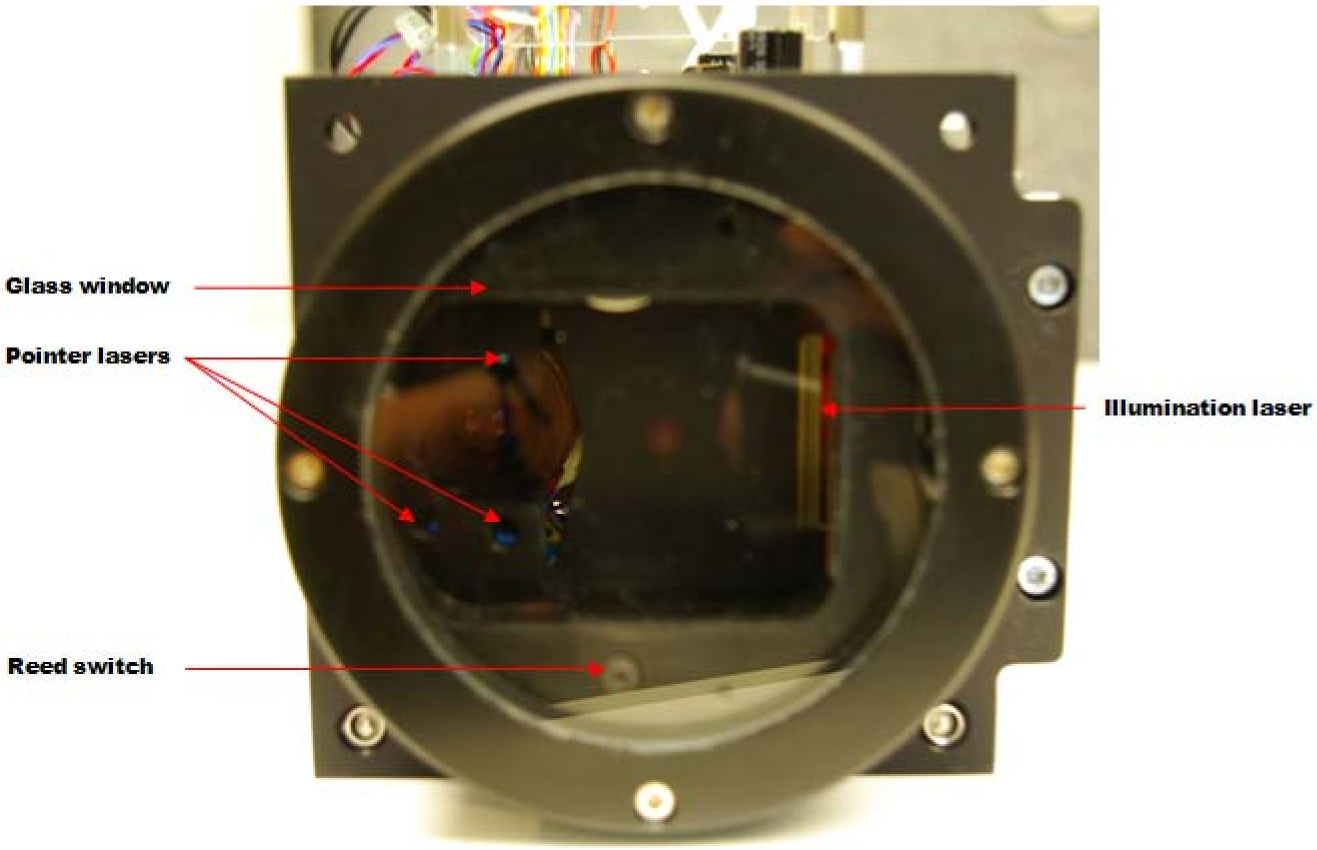


Figure 1-4 FSMM Gap Side

Compressed air is not required for the FotoSurf sensor. Behind the window there are three pointer lasers, an illumination laser, and a reed switch that couples with the FSBM magnet to make a safety interlock.

1.2. The FotoSurf backing module

Figure 1-5 shows the gap side of the FSBM. The FSBM provides magnetic coupling for the FSMM reed switch (the position of the magnet is shown in the image), and a white surface for standardization actions. The modules work together in such a way that if the FSMM and the FSBM are separated from each other by more than 30 mm (1.18 in.), horizontally or vertically, power to the lasers is cut off. This means that the laser cannot stay on if either of the modules is uninstalled from the sensor head. The magnet of the FSBM and the reed switch of the FSMM must be aligned when installing the FotoSurf sensor.

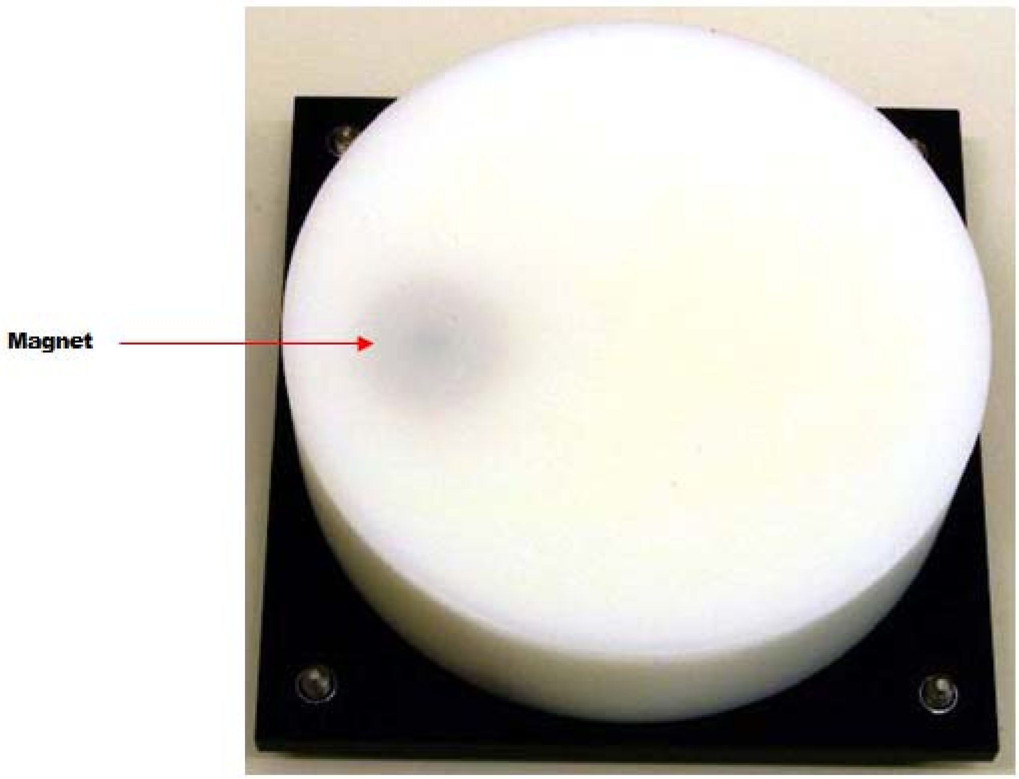


Figure 1-5 FSBM Gap Side

1.3. Measurement principle

Surface topography measurement is based on digital imaging and image analysis performed in the sensor. Figure 1-6 shows the measurement principal.

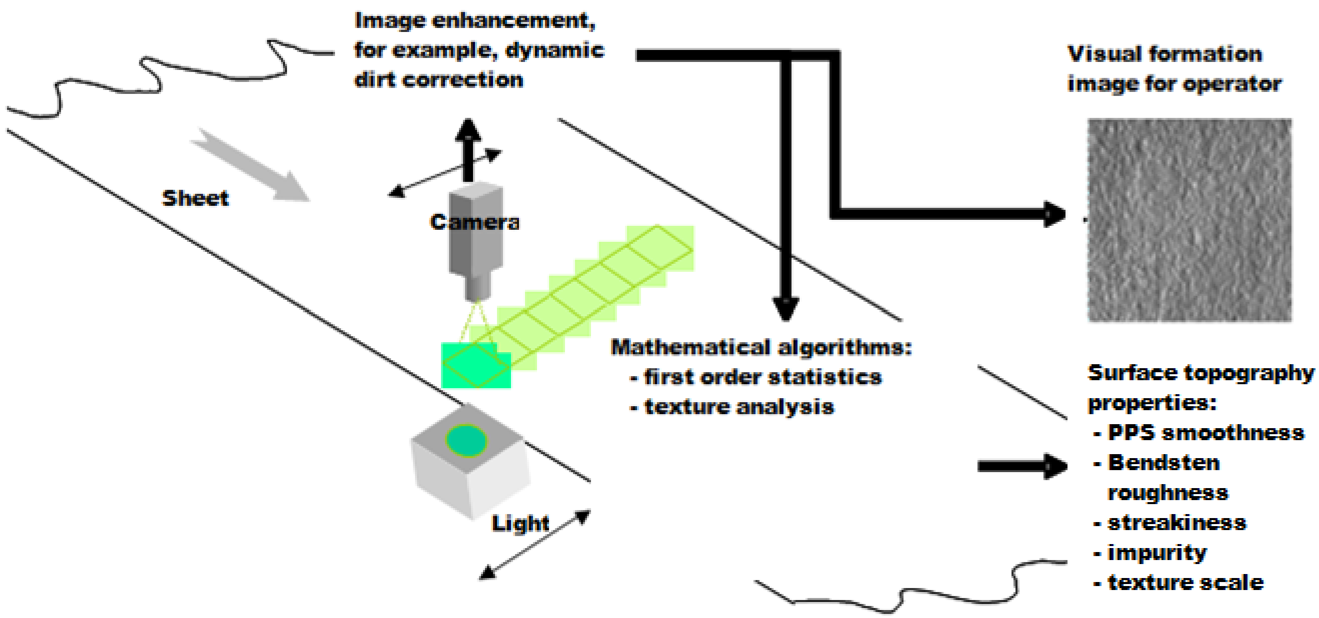


Figure 1-6 Measurement Principle

The sensor traverses over the running paper web inside the scanner head. The FSMM and the FSBM are mounted on opposite sides of the web, and are both flush to the scanning head front plate. There is a 10 mm (0.39 in.) open gap between the FSMM and the FSBM, where the web moves.

The FSMM takes digital images of the web. The web is illuminated with low-angle light pulses emitted by the FSMM. Images of the web are enhanced. For example, dirt on the windows is digitally removed, then analyzed by mathematical algorithms in the FSMM. The results (surface topography properties) are sent to the QCS server for building trends and profiles. Also, images of the web surface are sent to the operator station to enable visual assessment of the roughness, smoothness, and other properties of the surface.

Figure 1-7 shows the operation principle of the FotoSurf sensor in the Experion MX system. The sensor needs 24 V DC power, but no pressurized air or water. Internal operation of the sensor is controlled by the FSMM processor module, which receives mode commands from the MSS through the sensor network. The FSMM sends measurement results directly to the MSS using Ethernet CSLP (Camera Sensor Link Protocol).

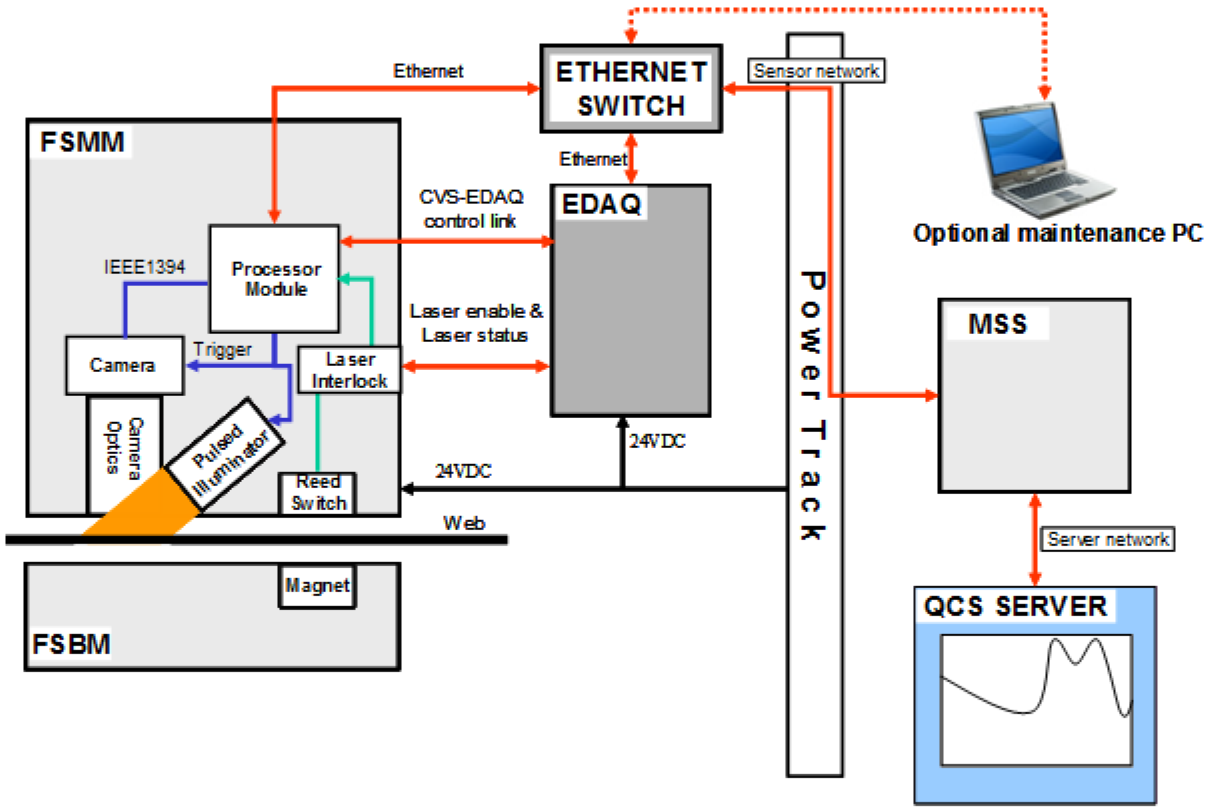


Figure 1-7 Operation Principle

The role of the EDAQ is to give IP address and clock synchronization to the processor module through the serial CVS-EDAQ control link. It also handles laser safety interlock *enable* and *status* signals.

The MSS is connected to the QCS server through an Ethernet connection. The QCS server gathers surface topography data, and provides standard tools for displaying the data as profiles and trends.

Surface topography software includes special tools for displaying on-line images of the surface, and studying the history and targets of topography for different grades. A sample measurement mode with surface image gallery is included.

The processor module operates an industrial camera with two connections:

- IEEE 1394 cable (power, image transfer, and configuration)
- trigger cable

The camera is configured automatically for different grades and operational modes by the processor module. Imaging by the camera and the pulsed illuminator is timed by the triggering from the processor module. The camera optics project a sharp image of the web on the CCD (charge-coupled device) of the camera, independent of the position of the web in the sensor gap. Images are transferred to the processor module, which calculates formation properties from them after automatic image enhancement (such as dirt correction).

The FSBM has a flat white surface to facilitate offsheet standardize operations. It also contains a magnet paired with the reed switch of the FSMM to provide magnetic interlock for laser safety. If the FSMM and the FSBM are separated from each other by more than 30 mm (1.18 in.), horizontally or vertically, power to the lasers is cut off. This covers both head-split operations and uninstalling sensor modules.

1.4. Time synchronization

The internal time of the FotoSurf sensor synchronizes with the system time. The timestamp is part of the slice measuring data of the sensor. The MSS uses timestamps to maintain profiles. Also, the starting point of the measurement and image positions are triggered by time. The timestamp signal is enabled at the edges of the sheet, sample measurement, single-point measurement, and idle mode.

Figure 1-8 illustrates the time synchronization process.

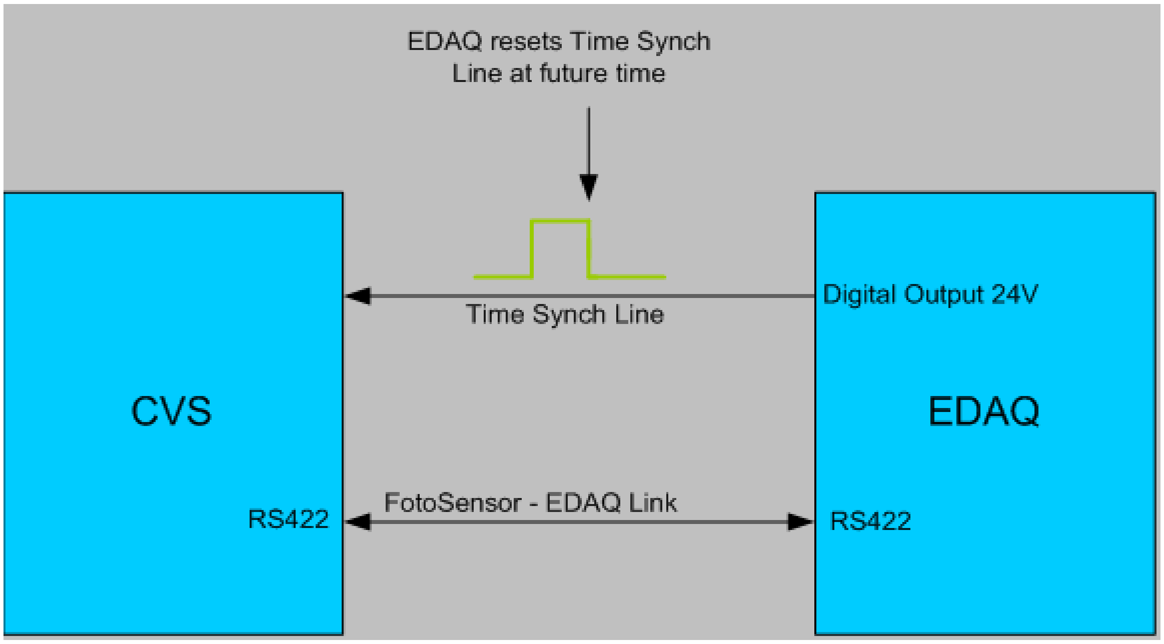


Figure 1-8 Time Synchronization

Time synchronization has the following steps:

1. The EDAQ is synchronized by the system time. It sends a future time specification through the CVS–EDAQ control link (serial) to the CVS once per second.

2. The CVS reads future time specification and waits for the trailing edge of the Time Synch Line.

3. The EDAQ sets the Time Synch Digital Output line, and then resets it precisely at future time.

4. The CVS initializes the internal time counter, and starts to process the monotonic clock.

1.5. Sensor specifications

Table 1-2 lists key imaging specifications.

Table 1-2 Key Imaging Specifications

Item	Specifications
Imaging area	15 x 15 mm (0.59 x 0.59 in.)
Pixel size	60 µm (0.0024 in.)
Depth of field	10 mm (0.39 in.)
Web movement during image exposure	40 µm (0.0016 in.)
Maximum machine direction speed	2600 m/min (8530 ft/min)
Measurement frequency	10 Hz
Dirt correction	Automatic
Adjustment to varying basis weight	Automatic
Moving parts	None
Contacting sheet guiding	None

Web movement during image exposure is on the order of one pixel for up to 2600 m/min (8530 ft/min) machine direction web speed, which means that the images are always very sharp.

Depth of field of the FotoSurf imaging system is enough to cover the entire sensor gap, which is why contacting sheetguiding is not needed (the web can move freely within the sensor gap). FotoSurf adapts itself easily to all grades due to automatic light pulse adjustment. Automatic dirt correction, and a lack of moving parts, makes operation and maintenance easy and robust.

Figure 1-9 shows the effect of a relatively low measurement frequency (10 Hz) on the positioning of the slice measurements:

- a = low cross direction scan speed (overlapping images)
- b = high cross direction scan speed (gaps between images)

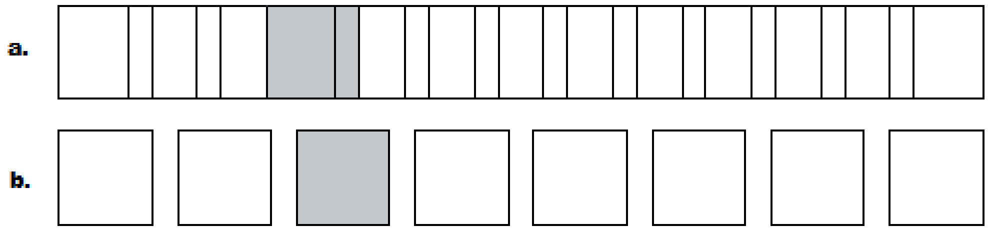


Figure 1-9 Positions of Formation Images In the Cross Direction

For low cross direction scan speed, the images overlap. For example, for a cross direction scan speed of 100 mm/s (3.94 in/s) there is a 5 mm (0.2 in.) overlap. On the other hand, for a high cross direction scan speed, there are gaps between the images. If the cross direction scan speed is 600 mm/s (23.62 in/s), there are 45.0 mm (1.77 in.) gaps in the cross direction.

The FotoSurf sensor provides powerful tools for analyzing the paper surface. The state of topography is characterized by a carefully selected set of intuitive descriptors, called surface topography properties. These properties efficiently handle the cases described in this section.

Table 1-3 lists surface topography properties, ranges, and typical values. For a more detailed description, see Section 6.3.

Table 1-3 Surface Topography Properties

Property	Units	Typical Values	Range	Visual Appearance (low value)	Visual Appearance (high value)
Surface PPS	µm	0.8–5.0	0.5–10.0	Silky smooth surface	Small-scale roughness
Surface Bendtsen	ml/min	50–3000	50–5000	Flat	Larger hills and valleys
Surface streak index	-	0–2	0–4	No vertical stripes	Distinct vertical streaks
Surface texture scale	mm	0.1–1.0	0.06–15.0	Fine structure	Large-scale texture
Surface impurity	-	-5.0–5.0	-100 to +100	Dark areas dominate	Bright areas dominate

2. 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).

2.1. 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.

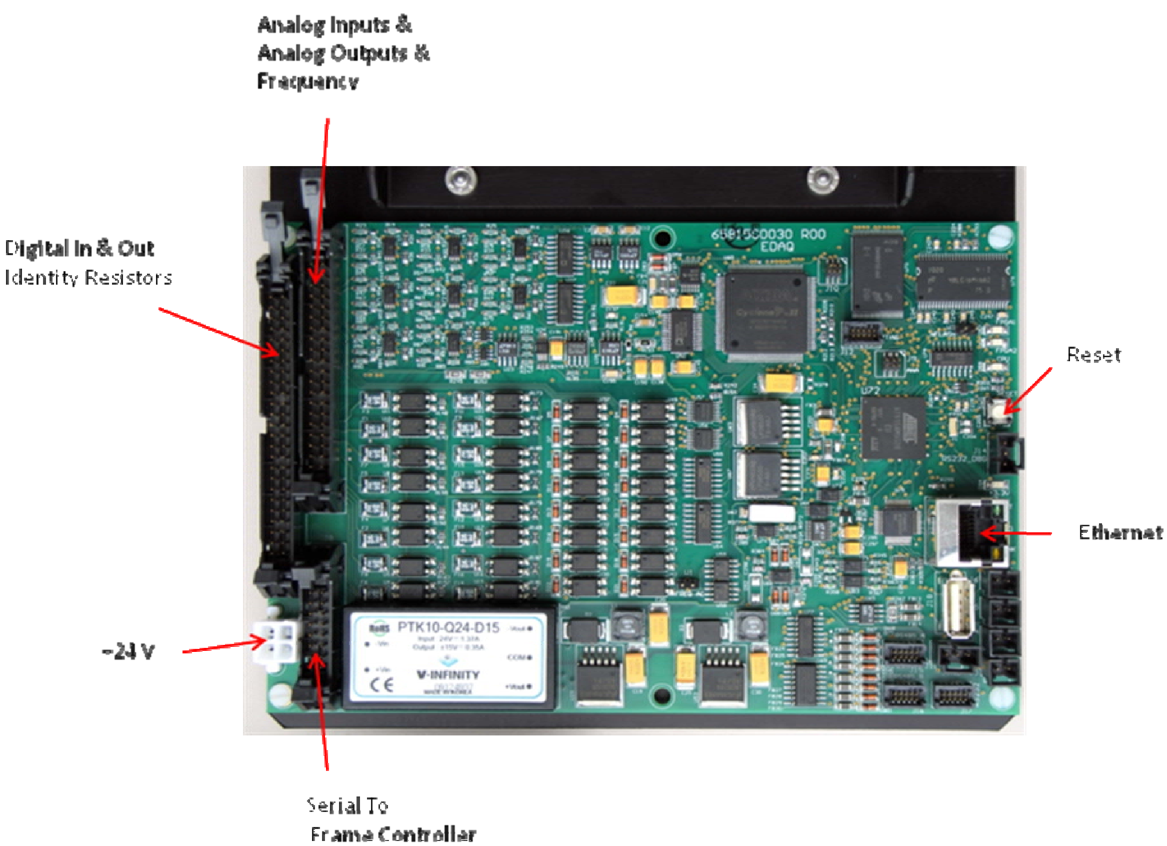


Figure 3-1 EDAQ Board

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.

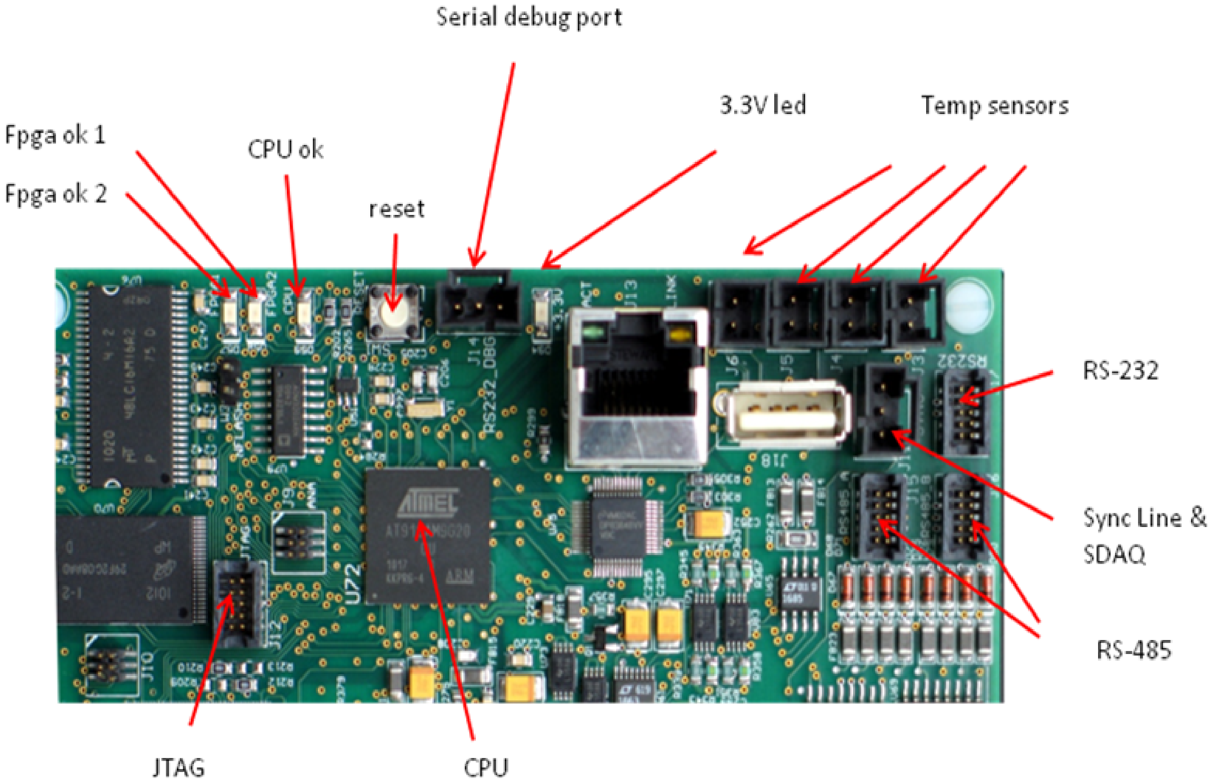


Figure 3-2 EDAQ Board: Ports and Diagnostic LEDs

2.2. 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

2.3. 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.

2.4. 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.

2.5. 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).

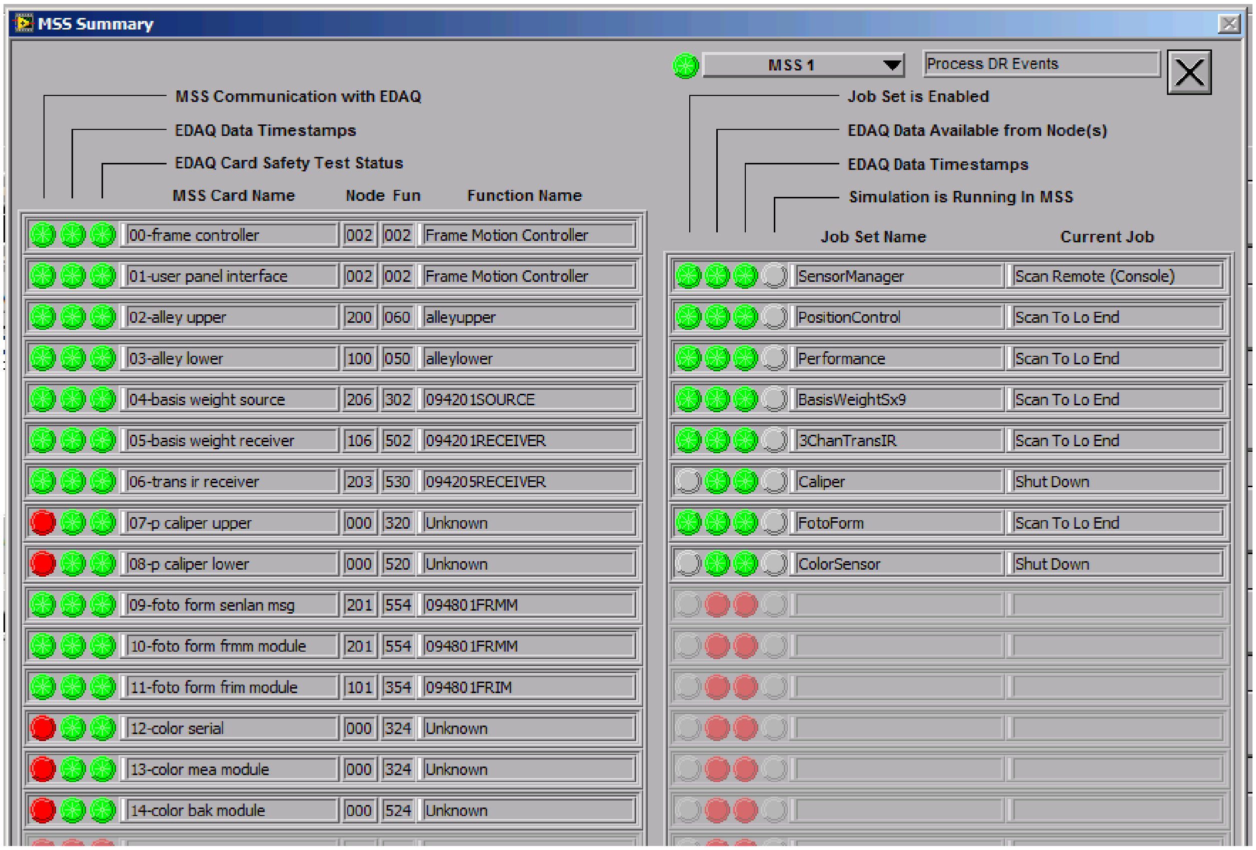


Figure 3-3 MSS Summary

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

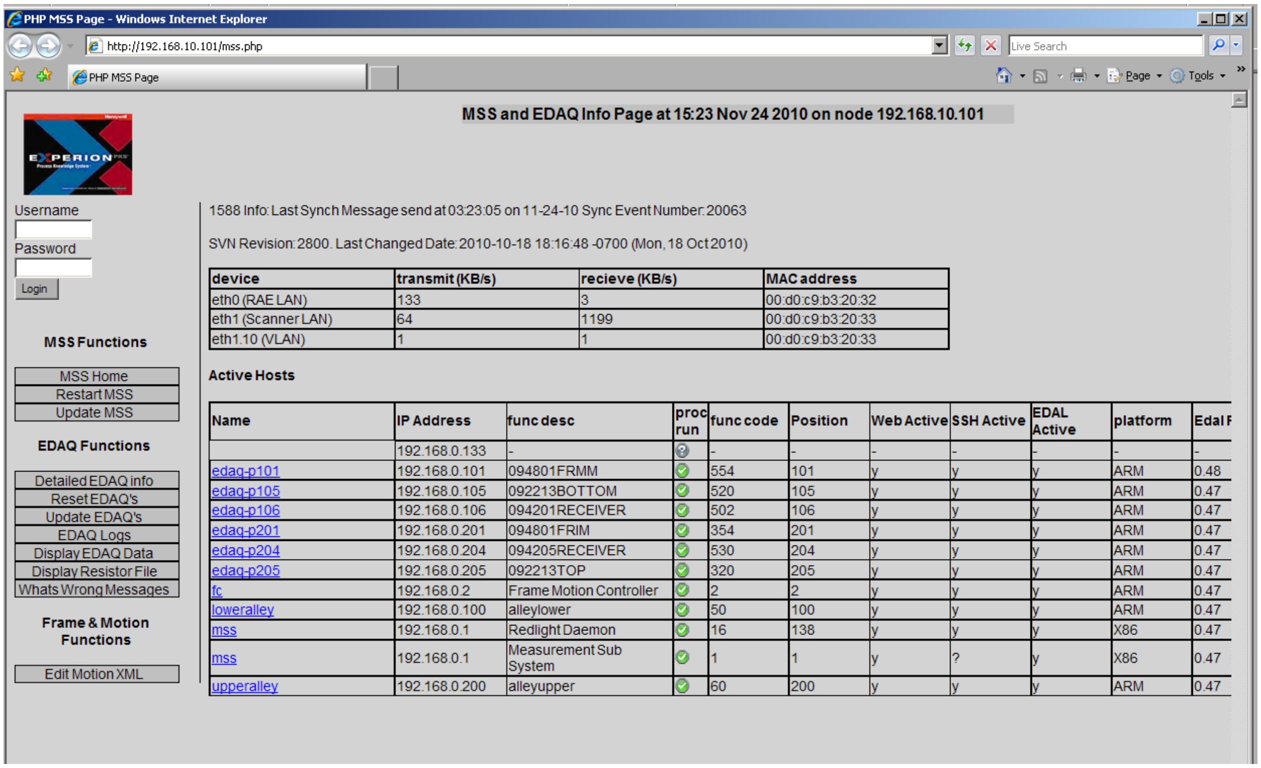
Sensors that are part of the QCS database, but are not enabled on the scanner, appear in the left column indicators in red, for example, *07-caliper upper* in Figure 3-3.

2.6. 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).


PHP MSS Page - Windows Internet Explorer

http://192.168.10.101/mss.php

PHP MSS Page

MSS and EDAQ Info Page at 15:23 Nov 24 2010 on node 192.168.10.101

Username

Password

Login

MSS Functions

MSS Home
Restart MSS
Update MSS

EDAQ Functions

Detailed EDAQ info
Reset EDAQ's
Update EDAQ's
EDAQ Logs
Display EDAQ Data
Display Resistor File
Whats Wrong Messages

Frame & Motion Functions

Edit Motion XML

1588 Info: Last Synch Message send at 03:23:05 on 11-24-10 Sync Event Number: 20063

SVN Revision: 2800. Last Changed Date: 2010-10-18 18:16:48 -0700 (Mon, 18 Oct 2010)

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

Active Hosts

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

Figure 3-4 PHP MSS Page

The left panel shows a column of options divided into:

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

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

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

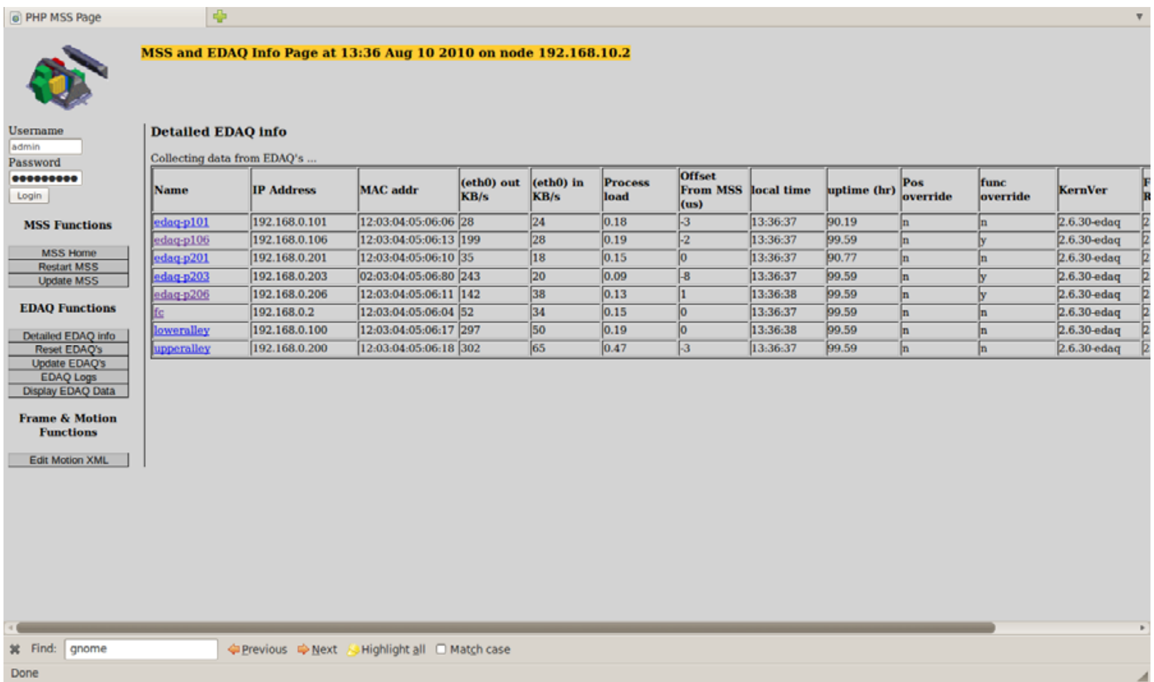
The second table lists all EDAQs discovered on the scanner LAN, their IP numbers, a brief description (related to model number), a program status column, the associated function code and position code, and whether the communication protocols are running (http, SSH, and Edal, the proprietary sensor data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

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

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

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

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



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

Figure 3-5 Detailed EDAQ Information: Partial Display

3. Installation

This chapter describes procedures for installing the Surface Topography sensor into the Experion MX Q4000 scanner, including the mechanical and communication aspects.

For information about choosing a location for the sensor at a paper machine, see Subsection 3.2.7.

3.1. Hardware configuration

The Surface Topography sensor is installed into the Experion MX Q4000 scanner as an inboard sensor.

The FSMM is oriented so that the web illumination goes into the cross direction of the web, and so that its magnet, and the reed switch of the FSMM, are aligned together.

3.2. Installation procedure

Do not power on the sensor or scanner unless instructed to do so.

This procedure includes QCS server stops and starts. If there are any special instructions on the site regarding how to shut down or start the servers, or in which order those steps should be done, follow your local instructions. This may happen when, for example, there are data collecting systems or links which need special stop and start steps.

There is an on/off power switch on the Surface Topography sensor. When there is a request to power the sensor on or off, that means that the scanner may stay powered on while sensor power is controlled by the sensor switch.

CAUTION

Read your safety manual first. Do not look into FSMM illumination when the sensor has not been installed into the sensor head. Do not try to defeat the safety interlocks. Turn the sensor power switch off before plugging in, unplugging, or installing any cables or boards. Do not attach the cables to the Surface Topography sensor, or turn on the power, until you have checked the wiring.

3.2.1. Mounting the sensor

Power off the sensor before proceeding.

The FSMM and FSBM are mounted directly opposite each other, with one in the upper head and the other in the lower head.

If the configuration is to measure the top side of the sheet (relative to the scanner), mount the FSMM into the upper head. If the configuration is to measure the bottom side of the sheet (relative to the scanner), mount the FSMM into the lower head.

The FSMM and FSBM of the Surface Topography sensor are mounted on the baseplate for easy installation and removal from the scanner head. This assembly includes the EDAQ, which is mounted next to the sensor (see Figure 3-1 and Figure 3-2). Note that there are no electrical connections or cables running from the FSBM to the sensor base, or to the sensor head.

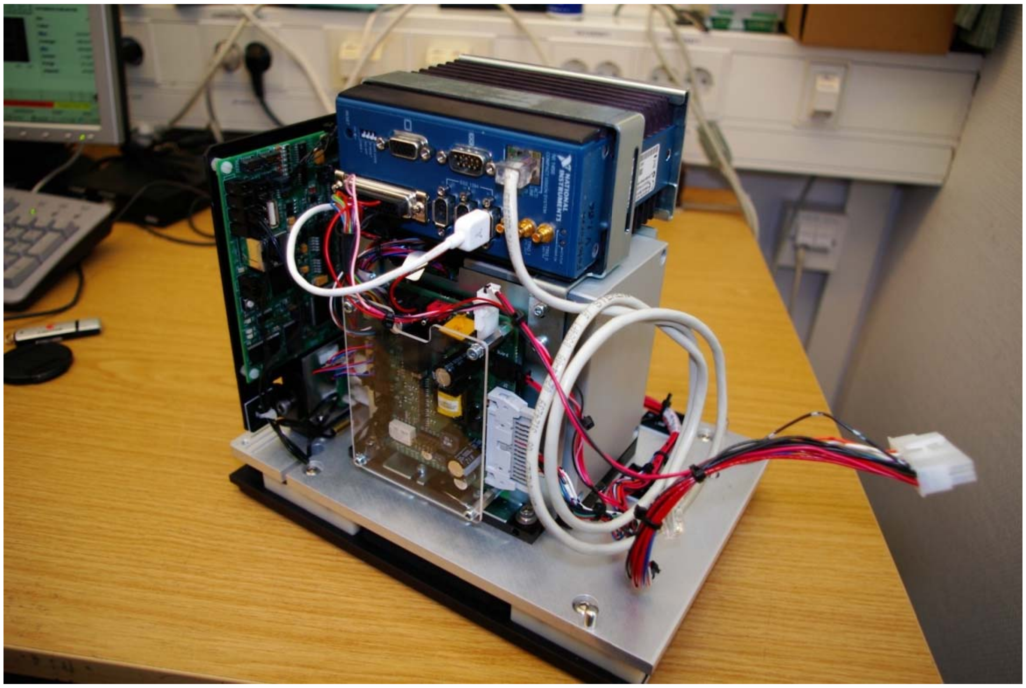


Figure 3-1 FSBM On Sensor Base With the EDAQ

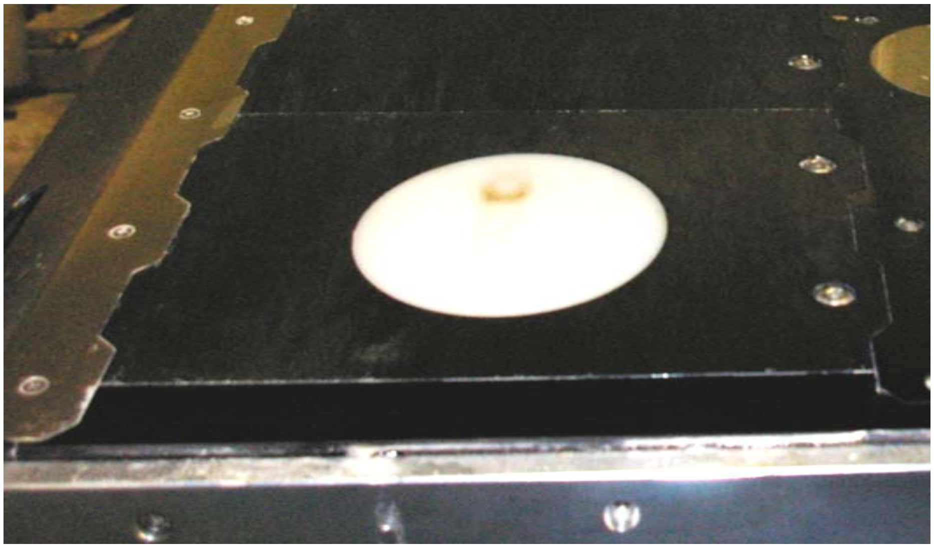


Figure 3-2 FSBM With Sensor Base Installed Into the Sensor Head

The cables of the Surface Topography sensor can be easily damaged. Never use them as handles, and do not pull, twist, or bend them sharply.

Exercise care when mounting or removing the sensor. Also, take care to avoid unintended detaching of any wires or cables.

To mount the Surface Topography sensor:

1. Check both the FSMM and FSBM to ensure that there are no broken parts, such as bad cables.
2. Check that every cable is connected properly.
3. Check for integrity and cleanliness of the FSMM window. Replace the window assembly if there are any cracks or bad scratches.
4. Mount the FSBM opposite the FSMM so that the FSBM magnet is just opposite the FSMM reed switch.

3.2.2. Power and signals

1. Ensure that the FSMM power switch is off.
2. Connect the Surface Topography sensor power cable to the sensor head.
3. Connect both the EDAQ and the processor module of the FSMM to the Ethernet port using CAT5 cables.

3.2.3. Start-up sequence

The Surface Topography sensor cannot start up before the sensor IP address, position code and function code are known. This information is needed to establish the MSS connection.

Two resistors are used to uniquely identify the Surface Topography sensor EDAQ. 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.

Also, 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.

The Surface Topography sensor communication links are shown in Figure 3-3.

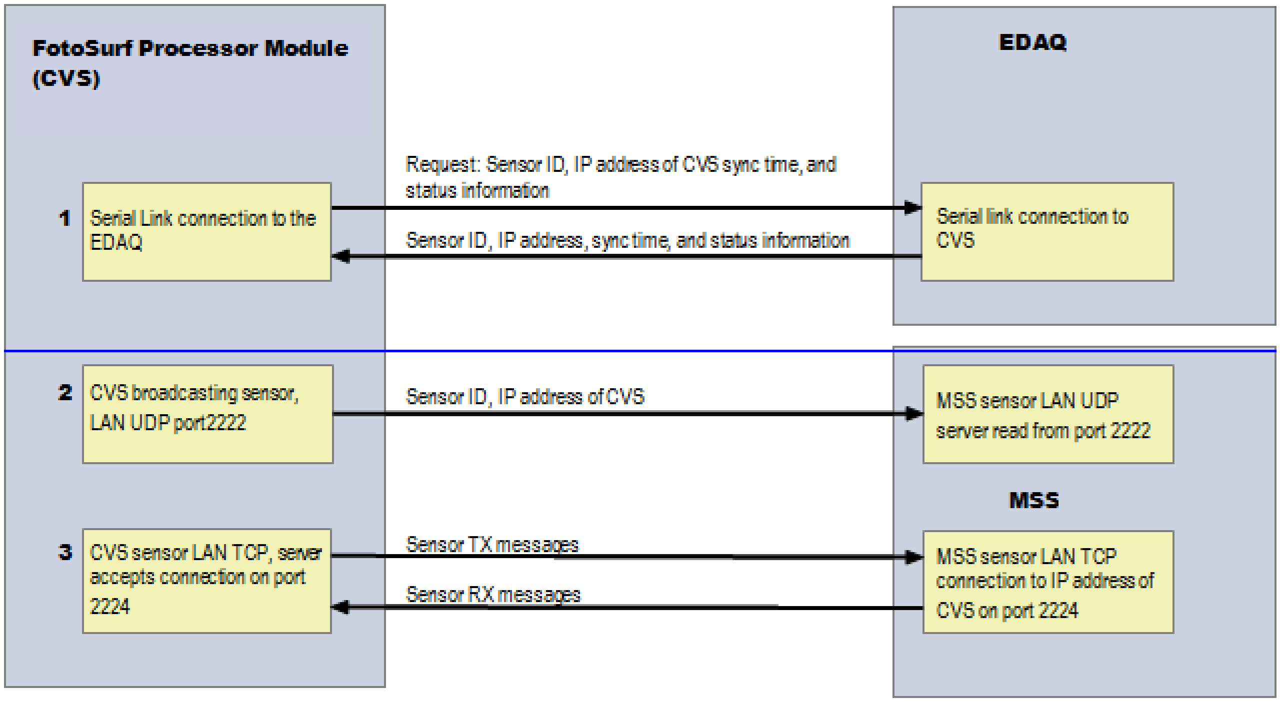


Figure 3-3 Communication Links

Initially, the Surface Topography sensor does not have a valid IP address, position code, or function code. The sensor requests the IP address of the CVS, and position code and function code from the EDAQ via the serial link.

Initially, the MSS does not know the Surface Topography sensor IP address, position, or function code. The sensor broadcasts the IP address, position code, and function code on UDP port 2223.

The MSS reads the CVS IP address, position code, and function code from UDP port 2223. The MSS uses this information to establish a TCP connection with the sensor on Port 2224. The MSS link is open for sensor communication. The sensor receives the system timestamp once per second via the EDAQ serial link. Either side can close the connection.

3.2.4. Checking sensor installation and communication

To verify successful installation, and confirm working communication:

1. Start the QCS server.
2. Power on the sensor and the scanner, and wait for at least two minutes before proceeding.

3. Verify that the sensor exists on the **PHP MSS Page** (the main MSS Web page) display (see Figure 2–4).

4. Verify that LEDs V26 (the *Alive and Well* message from the sensor to the MSS), V27 (the *Alive and Well* message from the MSS to the sensor), and V38 (time synchronization line) are blinking every four seconds (Figure 3-4 shows LEDs V10, V15, and V23 lit up).

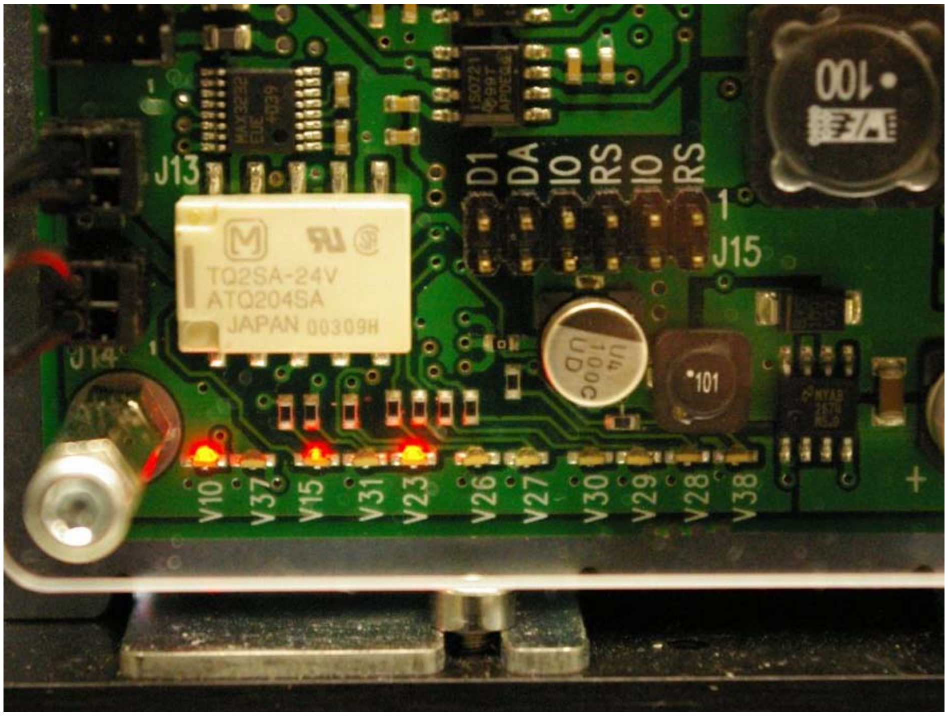


Figure 3-4 Diagnostic LEDs

5. Enable laser interlock by using the laser interlock keyswitch in the endbell.

Figure 3-5 HMI Controls For the Surface Topography Sensor

6. Push the surface topography enable button (see Figure 3-5). The button should stay lit after you push it.

7. On the server, using the **MSS Setup Diagnostics → MSS Summary** display, verify that MSS communication is up and running.

8. On the server, using the **MSS Setup Diagnostics → MSS Monitor → MSS Remote** display, verify that the *Alive and Well* message counters increment every four seconds (see Figure 3-6).

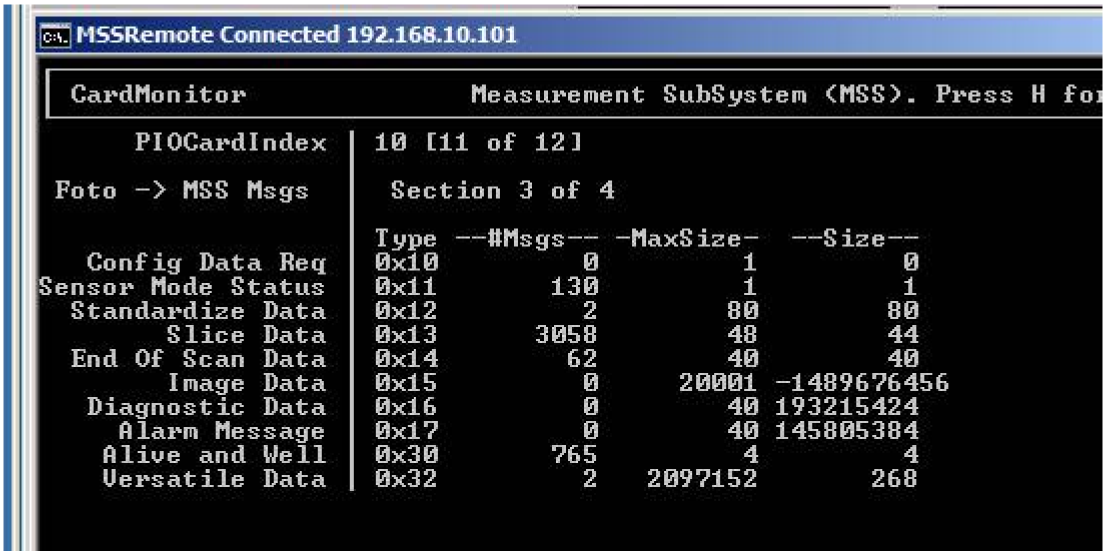


Figure 3-6 The *Alive and Well* Message From the Sensor to the MSS

9. On the server, using the **MSS Setup Diagnostics → MSS Summary** display, verify that MSS communication with EDAQ, the EDAQ Data Timestamps, and the EDAQ Card Safety Test Status have green status.

10. On the server, using the **MSS Setup Diagnostics → MSS Summary** display, verify that the Surface Topography sensor **Job Set** is *Enabled*, and EDAQ Data Available from Nodes(s), EDAQ Data Timestamps have green status.

11. Check the age of the measurement values during scan mode. On the server, using the **MSS Setup Diagnostics → MSS Job Set Monitor** display, the age of measured values in the middle of the sheet must be less than one second.

3.2.5. Checking sensor functions

Test the Surface Topography sensor by making a sample measurement in maintenance mode. To make a sample measurement:

1. Go to **Scanner** → **Sensor** → **Sensor Maintenance** display.
2. Select the FotoSurf Measurement processor.
3. Load the recipe, and enter maintenance mode.
4. Ensure that that the sample integration time is 40 seconds (change it if necessary).
5. Go to **FotoSurf** → **FotoSurf Image Gallery**, and switch to samples mode.
6. Save the previously measured samples, and click **Clean** to erase any previously measured samples.
7. Go back to the **Sensor Maintenance** display.
8. Insert a sample into the sensor gap between the FSMM and the FSBM, and press the **Sample** button of the Experion MX scanner, or click **Sample** on the **Sensor Maintenance** display.
9. After sampling finishes, go to the **FotoSurf Image Gallery** and switch to samples mode. If you can see a new paper surface photo with meaningful data, the sensor is working properly.

3.2.6. Primary performance evaluation

If you have surface topography standard tiles, make a sample measurement of them and compare that with the nominal values of the tiles.

3.2.7. Choosing a location for the sensor

The Surface Topography sensor may be installed to any scanner in the paper machine. The most typical single-sensor configuration is to place it near the winder measuring the final surface of the product. If coating or calendering changes (as compared to base paper properties) are important, one sensor can be installed before such operations.

3.2.8. Passline, tilt, and waviness of the web

The Surface Topography sensor is a non-contacting sensor, and has been designed to allow free web movement in the sensor gap. It automatically measures and compensates for passline and tilt variations of the web. However, tight waviness or curls of the web are not compensated for. Try to avoid anything that may lead to such phenomenon at the sensor.

4. Operation

This chapter describes Surface Topography sensor operation modes.

4.1. Configuration data

When the Surface Topography sensor links to the MSS, it first requests configuration parameters.

4.2. Onsheet sensor operation

To perform a scan:

1. Prepare scan.
2. Perform a slice measurements at 10 Hz frequency, and gather the scan average of image intensity.
3. Pass the data to the end-of-scan operations.

To perform a slice measurement (at 10 Hz):

1. Take a transilluminated image of the web.
2. Do an image enhancement (dynamic dirt and shading correction).
3. Apply mathematical algorithms to the corrected image to calculate all surface topography properties described in Section 6.3.
4. Save the image to a buffer of the last 100 valid (neither underexposed nor overexposed) frames.

5. Send the timestamped properties to the QCS for profile, trend building, and/or display.

6. If this is an image-monitoring slice, send the image to the QCS. Up to four positions can be selected from which the image is sent to the Experion MX display (allows on-line *light box* operation).

4.3. End-of-scan operation

All parameters of imaging (including camera and light pulse parameters) are adjusted at the end-of-scan:

- Auto-adjust the light source intensity based on the scan average in order to have a constant signal level (mean graylevel) from the camera. That allows significant grade changes with no preparation. The sensor adjusts itself automatically to changing light absorption of the web.

- Make imaging adjustments based on machine direction line speed.

- Update the illumination correction image for automated illumination non-uniformity and dirt correction based on the valid image buffer updated in the slice measurement procedure (see Subsection 5.3.4.5).

  The update interval is selectable between a once-per-standardization interval (default), and once-per-scan.

  Updating the illumination correction image causes the scanner to wait for approximately 1.5 seconds at the end position of the scan before scanning continues. Due to this delay, it is recommended that the default update interval be used unless extreme dirt build-up between standardizations is expected.

The illumination correction image can be viewed on the **fotosurf engineering** display (see Figure 4-1).

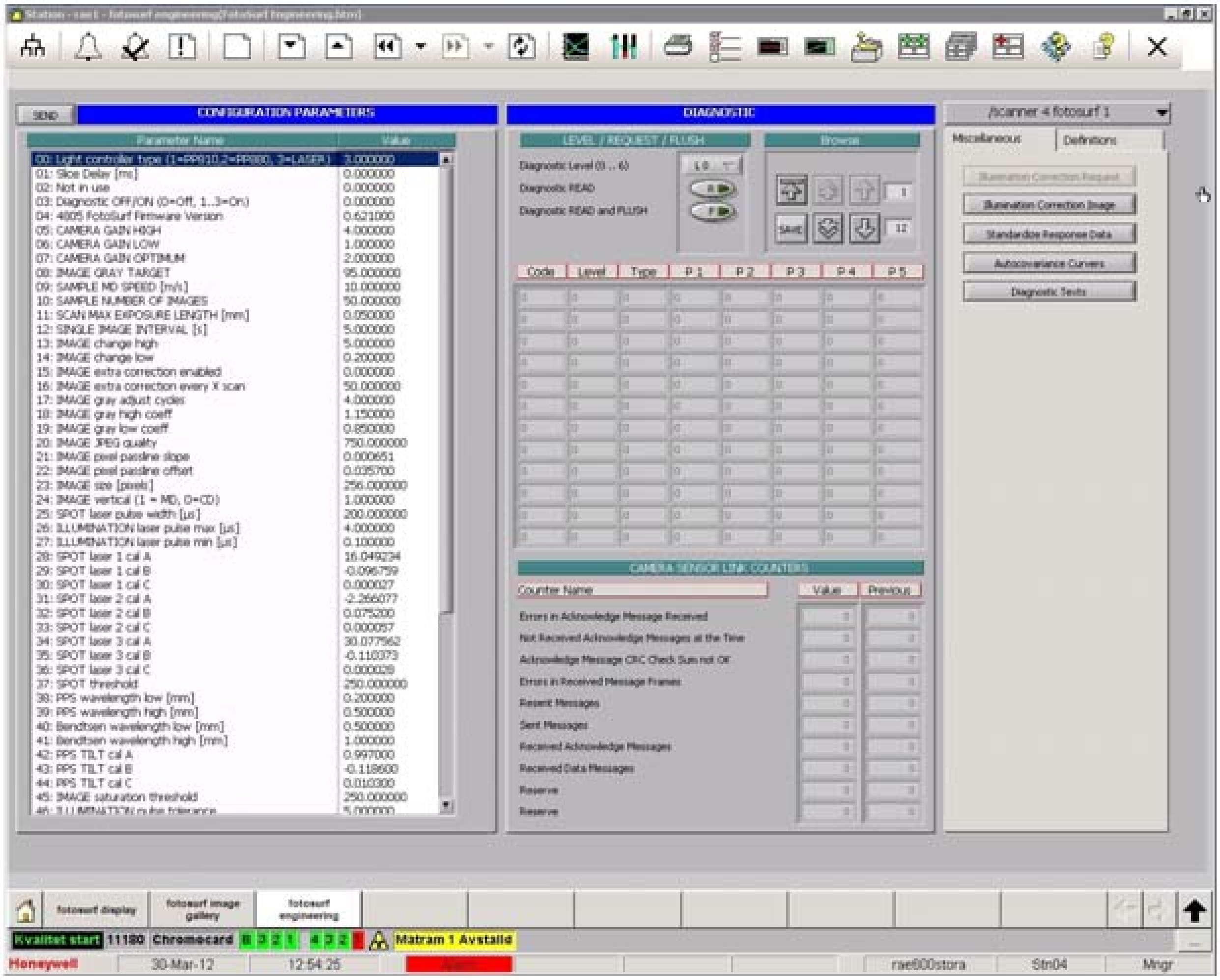


Figure 4-1 fotosurf engineering Display

4.4. Standardize, reference, and background

The Surface Topography sensor does not perform any background operations.

Standardize and reference functions do not currently perform any operations, they return default standardize response data filled with zeros. Future versions of the Surface Topography sensor firmware might add operations and values to standardize and reference.

4.5. Sample measurement

The Surface Topography sensor has **Sample Measurement** available as an offsheet function in maintenance mode.

To perform a sample measurement:

1. Configure the system to maintenance mode.
2. Set **Sample Integration Time** to at least 40 seconds. Longer integration times are rarely needed.
3. Go to the **fotosurf image gallery** display, change to sample mode, and clean the sample gallery.
4. Place the sample in the sensor gap in the same orientation as the paper web (machine direction and cross direction as in the paper web).
5. Push the **Sample** button.
6. Repeat Steps 4 and 5 until all samples have been measured (there is room for a maximum of nine samples at a time in the FotoSurf image gallery). Save the sample gallery to a folder, and clean it so you can measure more samples.
7. To observe the results go to the **Maintenance** display, and the **fotosurf image gallery** display.

Internal procedure of the Surface Topography sensor during sample measurement:

1. Initialization of the camera and light according to the sample machine direction speed parameter, and using the previous current.
2. Taking 10 images and calculating the mean graylevel.
3. If the mean graylevel was out of bounds, adjust the current and return to Step 2, otherwise proceed to Step 4.

4. Taking the specified number of images and calculating which of the images was the most typical. That selection is based on the least squared error with respect to mean values of all the formation properties.

5. Reporting the parameters of the most typical image.

5. Configuration

FotoSurf works with the QCS by exchanging configuration data, state change requests, and measurement results. In this chapter, the details of FotoSurf QCS software are described.

5.1. Functional overview

An overview of FotoSurf software is shown in Figure 5-1. The FotoSurf sensor communicates with the MSS over the sensor LAN. The MSS communicates state changes and statuses with the sensor. It also processes measurement data into, for example, profiles and trends, and saves the data into the real-time data repository (RTDR), which it shares with the QCS server.

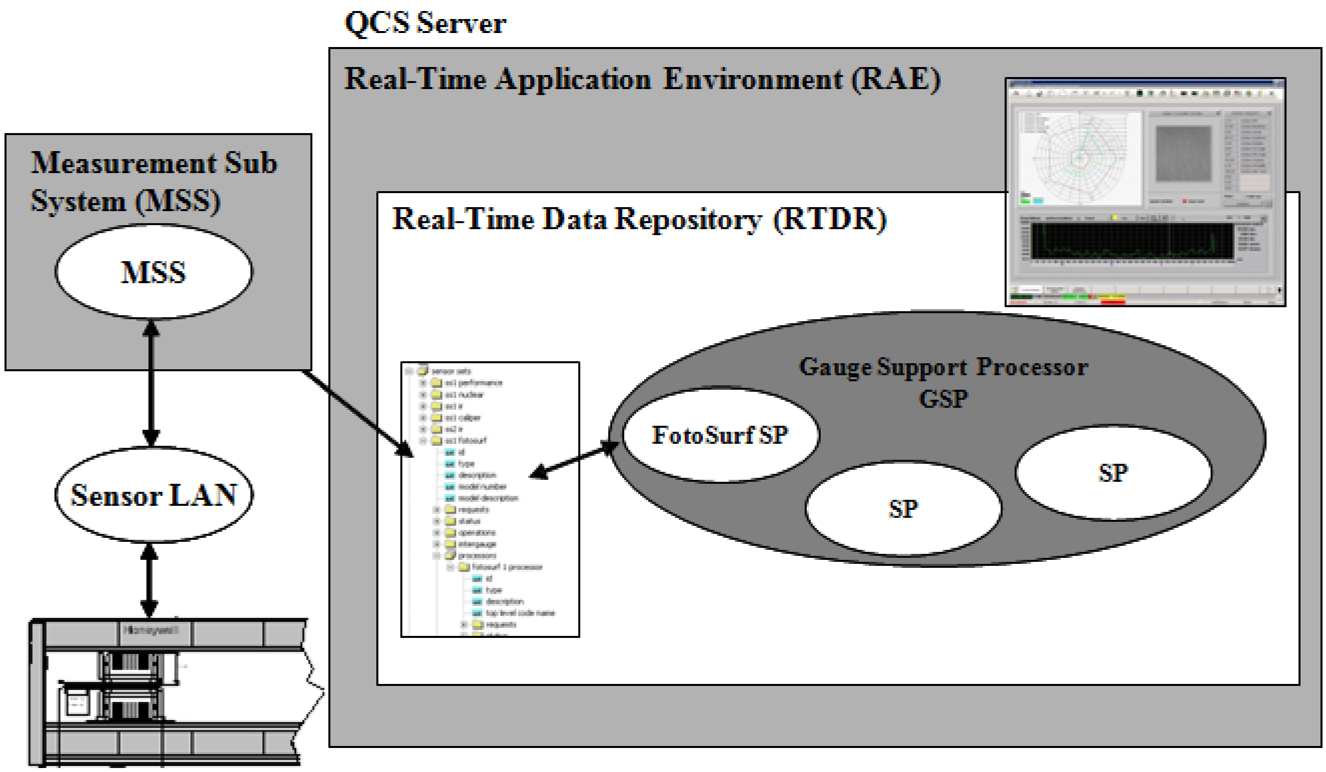


Figure 5-1 Surface Roughness Measurement Software

Surface topography measurement processing is done by the FotoSurf sensor processor (SP) inside the gauge support processor (GSP). Processed data can be visualized by the FotoSurf displays. Surface topography data can be stored and processed further by external databases such as the Honeywell Uniformance® Process History Database (PHD).

5.1.1. Data flow

The FotoSurf sensor is connected to the MSS through the sensor LAN (Ethernet). All communication to and from the sensor is done through this link, which employs 100 Mbit/s speed. This link is called the Camera Sensor Link (CSL).

The CSL data is located in *scannerX/mss/ssX FotoSurf/setup* RTDR record, where X = sensor set number. Message types sent by the FotoSurf sensor to the MSS are shown in Table 5-1.

Table 5-1 FotoSurf Sensor-to-MSS

Message	Type	Bytes	Sensor-to-RTDR
Configuration Data Request	10H/16	1	---
Alive and Well	30H/48	4	---

Message	Type	Bytes	Sensor-to-RTDR
Mode Status	11H/17	1	---
Stdz Data	12H/18	80	Standardize Data Buffer
Slice Data	13H/19	44	OFSxAIA… OFSxAIJ (*ScannerX/mss/ssX optform/sensor inputs/*)
End of Scan Data	14H/20	40	End Of Scan Data Buffer
Image Data	15H/21	20001	Image Data Buffer 1–5
Diagnostic Data	16H/22	40	Diagnostic Data Buffer
Alarm Message	17H/23	40	Alarm Message Buffer
Versatile Data	32H/50	Max 2Mb	Versatile Data Buffer

In Table 5-2 message types sent by MSS to the FotoSurf sensor are listed. Detailed descriptions of these messages are outside of the scope of this manual.

Table 5-2 MSS-to-FotoSurf Sensor

Message	Type	Bytes	RTDR-to-Sensor
Configuration Data	20H/32	200	Configuration Data Buffer
Alive and Well	30H/48	4	Process Data (line speed in meters per second is sent to the sensor within the Alive and Well acknowledgment message)
Mode Change Request	21H/33	1	---
Diagnostic Request	22H/34	2	---
Initial TIC Count	23H/35	1	---
Trigger Image	24H/36	5	---
Recipe Parameters	31H/49	80	Recipe Data Buffer
Versatile Data	32H/50	Max 2Mb	Versatile Data Download

5.1.2. Sensor processor

The FotoSurf SP is located under *C:\Program Files\Honeywell\Experion MX\Gauging\Labview VIs\ Processors\Precision FotoSurf* folder, and it handles all data sent from the sensor.

The correspondence between SP activity, the sensor inputs child record, and the VI that handles data is shown in Table 5-3.

Table 5-3 SP Activity and Sensor Inputs Child Record Correspondence

SP Activity	Sensor Inputs Child Record	Handled By VI
Maintenance background	Background	Not in use
Maintenance reference	Reference	*SP PFSx Reference.vi*
Maintenance sample	Sample	*SP PFSx Single Point.vi*; *SP PFSx Sample Image Data.vi*
Production background	Background	Not in use
Production standardize	Reference	*SP PFSx Reference.vi*
Production single point	Single point	*SP PFSx Single Point.vi*
Production periodic measurement	Periodic	*SP PFSx Single Point.vi*
Production EOS forward and production EOS reverse	Scan	*SP PFSx End of Scan.vi*; *SP PFSx Image Data.vi*
Production buffered single point	Buffered single point	*SP PFSx Buffered Single Point.vi*
Scan forward	Scan	*SP PFSx End of Scan.vi*
Scan reverse	Scan	*SP PFSx End of Scan.vi*

The SP processes the functions listed and described in Table 5-4.

Table 5-4 Functions Processed by the SP

VI	Function/Execution
SP PFSx Disable Processor.vi	Disables sensor set and SP when CSL is down. Function checks is sensor sending data read from the *./job set/sensorsendingdata* RTDR parameter
	Running cycle = 2s
SP PFSx Read Line Speed.vi	Reads current line speed and scales it to m/s. *./scannerX/status/scan data/speed * ./calibration parameters/ speed slope + ./calibration parameters/ speed intercept → ./scannerX/mss/setup/process data buffer*
	Running cycle = 2s
SP PFSx Image Folders Create.vi	Creates Image folders if they do not exist
	Saves image data from the files exist to the RTDR
	Executed once at server startup
SP PFSx Save Grade Images.vi	Saves image data to reference images
	Waits event (user1 = 65536) from the **fotosurf image gallery** display. Event is set by the *PFS Save New Grade Image.vi* when saving image to reference image.
SP PFSx Reference by Grade Change.vi	Gets reference image for the **fotosurf image gallery** display and copies grade based configuration parameters to the recipe data buffer for sending to the sensor
	Waits event (Code start = 16) by the grade change

VI	**Function/Execution**
SP PFSx Display Data Request.vi	Gets history image data for the **fotosurf display**
	Gets reference image data for the **fotosurf image gallery** display
	Waits event (Data changed = 2) from the **fotosurf image gallery** display and the **fotosurf display**. Event is set by: • *Image Gallery Request.vi* in reference image access • *History Image Request.vi* in slice data history access
SP PFSx Display Functions.vi	Waits event (Data changed = 2) from the **fotosurf image gallery** display. Function makes next operations: • save sample images • clean sample images • get sample images • delete sample images
SP PFSx Handle Versatile Message.vi	Sends configuration data to the sensor. Sensor sends configuration request after startup by versatile data
	Reads illumination correction data sent by the sensor
	Reads configuration data sent by the sensor
	Waits event (Versatile = 2097152) from the MSS. Event is set when sensor sends Versatile data message: • Configuration request by the *State Machine.vi* • Configuration data by the *Parameters.vi* • Illumination Correction Image by the *Edge.vi*
SP PFSx Sample Image Data.vi	Reads and saves sample image data in sample mode. Image data is sent by the sensor to the *./scannerX/mss/ssX optform/setup/image data buffer 5*
	Executes once when sample is ready (in maintenance sample)
SP PFSx Image Data.vi	Handles image data sent by the sensor (see Figure 5-2): • Reads image data setup from the *./configuration parameters/image data setup* RTDR parameter • Creates log folder after reel has changed • Deletes oldest saving data (folder) if max folders reached • Finds typical image of the roll • Saves reel image data to the image gallery and delete oldest one (max = 8 gallery image) • Reads scanning image data from the *./scannerX/mss/setup/image data buffer 1–4* sent by the sensor
	Saves scanning image data to the files. File names and folder are defined by the image data setup RTDR parameter
	Executed once when Production EOS (Fwd, Rvs)
SP PFSx Pack Config Data to Versatile.vi	Reads configuration parameters, pack and write them to *./scannerX/mss/ssX optform/setup/versatile data download* RTDR parameter. Done in server startup.
	Executed once at server startup

5.1.3. Saving images

Surface images and their values are saved to the hard disk at every end-of-scan, and to the image gallery when the reel is completed. Sample images are saved with the sample function.

The base path for saving images is *%MXRTDB%\CS Data\FotoSurf*, where the default value for the environment variable *MXRTDB* = *C:\ProgramData\Honeywell\Experion MX\Database*.

5.1.3.1. Image data setup parameters

Definitions for image saving are defined by the image data setup configuration parameter of the SP (see Figure 5-2).

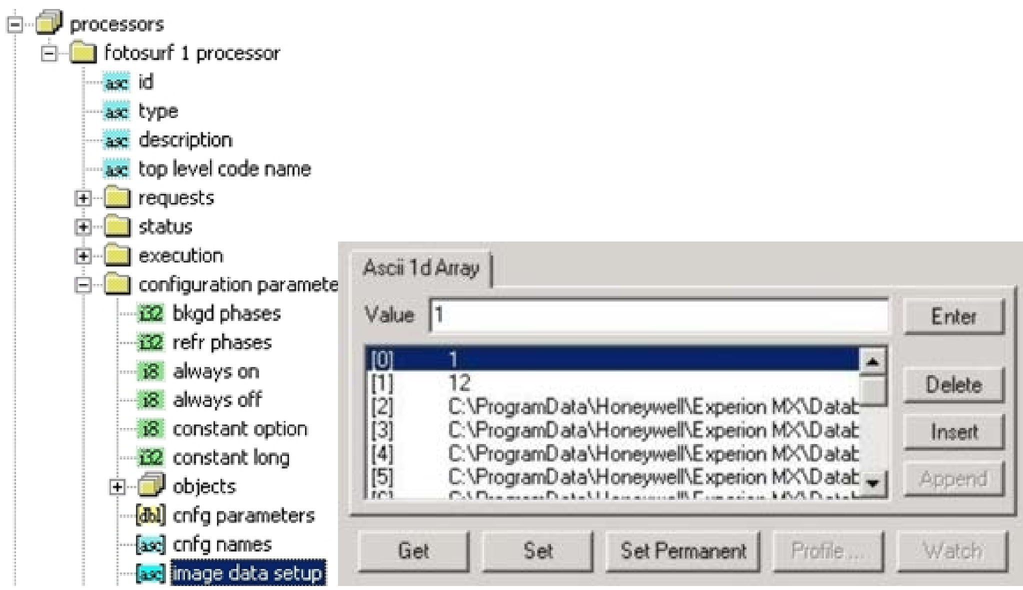


Figure 5-2 Image Save Definitions

Table 5-5 lists the default values for image data setup parameters.

Table 5-5 Image Data Setup Parameters: Default Values

Idx	Parameter	Description	Default Value
0	Log ON/OFF (1/0)	Enable/disable image saving	1 = saving images
1	Max Folders to be Saved	Number of saved reels	12
2	Log Main Folder	Main folder name	*C:\ProgramData\ Honeywell\ Experion MX\ Database\ CS Data\ FotoSurf\ PFS1_Data*
3	Log Saving Folder	Folder name for image history	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Saved_Data*
4	*Main Folder\Image1FileName.ext*	Image 1 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image1.jpg*
5	*Main Folder\Image2FileName.ext*	Image 2 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image2.jpg*
6	*Main Folder\Image3FileName.ext*	Image 3 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image3.jpg*
7	*Main Folder\Image4FileName.ext*	Image 4 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image4.jpg*
8	*Main Folder\Image5FileName.ext*	Image 5 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image5.jpg*
9	*Main Folder\Data1FileName.ext*	Slice data 1 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image1.dat*
10	*Main Folder\Data2FileName.ext*	Slice data 2 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image2.dat*
11	*Main Folder\Data3FileName.ext*	Slice data 3 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image3.dat*
12	*Main Folder\Data4FileName.ext*	Slice data 4 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image4.dat*
13	*Main Folder\Data5FileName.ext*	Slice data 5 file name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Data\image5.dat*
14	Image Gallery Folder Name	Image gallery folder name	*C:\ProgramData\ Honeywell\ \Experion MX \Database \CS Data \FotoSurf \PFS1_Image Gallery*
15	Slice Data Mean Values File Name	Slice data file name	*Mean Values.dat*

Idx	Parameter	Description	Default Value
16	Auto Reference Image ON/OFF (1/0)	Save/do not save reference imgs	0 (off)
17	Max Files in Log Saving Folder	# max files to be saved to	3000

5.1.3.2. Image folders

Figure 5-3 shows a screenshot of the images folders (under *%MXRTDB% \CS Data \FotoSurf * directory by default).

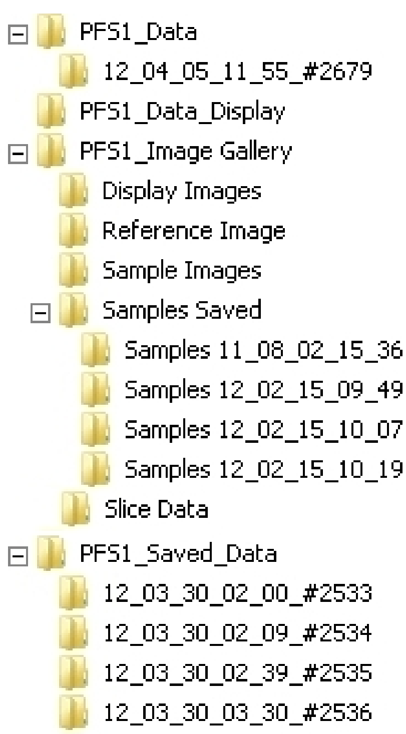


Figure 5-3 Images Folders

Table 5-6 lists and describes some of the images folders.

Table 5-6 Images Folders and Contents

Folder	Description
PFS1_Data	Storage for latest images and their data and current reel
PFS1_Data\ 12_04_05_11_55_#2679	Image folder of the current reel
PFS1_Data\ PFS1_Data_Display	Storage for current FotoSurf display images
PFS1_Image Gallery	Folder for the **fotosurf image gallery** display data
PFS1_Image Gallery\ Display Images	Images currently shown on the **fotosurf image gallery** display

PFS1_Image Gallery\ Reference Image	Reference image folder shown in the middle of the **fotosurf image gallery** display
PFS1_Image Gallery\ Sample Images	Current sample images
PFS1_Image Gallery\ Samples Saved	Saved sample image folders. Each folder contains maximum of 9 samples.
PFS1_Image Gallery\ Slice Data	Topography data of images currently shown on the **fotosurf image gallery** display
PFS1_Saved_Data	Folder for the reel history of image and topography data. Folders inside this folder each contain all saved images of one reel. If the number of images exceeds image data setup configuration parameter *Max Files in Log Saving Folder*, a new folder is created with the same reel number.

ATTENTION

Image and topography data history folders of the reels, for example, *06_11_16_17_48_#11* = Roll #11 started 16.11.2006 17:48. These folders are copied from the *PFSx_Data* folder when the reel is ready. The maximum number of reels, the images of which are saved, is defined by the image data setup parameter *Max Folders to be Saved*.

5.1.3.3. Folder and file names

Figure 5-4 shows a screenshot of the folder hierarchy of the *PFS1 Data* directory.

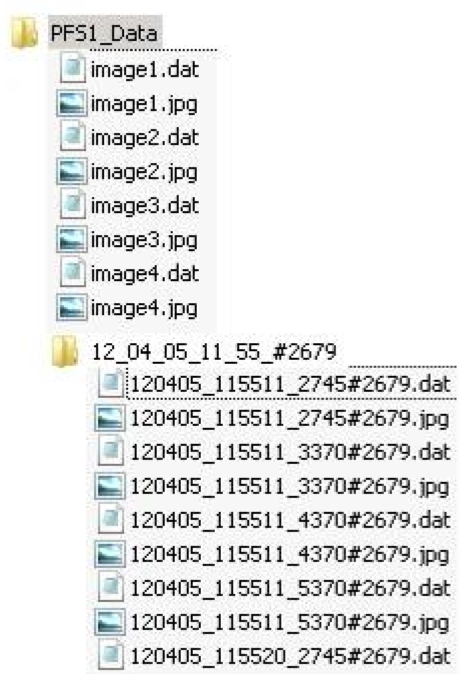


Figure 5-4 Folder Hierarchy: PFS1_Data

Table 5-7 lists and describes the folders shown in Figure 5-4.

Table 5-7 Folder Hierarchy Description: PFS1_Data

Folder	Description
Parent folder (PFS1_Data)	Current Image files: ImageX.dat = Slice data file ImageX.jpg = Image X file name
Current reel image folder (12_04_05_11_55_#2679)	YY_MM_DD_hh_mm_#Reel, where YY = year, MM =month, DD = day, hh = hour, mm = minutes, #Reel = reel number
	Image and data files Inside Current Reel Image Folder: YYMMDD_hhmmss_Pos#Reel.ZZZ, where YY = year, MM = month, DD = day, hh = hour, mm = minutes, ss = seconds, Pos = Image position in mm, #Reel = reel number, ZZZ = filename extension (.jpg for image, .dat for associated slice data).

Figure 5-5 shows a screenshot of an expanded view of the *PFS1_Image_Gallery* folder.

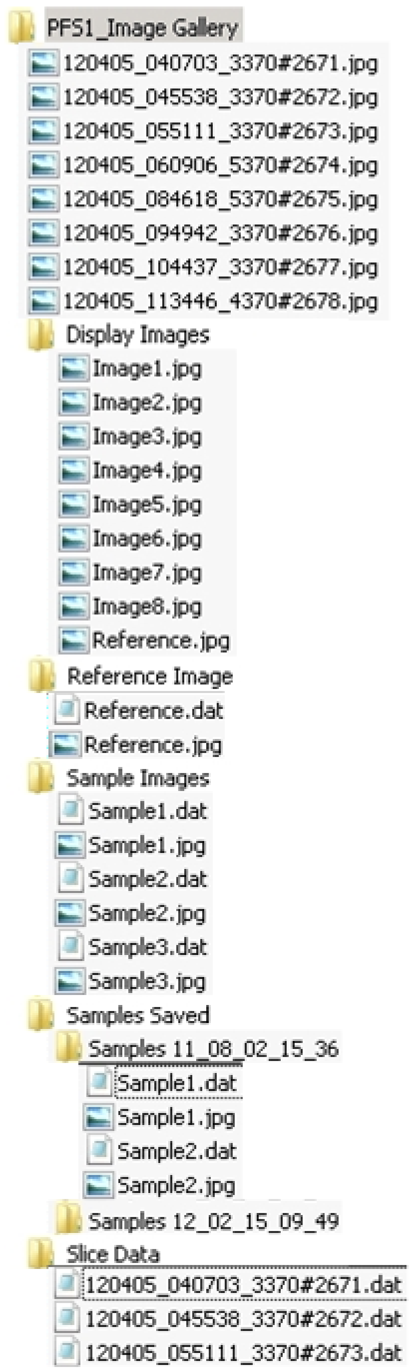


Figure 5-5 Folder Hierarchy: PFS1_Image_Gallery

Table 5-8 lists and describes the *PFS1_Image_Gallery* contents shown in Figure 5-5.

Table 5-8 Folder Hierarchy: PFS1_Image_Gallery

Folder	Description
PFS1_Image Gallery	Original saved image gallery files
	YYMMDD_hhmmss_Pos#Reel, where: YY = year, MM =month, DD = day, hh = hour, mm = minutes, ss = seconds, Pos = Image position in mm, #Reel = reel number
Display Images	Temporary storage of images for display purposes.
Reference Image	Temporary storage of reference image for current grade for display purposes. Reference images are saved in RTDR records.
Sample Images	Current sample images: sample images are named in order of made samples. Maximum number of sample images to show at the same time is 9. If more needed, then images need to be saved.
Samples Saved	Sample images are saved by the SAVE function. The folder name format is: Samples YY_MM_DD_hh_mm, where YY = year, MM =month, DD = day, hh = hour, mm = minutes. Files are named as SampleN.ZZZ, where N=1…9, ZZZ = filename extension (".jpg" for image, ".dat" for associated slice data).
Slice Data	Slice data of original saved image gallery files (typical files of last 8 reels).

5.2. Database configuration

Precision FotoSurf Measurement software is a standard feature of the RAE, versions later than R603. Precision FotoSurf Measurement software can be added to the following RAE versions by installing the add-on package:

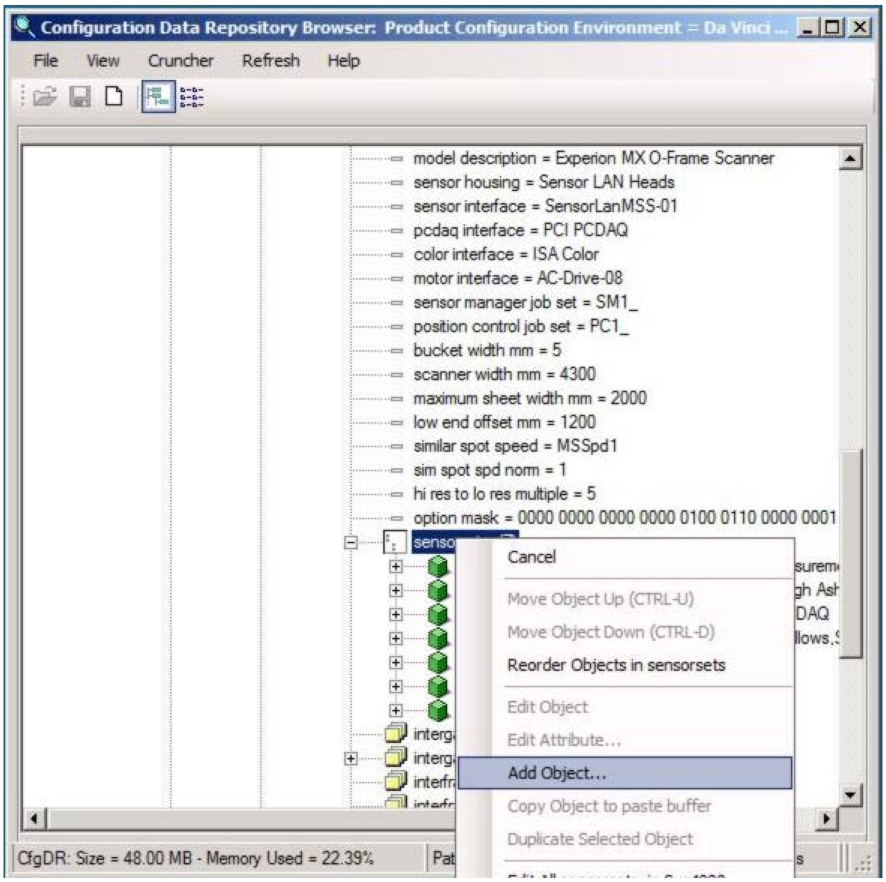
- RAE 600
- RAE 601
- RAE 602
- RAE 603

If your system is among the add-on compatible versions, contact Honeywell QCS TAC for assistance to get the FotoSurf add-on package.

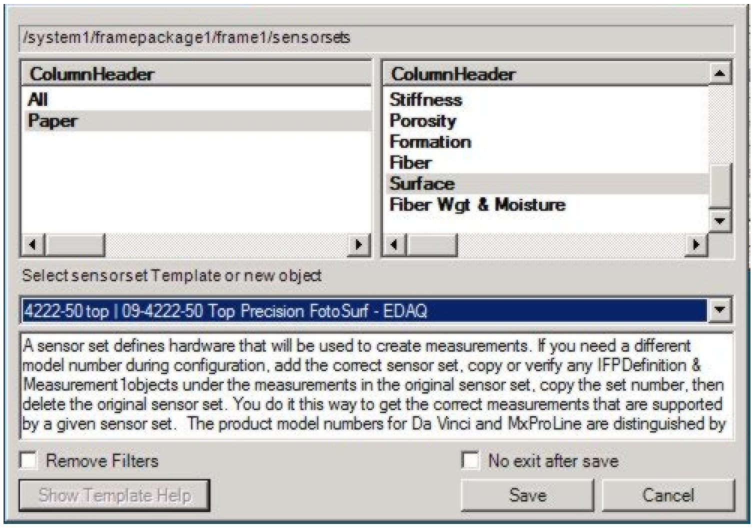
5.2.1. Add FotoSurf sensor to the system

To add the sensor to the system:

1. Open **Configuration Data Repository Browser**.
2. Navigate to */Systems/SysXxxx/framepackeges/Same or Similar Spot/frames/scannerX/sensorsets/*.
3. Right-click on *sensorsets* and select **Add Object…**.

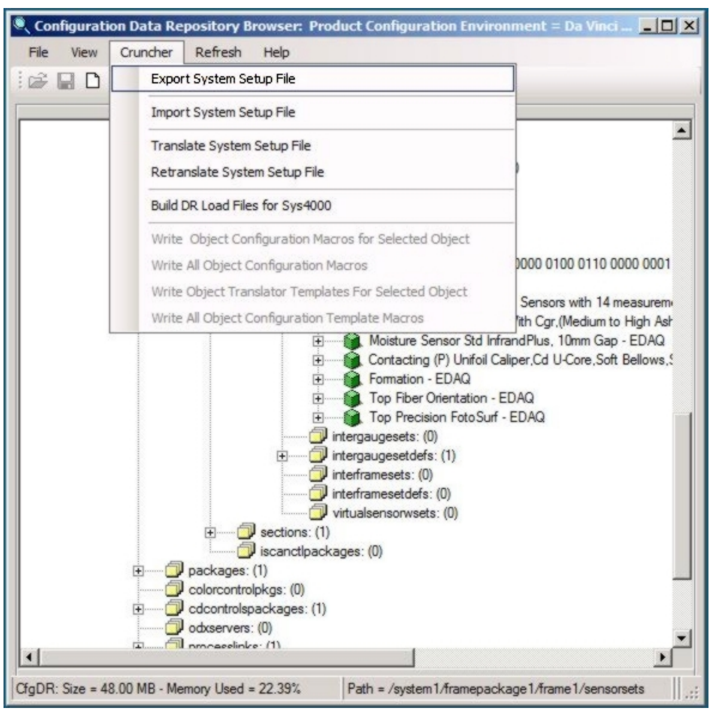


4. Select **Surface** from the sensor list, **Top** or **Bottom** installation from the drop-down arrow, and click **Save**.

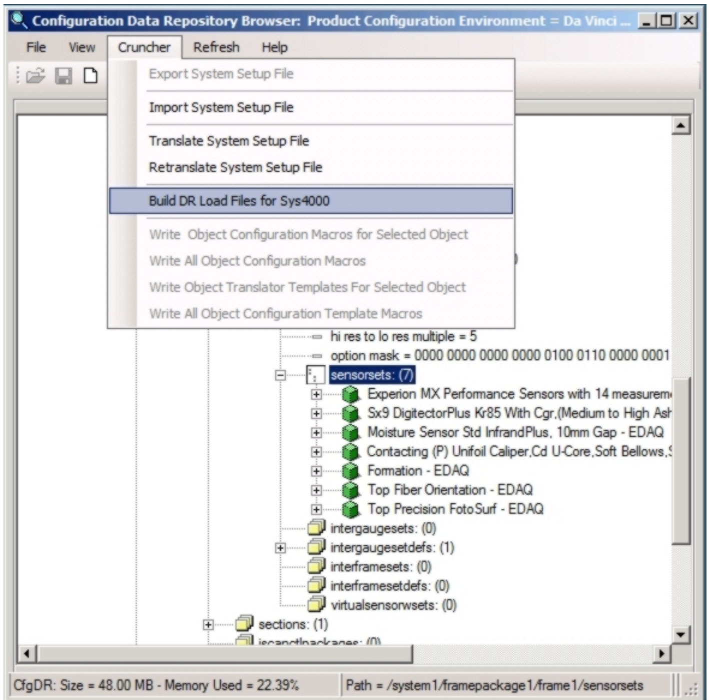


The FotoSurf sensor is added to the sensor set of the selected system.

5. Select **Cruncher → Export System Setup File**. Click **Yes**, then click **OK** on the pop-up window.



6. Select **Cruncher → Build DR Load Files for SysXxxx**, wait for build progress, then click **OK**.



5.2.2. Set configuration parameters

5.2.2.1. Image data definitions

The image data folder and file names are defined with image data setup configuration parameter (see Figure 5-6). Default values are set by the build *C:\Program Files\Honeywell\Experion MX\Rae\ DRGeneration\ MultiIndustry\ Gauging\ Processors FotoSurf_Processor.mac*, and they do not need to change, except indexes 0, 1, 16, and 17.

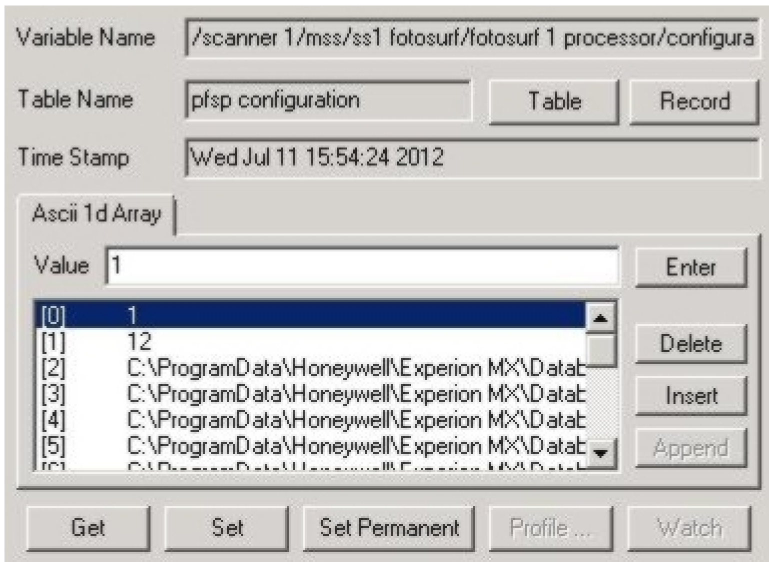


Figure 5-6 Ascii 1d Array

Table 5-9 lists and describes indexes and index functions.

Table 5-9 Index Functions

Idx	Parameter Name	Description
0	Enable/Disable Image Saving	Allows or inhibits history images saving to the files: • 1 = save images (default) • 0 = do not save images
1	Number of Saved History Reels	Defines number of reels to be saved history. Default = 12. Note: each scanning image saving file size is about 5–10 kB. If all four scanning images are defined, and one scan gets 10 seconds, and the reel is finished in one hour, the maximum size on the disc is 14400 kB.
16	Auto Reference Image ON/OFF (1/0)	Defines whether or not reference images are saved automatically. Note: default = OFF
17	Max Files in Log Saving Folder	Defines how many file are saved to the log saving folder (roll image and slide data files

To change the value:

1. Activate *Value entering* by double clicking a value to be changed.
2. Enter the new value, then click **Enter**.
3. Click **Set**.
4. Click **Set Permanent**.

5.2.3. Set line speed scaling

The Surface Topography sensor needs to receive current line speed in units of m/s from the QCS server for proper exposure adjustment. Because the line speed available in the RTDR parameter *./scannerX/status/scan data/speed*, might not always be in these units, scaling is needed:

Line Speed [m/s] = speed * speed slope + speed intercept

Parameters./calibration parameters/speed slope, and *./calibration parameters/speed intercept* need to be configured in order to get correct scaling.

Reading, scaling, and writing the scaled line speed to *./scannerX/mss/setup/process data buffer* RTDR parameter is performed by *SP PFSx Read Line Speed.vi* (see Table 5-4).

5.3. User interface

The FotoSurf sensor displays are located under the FotoSurf display category. There are three displays:

- **fotosurf engineering**
- **fotosurf image gallery**
- **fotosurf display**

Images and descriptions of the displays are shown in Figure 5-7.

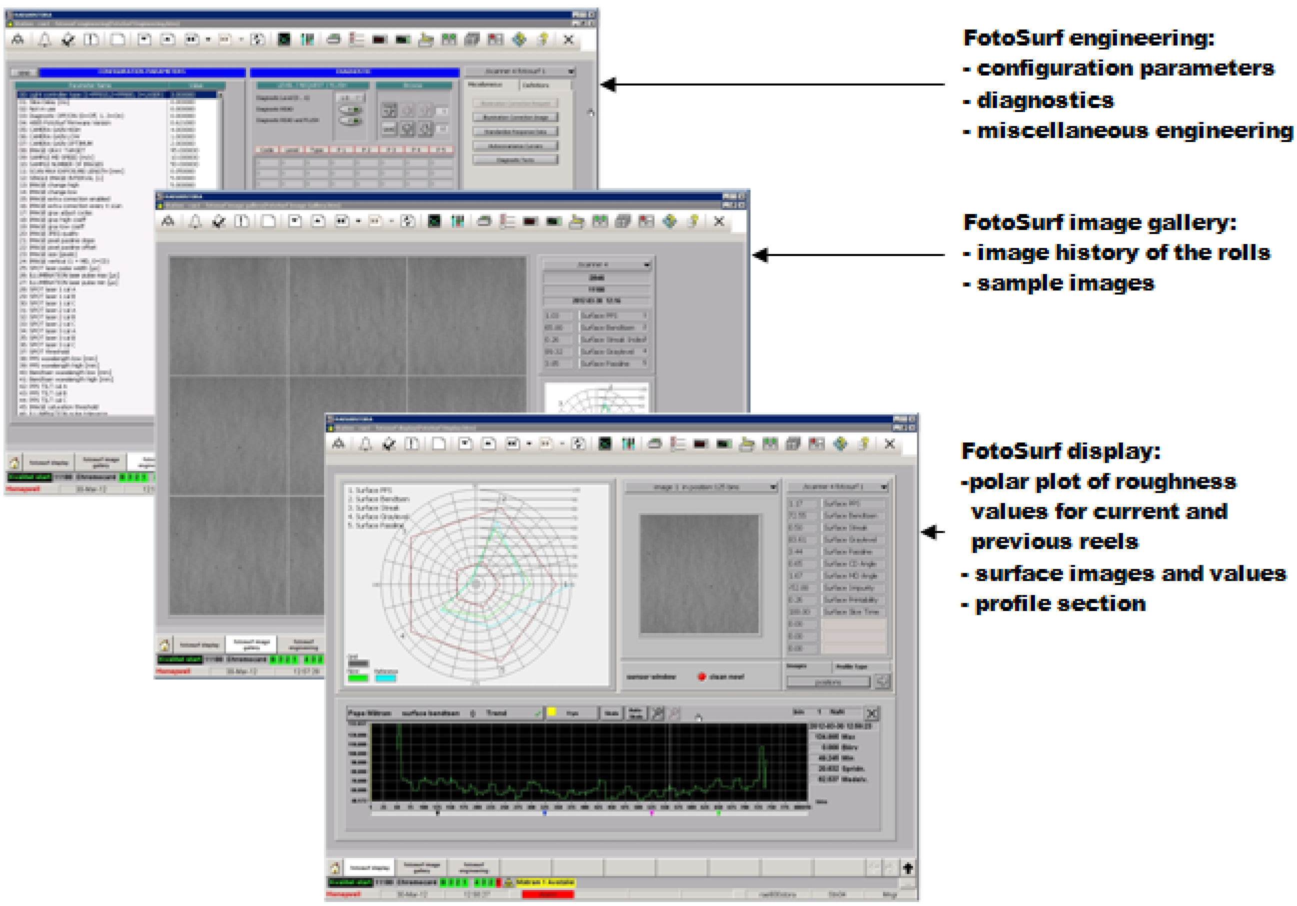


Figure 5-7 FotoSurf Displays

The FotoSurf displays are located at: *C:\Program Files\Honeywell\Experion MX\Gauging\Labview VIs\ Displays\ Precision FotoSurf*.

The pop-ups are located at: *C:\Program Files\Honeywell\Experion MX\Gauging\Labview VIs\ Displays\ Precision FotoSurf\Sub Level*.

Table 5-10 lists and describes the VIs of the FotoSurf displays.

Table 5-10 FotoSurf Displays: VIs

Title	File Name	Type
fotosurf display	*Precision FotoSurf Display.vi*	Display
fotosurf image gallery	*Precision FotoSurf Image Gallery.vi*	Display
fotosurf engineering	*Precision FotoSurf Engineering.vi*	Display
Image Positions	*PFS Image Positions.vi*	Pop-up
Polar Plot Scales	*PFS Polar Plot Scales.vi*	Pop-up
Illumination Correction Image	*PFS Illumination Correction Image.vi*	Pop-up
Standardize Response Data	*PFS Stdz Response.vi*	Pop-up
Auto Covariance Curves	*PFS Autocovariance Curvers.vi*	Pop-up

5.3.1. The fotosurf display

The **fotosurf display** is designed to provide thorough, real-time status of surface topography. Surface topography properties are displayed in numeric form, as a polar plot, and as a profile. Also, on-line surface images are shown from up to four cross direction positions of the web. Scaling of the polar plot and cross direction positions of the on-line surface images are customizable on this display. The **fotosurf display** is the most important display for analyzing the current state of surface topography and its recent history.

5.3.1.1. fotosurf display pages

The **fotosurf display** consists of two pages. The first page (see Figure 5-8) is the default page, which is called up when the **fotosurf display** is launched. This page shows general status of surface topography, and detailed information of a single selected position.

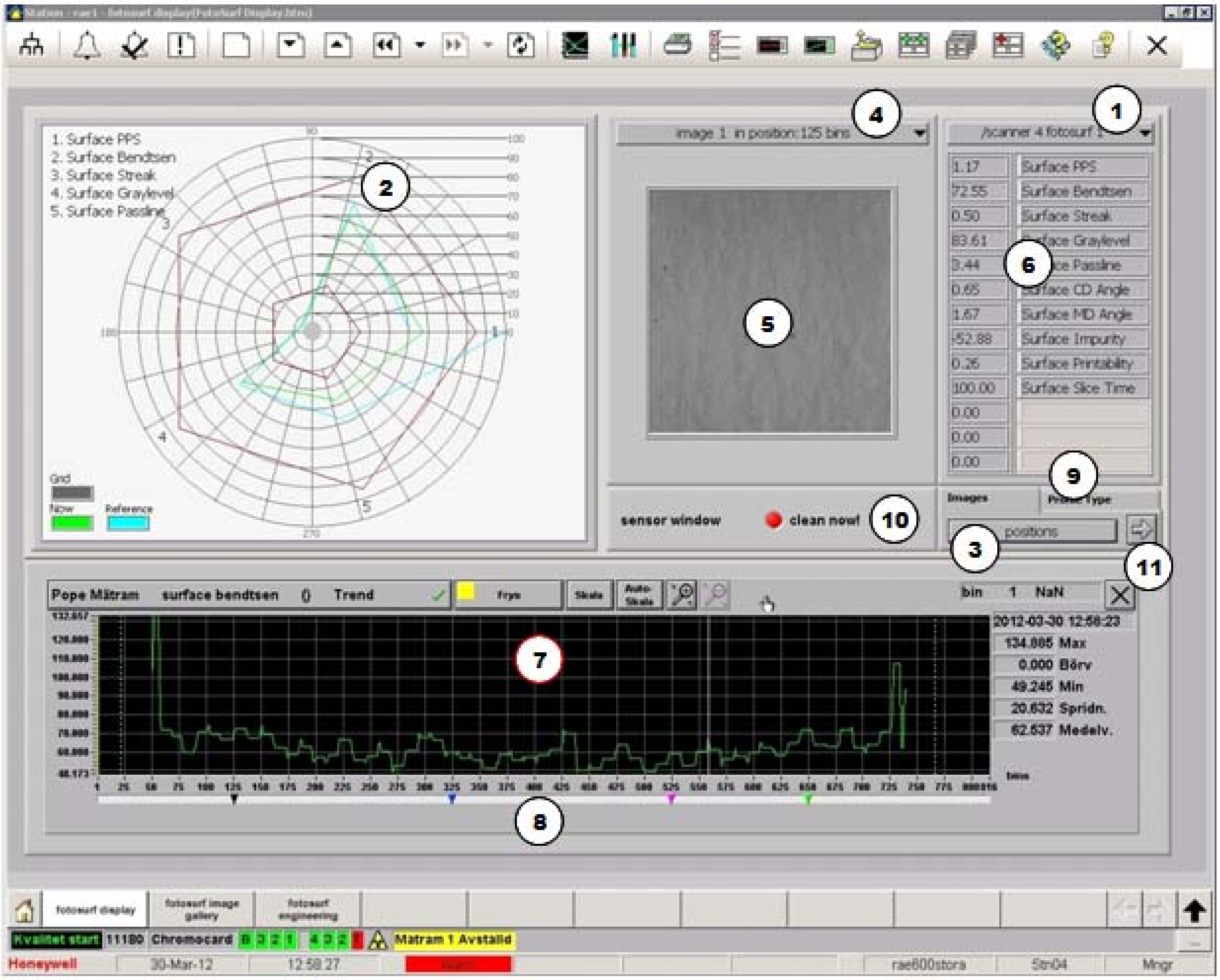


Figure 5-8 fotosurf display (first page)

Table 5-11 lists and describes items labeled in Figure 5-8.

Table 5-11 fotosurf display (first page items)

Item	Description
1	Selection of the FotoSurf sensor
2	Polar plot of surface topography characters
3	Configuration of cross direction positions of surface topography images
4	Selection of cross direction position for the on-line surface image

Item	Description
5	Single on-line surface image
6	Surface topography characters of single on-line surface image
7	Profile of selected measurement
8	Indicator of configured cross direction positions
9	Selection of profile type
10	Sensor window cleanliness indicator
11	Click arrow to display the second page of the **fotosurf display**

The second page of the **fotosurf display** (see Figure 5-9) shows live, on-line imagery from up to four cross direction positions. Surface topography properties are shown for each image. You can move between the pages by clicking the arrow button (item 6 in Figure 5-9).

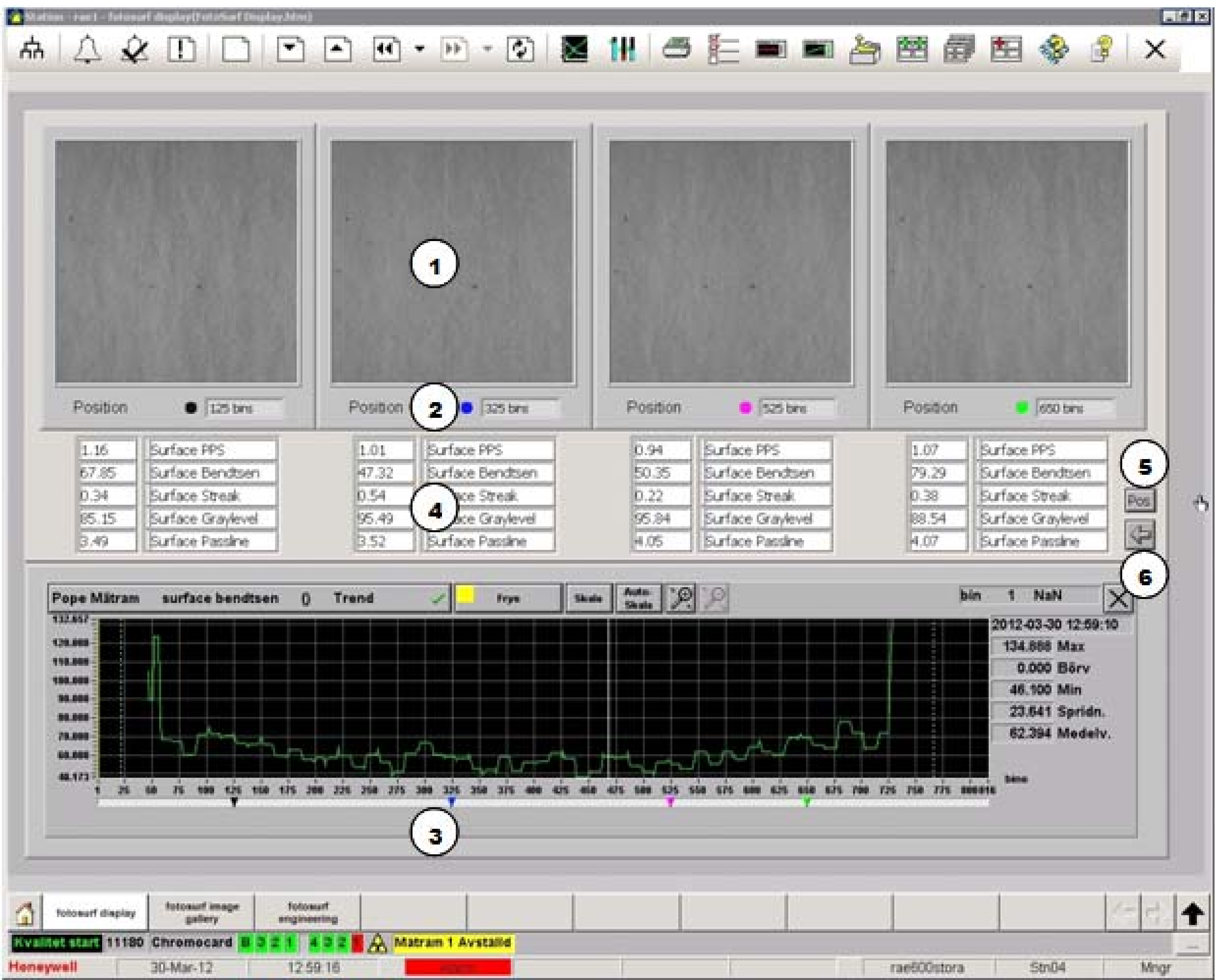


Figure 5-9 fotosurf display (second page)

Table 5-12 lists and describes items labeled in Figure 5-9.

Table 5-12 fotosurf display (second page items)

Item	Description
1	On-line surface images of the defined position
2	Numeric cross direction position indicator and color symbol
3	Indicator of configured cross direction positions
4	Surface topography characters of single on-line surface image
5	Configuration of cross direction positions of surface topography images
6	Click arrow to display first page of the **fotosurf display**

5.3.1.2. Select the FotoSurf sensor

All FotoSurf sensors installed to the system are listed in the **FotoSurf** selection menu. Your system can have one or more FotoSurf sensors on different scanners (maximum two per scanner). Select the one you want to monitor on the first page. You can change your selection at any time. Only one FotoSurf sensor can be monitored at a time.

Figure 5-10 FotoSurf Sensor Selection Menu

5.3.1.3. Polar plot of FotoSurf properties

The polar plot (see Figure 5-11) shows, graphically, current and reference values of surface topography properties. The plot consists of several axes (all starting from the center), one for each of the five surface topography properties. The points representing current (or reference) values of surface topography properties are connected with a line. The graph creates a pentagon. The pentagon tip distance from the center is proportional to the value of the surface topography character. The polar plot is useful to quickly identify when a surface topography character is bad, for example, any of the axes increasing a lot. The smaller the pentagon is, the better the surface topography is overall.

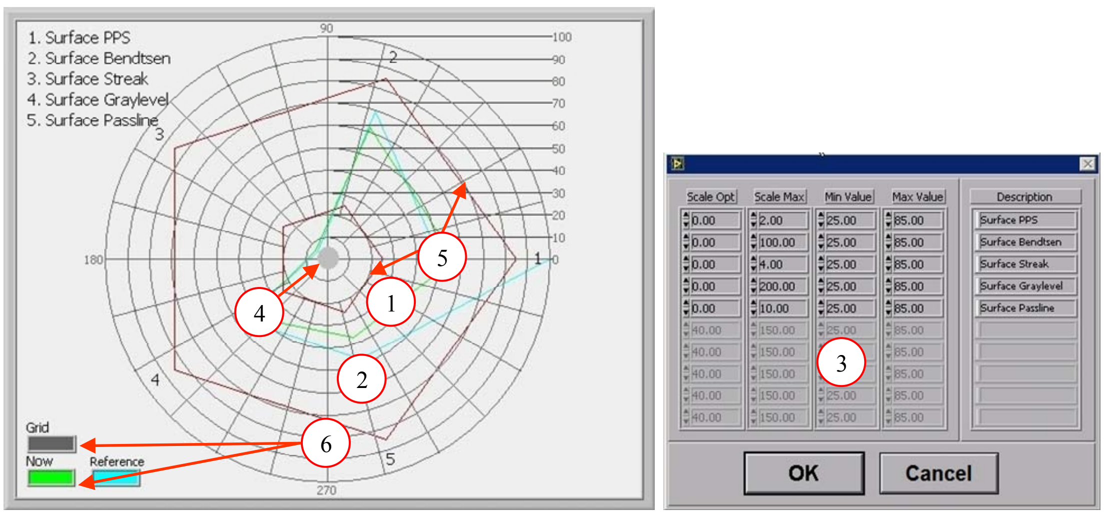


Figure 5-11 Polar Plot (left); Scale Configuration Pop-up (right)

Table 5-13 lists and describes items labeled in Figure 5-11.

Table 5-13 Polar Plot Items

Item	Description
1	Current (Now) plot of surface topography properties (green pentagon): Average surface topography properties of the last scan. The plot is updated at the end of scan.
2	Reference plot of surface topography properties (cyan pentagon): Typical surface topography properties of the reference image of the grade.
3	Scale configuration pop-up: A pop-up in which the scales of axes of the polar plot are defined. This pop-up appears when you click the center of the polar plot, item 4.
4	Button to call up the scale configuration pop-up: Clicking the center of the polar plot outputs the scale configuration pop-up, item 3.
5	Min and Max scale values (red pentagons): Displays the reference values of scaled surface topography properties. Min and Max values are set in the Scale configuration pop-up, item 3.
6	Color selection for the Grid, current (Now) plot and Reference plot: Clicking any of these rectangles outputs a color selection pop-up. The default colors are: Grid–gray, Now–green, Reference–cyan.

The current state of surface topography is shown as a green pentagon (item 1). It represents the last scan average of surface topography properties, and is updated at each end of scan. The reference of surface topography for the current grade is shown as a cyan pentagon (item 2). The reference data is stored for the first reel of the grade or some later manually selected reel. Reference shows the most typical surface image of the reel.

The axes of the polar plot represent scaled values. Scaling of the axes can be defined in the scale configuration pop-up (item 3), which appears when you click on the gray button (item 4) in the middle of the polar plot. In this pop-up, the mapping of surface topography properties (typical scales, explained in Section 1.5) to scale 0–100% (polar plot units) is given. This is accomplished by giving two reference values, **ScaleOpt** and **ScaleMax**, in the surface topography units, and their corresponding **MinValue** and **MaxValue** in the polar plot units, and linearly interpolating between and extrapolating beyond the reference values.

Figure 5-11 shows an example where all the reference values are given with respect to 25% and 85% polar plot values. These reference values are also shown as red pentagons on the polar plot (item 5). It is a good practice to scale all the properties so that the acceptable surface topography keeps all the tips of the polar plot within 50% value. In this way, any degradation of a surface topography property is seen as the corresponding tip going over the 50% threshold.

There are cases in which the scaled surface topography property value goes outside the 0–100% region. The surface impurity can sometimes be negative (see Section 1.5 and Section 6.2). That is why absolute values are always used for the polar plot. On the other hand, it is possible for any of the properties to have a scaled value over 100%. In this case, the plot may extend outside the bounds of the polar plot display area. To avoid this situation, the scales should be redefined as necessary. The color of **Grid**, **Now**, and **Reference** plots can be customized by using the color picker pop-up (item 6).

5.3.1.4. Configuration of cross direction positions of FotoSurf images

The FotoSurf sensor can deliver up to four images per scan from different cross direction positions for visual assessment on the **fotosurf display**. These positions are configured in the **Image Positions** pop-up (see Figure 5-12).

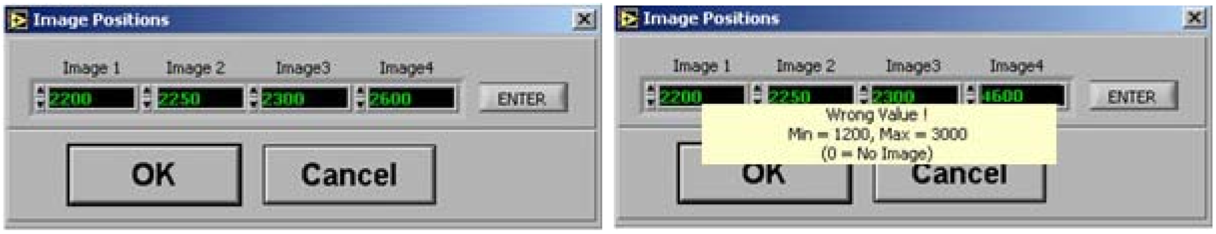


Figure 5-12 Image Positions Pop-up: Valid (left); Error Message (right)

The **Image Positions** pop-up can be called up by clicking **Pos** (item 5 in Figure 5-9). The positions are given as distances in millimeters from the low-end offset, from the smallest value to the highest. The positions are fixed relative to the scanning frame (but not to the web, if the web width or position change). If you do not want images from all four positions, enter zero as the distance for the image to be omitted. Values of cross direction positions are limited between the current web edges. The edges of the web are read from RTDR parameters:

- lower limit: *./scannerX/mss/unit info/low end offset mm*
- upper limit: *./scannerX/mss/hi other end/scan position*

If any of the values is outside the limits, an error message, as shown in Figure 5-12, is displayed. In that case, enter valid values to the invalid fields and click **ENTER** on the **Image Positions** pop-up.

5.3.1.5. Selection of cross direction position for the on-line surface image

One preconfigured image position (item 5 in Figure 5-8) at a time can be monitored on the first page of the **fotosurf display** as the on-line surface image. The drop-down menu (see Figure 5-13) is used to select the image position.

Figure 5-13 Cross Direction Position Selection Drop-down Menu

If a position is not defined (zero is entered as the position), the text *IMAGE x In Position: No Image!* is shown in that row.

5.3.1.6. Single on-line surface image

A single on-line surface image (see Figure 5-14) is derived from the original image from which the surface topography properties are computed. The only difference is that the displayed image is a JPEG compressed with a 1:10 compression ratio, whereas surface topography properties are computed from the uncompressed image. The compression is done in order to save bandwidth on the CSL. The compression factor can be controlled in the **fotosurf engineering** display (see Figure 5-28).

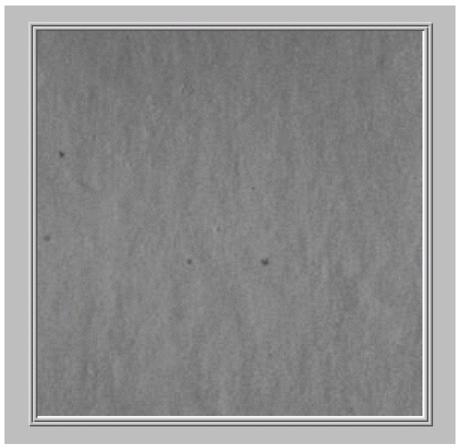


Figure 5-14 On-line Surface Image

5.3.1.7. FotoSurf properties of a single on-line surface image

Surface topography properties (see Figure 5-15) of the current on-line surface image are shown as a table on the first page of the **fotosurf display**.

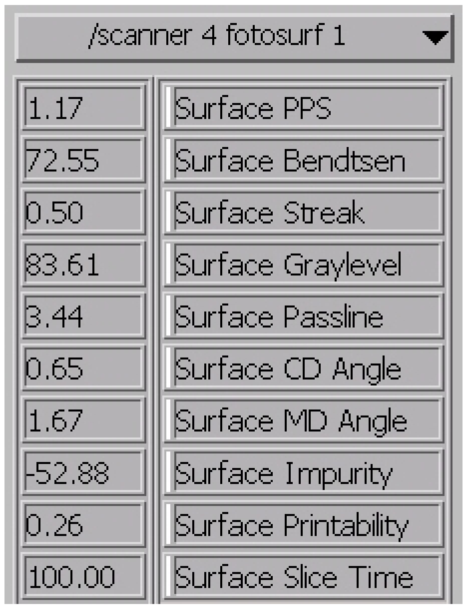


Figure 5-15 On-line Surface Image Properties

The surface topography properties and their typical ranges are described in Section 1.5 and Section 6.2.

5.3.1.8. Display of multiple on-line surface images and data

On the second page of the **fotosurf display**, on-line surface images of all defined positions (up to four) are shown side by side (see Figure 5-16). The images are updated live during scanning. Five selected surface topography properties are shown below each image. Selection of the five properties is performed in the **fotosurf engineering** display (see Subsection 5.3.5).

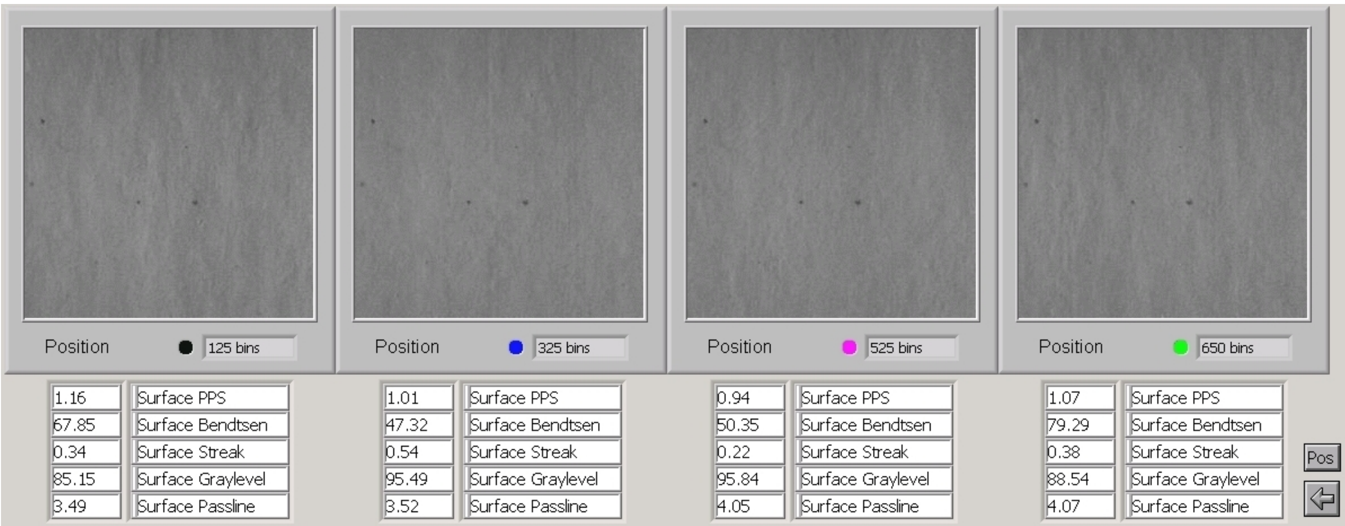


Figure 5-16 Multiple On-line Surface Images and Data

5.3.1.9. Profile and cross direction position indicator

The profile on the **fotosurf display** can show any profile defined in the system. Typically, you might want to see one of the surface topography properties plotted as a profile. When there is a position which shows abnormal topography, one of the image positions can be defined at that cross direction position with the help of the profile. This is assisted by the indicator of configured cross direction positions, which is located below the profile (item 8 in Figure 5-8, and item 3 in Figure 5-9).

Each cross direction position is marked with a colored wedge corresponding to the color of the circle to the left of the position data below the on-line image on the second page of the **fotosurf display**.

5.3.2. The fotosurf image gallery display

The **fotosurf image gallery** display (see Figure 5-17) is a tool for comparing surface images and related surface topography properties. The display has two operating modes: gallery mode, and sample mode. The mode is selected by the gallery/samples switch (item 1 in Figure 5-17). Whenever you have new data coming in, and this display is open, it is useful to click **Refresh** (item 2 in Figure 5-17), to update the display with the latest data.

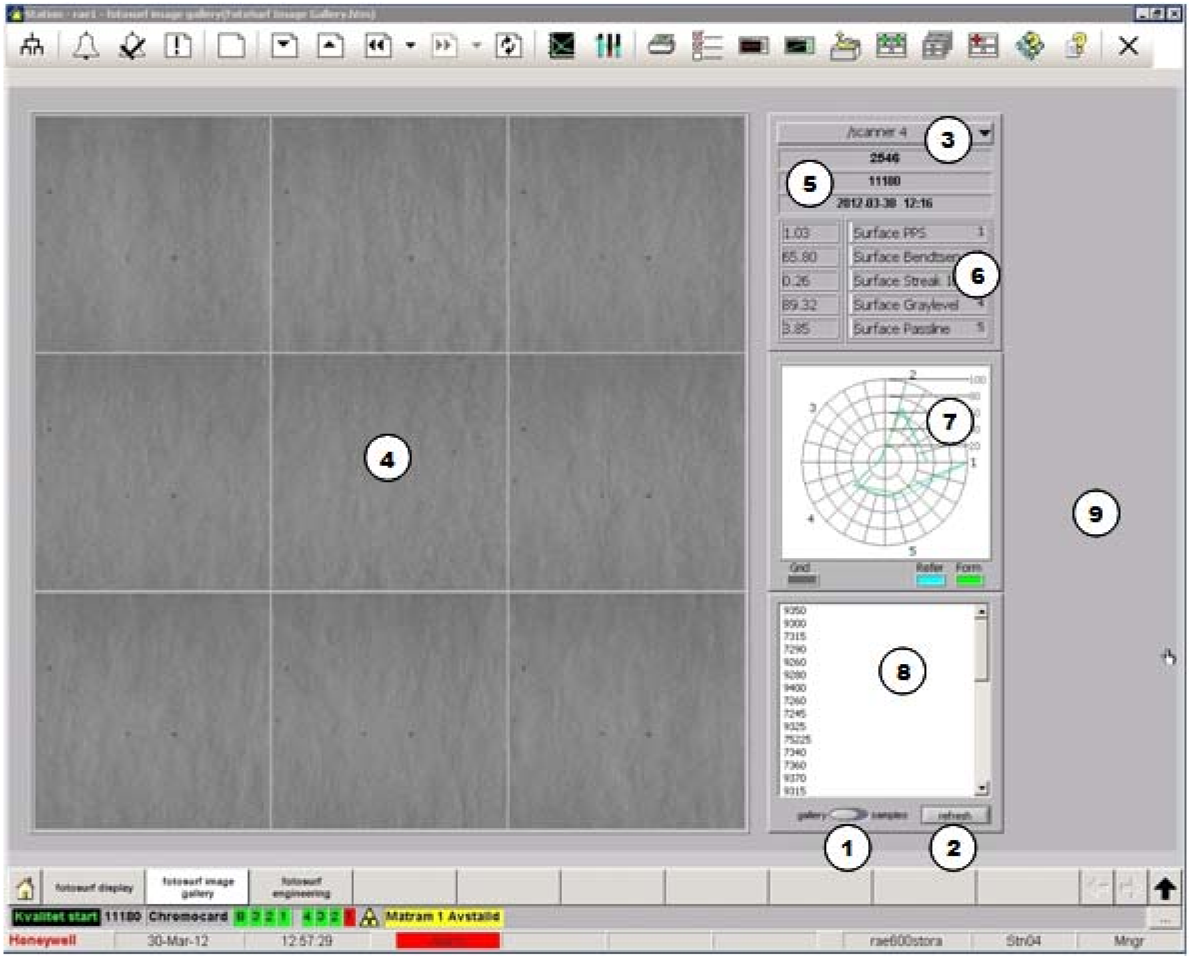


Figure 5-17 fotosurf image gallery Display

The FotoSurf sensor for this display is selected from the drop-down arrow (item 3), in the same way that it is in the **fotosurf display**.

Items 4–8 of this display are mode dependent.

Table 5-14 lists and describes items labeled in Figure 5-17.

Table 5-14 fotosurf image gallery Display Items

Items	Description
1	Mode selection: gallery mode; sample mode
2	Refresh display button
3	FotoSurf Sensor selection
4	Nine-image grid: gallery mode = reel images; sample mode = sample images

Items	Description
5	Gallery mode: reel number of the rolled over image. Sample mode: sample number of the rolled over image
6	Surface topography properties of the rolled over image
7	Polar plot of surface topography properties
8	Gallery mode: grade codes for temporary reference image selection. Sample mode: sample gallery management buttons
9	Area to restore the image selection mode

5.3.3. fotosurf image gallery display: gallery mode

In gallery mode, the **fotosurf image gallery** display shows historical data from the last eight reels. You can select gallery mode using the gallery/samples mode switch (see Figure 5-18).

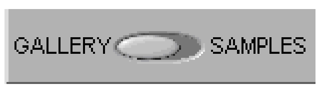


Figure 5-18 Mode Switch

5.3.3.1. Reel data collection

Historical surface topography data of reels is collected based on up to four images collected during each scan. Image positions are defined in the **fotosurf display**.

The images and the surface topography properties from all the configured positions (positions with a non-zero distance) are saved during the production of the current reel. This means, for example, that if there are four image positions configured, and the scanning frequency is two scans per minute, and the production of a reel lasts two hours, the system will save *4 * 2 * 120 = 960* surface images, and their surface topography properties, for the reel. If no image position is configured, for example, all distances are zero, no data is saved. The images are saved temporarily to the directory created at the start of the reel in the base path defined by the image data setup parameter *Log Main Folder* (see Subsection 5.1.3.1) at every end-of-scan.

When the reel is complete (and a new reel number is available), the reel data is summarized and saved. This is accomplished by selecting the most representative surface image of the reel from the saved images.

The selection criterion is: the most representative surface image of the reel is the image whose squared deviation of surface topography properties from the mean surface topography properties of all the images of the reel.

This means that, for example, one image out of 960 images will be selected to represent the entire reel. Both the surface image and its surface topography properties will be saved as the historical representation of the reel. The image and the data are saved to the path defined by image data setup parameter *Image Gallery FolderName* (see Subsection 5.1.3.1). After the history data is archived, the temporary images and data are removed.

5.3.3.2. Reel images

The most representative images of the last eight reels are displayed on the edge slots of the nine-slot image grid (item 4 on Figure 5-17). When a reel is completed, its most representative image is placed into the upper left corner of the grid (see Figure 5-19). Images of older reels are moved forward clockwise around the center slot, and the oldest image is discarded.

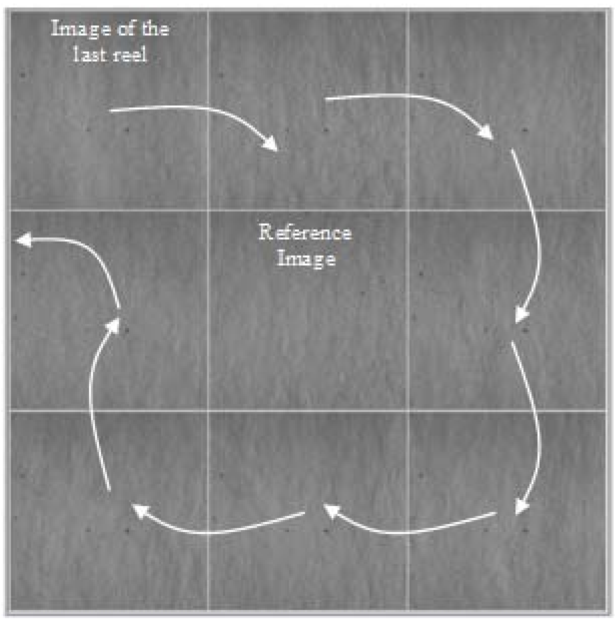


Figure 5-19 Reel History Images

The center slot is reserved for the reference image of the current paper grade. The reference image is an image that is selected to represent typical surface topography of the grade (see Subsection 5.3.3.3). When there is a long production run (several reels of one paper grade), the reference image is ideally located in the center of the grid to facilitate visual comparison.

At the grade change, the reference image is changed immediately, which means that from then on the relevant comparison can be done only between the reference image and the new reel images.

Any image on the grid can be selected for inspection by rolling the mouse pointer over it (without clicking). Items 5–7 in Figure 5-17 are updated and show data for the selected image. If you click any of the images, the reference image selection pop-up appears (see Subsection 5.3.3.3). After closing the pop-up, you have to click somewhere in the empty gray area (item 9 on the right-hand side of the **fotosurf image gallery** display), to restore image selection mode. If you do not click there, selection mode remains disabled.

5.3.3.3. Paper grade reference image

Surface topography may vary quite a lot between different paper grades produced on the same paper machine. For example, a board machine may be used to produce both uncoated and coated paper where the degree of roughness, one to the other, is very different. That is why the optimum surface topography of these grades will look very different with respect to each other. Surface topography of these grades should be assessed individually. To facilitate the visual assessment, the reference image of the current grade is shown in the center slot of the image grid (see Figure 5-19).

At the first occurrence of a paper grade, for example, when the FotoSurf sensor is newly deployed, there are no reference images saved in the system, and the center slot is blank. At the end of the first reel of each grade, the most representative image of the reel will be automatically saved as the reference image of the grade. Subsequent reels of the same grade will *not* automatically change the reference image.

The reference image of a paper grade can also be selected manually. Any image currently shown in the image gallery can be saved as the reference image using the **File Dialog** dialog (see Figure 5-20), which is called up when you click the image. In the **File Dialog** dialog, the name of the image is given in the form *grade_code.jpg*, where *grade_code* is the name of the grade code you want to save.

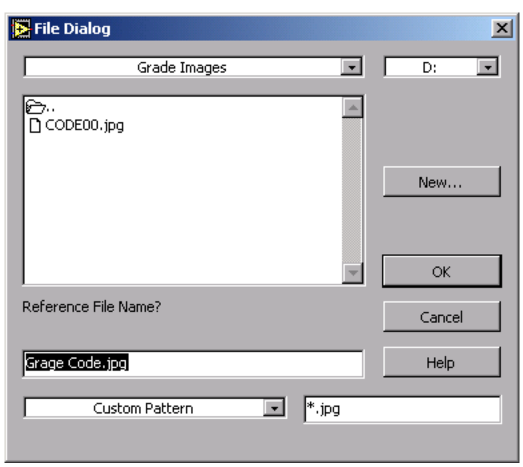


Figure 5-20 File Dialog, Dialog

For example, if you want to save the selected image as the reference image of grade CODE42, you name the image *CODE42.jpg* in the dialog. You can type the name or select any of the existing reference images. Note that you can replace the reference image of any grade in the **File Dialog** dialog. Be careful not to overwrite any reference image by accident. Click **OK** to save the image and close the dialog. To return to image selection mode after closing the dialog, follow the instructions in Subsection 5.3.3.2.

5.3.3.4. The selected image reel number

When the mouse pointer is rolled over the image grid, the reel number of each rolled-over image is shown in item 5 in the **fotosurf image gallery** display. The reel number is updated as the mouse pointer is rolled over the images. When the reference image (on the center of the image grid) is rolled over, the reel number field shows the text *Reference*.

5.3.3.5. Surface topography properties of the rolled-over image

When the mouse pointer is rolled over the image grid, the surface topography properties of the rolled-over image are shown in the surface topography properties area of the **fotosurf image gallery** display (item 6 in Figure 5-17). Typical data is shown in Figure 5-21.

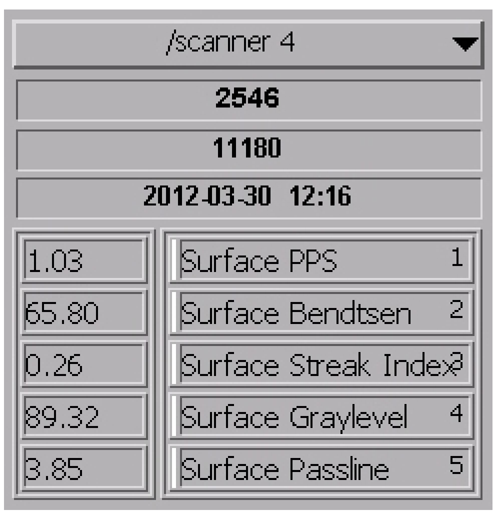


Figure 5-21 Surface Topography Properties

5.3.3.6. Polar plot of surface topography properties

Surface topography properties of the rolled-over image are shown as a polar plot (see Figure 5-22) on the **fotosurf image gallery** display. This plot is related to the polar plot on the **fotosurf display**. The differences are that last scan data is replaced by data of the rolled-over image, and the history reel data is replaced by the reference image data. The scales of the axes that are defined on the **fotosurf display** apply to this polar plot on the **fotosurf image gallery** display. If you need to change the scales, you can do so only on the **fotosurf display**.

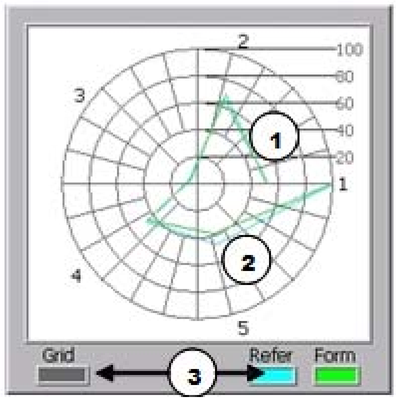


Figure 5-22 Polar Plot of Surface Topography Properties

Table 5-15 lists and describes items labeled in Figure 5-22.

Table 5-15 Polar Plot Items

Item	Description
1	Surface topography properties of the rolled over image (green pentagon). This plot is updated as mouse pointer is moved over the images.
2	Surface topography properties of the reference Image (cyan pentagon): represents current grade
3	Color selection buttons for the Grid, reference image pentagon, and rolled over image pentagon. Clicking on the button outputs the color selection pop-up. Grid: color of the polar plot grid, default color gray. Refer: color of the of the reference image, default color cyan. Form: color of the rolled over image, default color green.

5.3.3.7. Temporary reference image selection

There is another method to select the reference image to the image grid on the **fotosurf image gallery** display. The existing reference images are shown as a list (see Figure 5-23) by their grade codes. Double-clicking any code in this list will copy the reference image of that grade to the center slot of the image grid. This selection is temporary, and is replaced at the next grade change by the reference image of the new grade. This function allows comparison between the gallery images and the reference image of any grade whenever needed.

Figure 5-23 Temporary Reference Images List

5.3.4. fotosurf image gallery display: sample mode

In sample mode, the **fotosurf image gallery** display shows sample measurement data. Sample mode is selected by the mode switch (see Figure 5-18).

5.3.4.1. Sample data collection

Detailed instructions on performing sample measurements are provided in Section 4.5.

5.3.4.2. Sample images

Sample measurement images are shown in the image grid of the **fotosurf image gallery** display. Sample images are arranged in the measurement order, starting from upper left corner and ending at the lower right corner, as shown in Figure

5-24. This arrangement differs from the arrangement in gallery mode (see Figure 5-19).

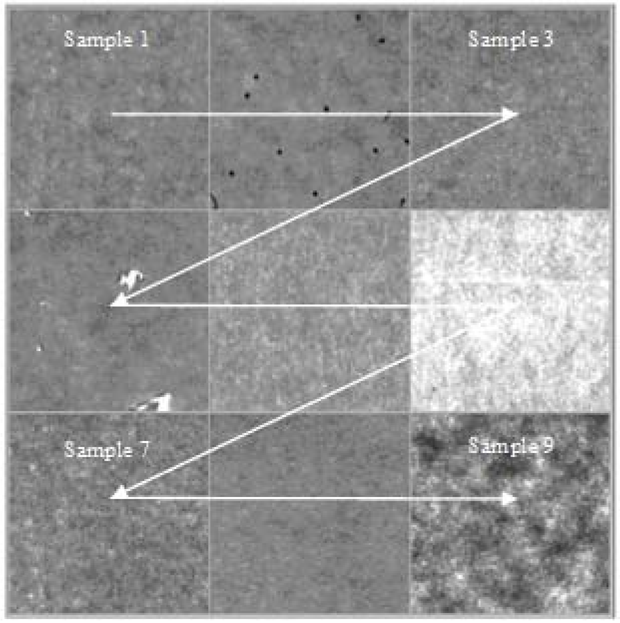


Figure 5-24 Arrangement of Sample Images

There is no reference image in sample mode, and up to nine sample measurement images can be displayed at a time. If you need to view more samples, save the samples and clean the sample gallery (see Subsection 5.3.4.5).

Using the image grid in sample mode is similar to gallery mode (see Subsection 5.3.3.2). For example, images on the grid are selected for inspection by rolling the mouse pointer over them without clicking.

5.3.4.3. FotoSurf properties of the rolled-over image

When the mouse pointer is rolled over the image grid, the FotoSurf properties and the sample number (not the reel number) of the rolled-over image are shown in the surface topography properties area (see Figure 5-21) of the display, items 5 and 6 in the **fotosurf image gallery** display (see Figure 5-17). The order of sample images in the sample gallery is shown in Figure 5-24.

5.3.4.4. Polar plot of surface topography properties

Surface topography properties of the rolled-over image are shown in a polar plot (item 7 in the **fotosurf image gallery** display). Polar plot details are shown in Figure 5-11. This plot is related to the polar plot on the **fotosurf display** (see Subsection 5.3.1.3). The differences are that last scan data is replaced by data of the rolled-over image, and the history reel data is replaced by the reference image data. The scales of the axes that are defined on the **fotosurf display** (see Figure 5-8) apply to this polar plot as well. If you need to change the scales, you can do so only on the **fotosurf display**.

5.3.4.5. Sample gallery management

In sample mode, the **fotosurf image gallery** display contains sample gallery management buttons (see Figure 5-25), instead of a temporary reference image selection list. When the sample gallery is full, a notification appears above the buttons.

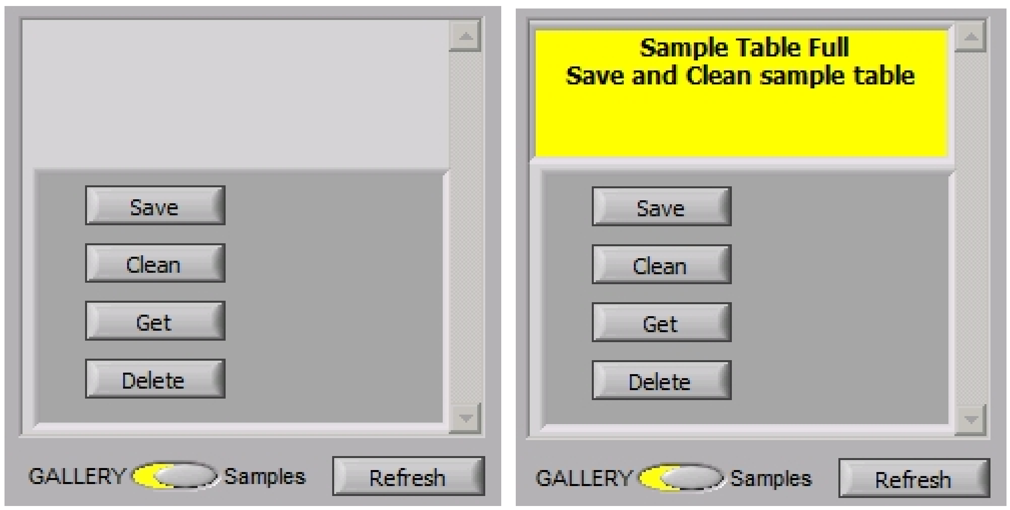


Figure 5-25 Sample Gallery Management Buttons (left); Gallery Full (right)

Click **Save** to save the images currently shown in the gallery. Images are saved to the path *Image Gallery\Samples Saved*, which is defined by the image data setup parameter (see Subsection 5.1.3.1). The file name format is: *Samples YY_MM_DD_hh_mm*, where YY = year, MM = month, DD = day, hh = hour and mm = minutes.

The save is confirmed in the **Boolean Panel** pop-up shown in Figure 5-26.

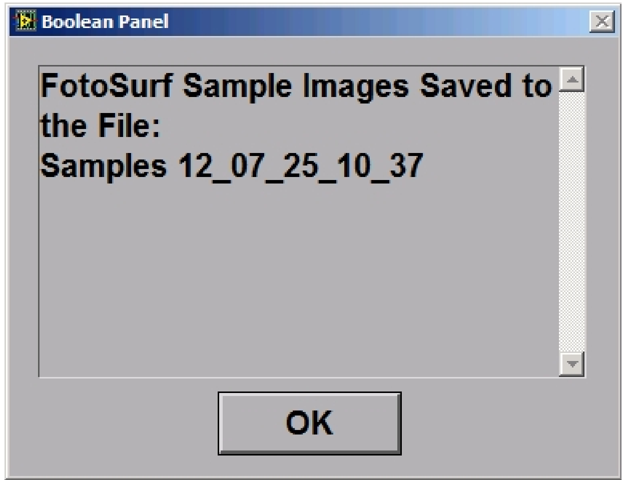


Figure 5-26 Boolean Panel Pop-up (sample save)

The saved samples can later be reloaded into the gallery by clicking **Get**, which brings up the **File Dialog** dialog (see Figure 5-27), where the sample directory can be selected.

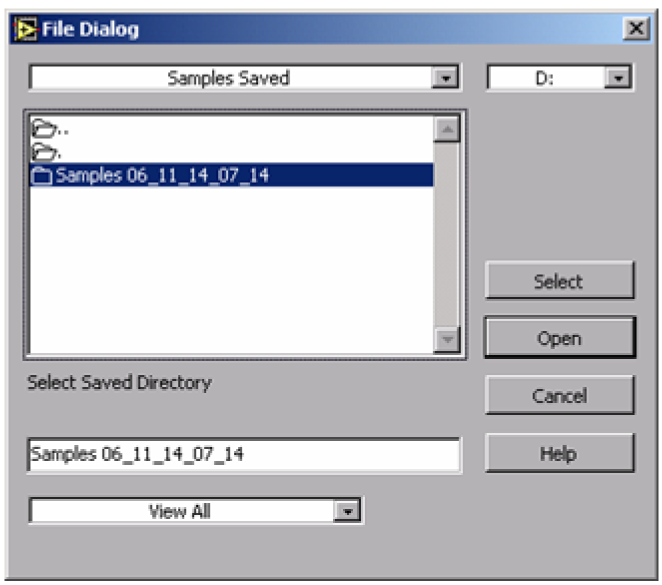


Figure 5-27 File Dialog, Dialog

If you want to do more than nine sample measurements, the gallery has to be cleaned after saving the current gallery contents. Cleaning is performed by clicking **Clean**. If you want to delete one of the saved galleries, click **Delete**.

5.3.5. The fotosurf engineering display

The **fotosurf engineering** display (see Figure 5-28) is a tool for configuring and diagnosing the FotoSurf sensor. The sensor to be configured or diagnosed is selected in this display from the drop-down arrow (item 1) in the same way it is selected in the **fotosurf display** (see Section 5.3.1).

Items 2 and 3 handle FotoSurf configuration through customizing and uploading configuration parameters. States of FotoSurf can be traced using items 4–6. CSL data is summarized in item 7. Advanced diagnostic and configuration of sensor operation can be performed using the controls under item 8, the **Miscellaneous** and **Definitions** sub-tabs.

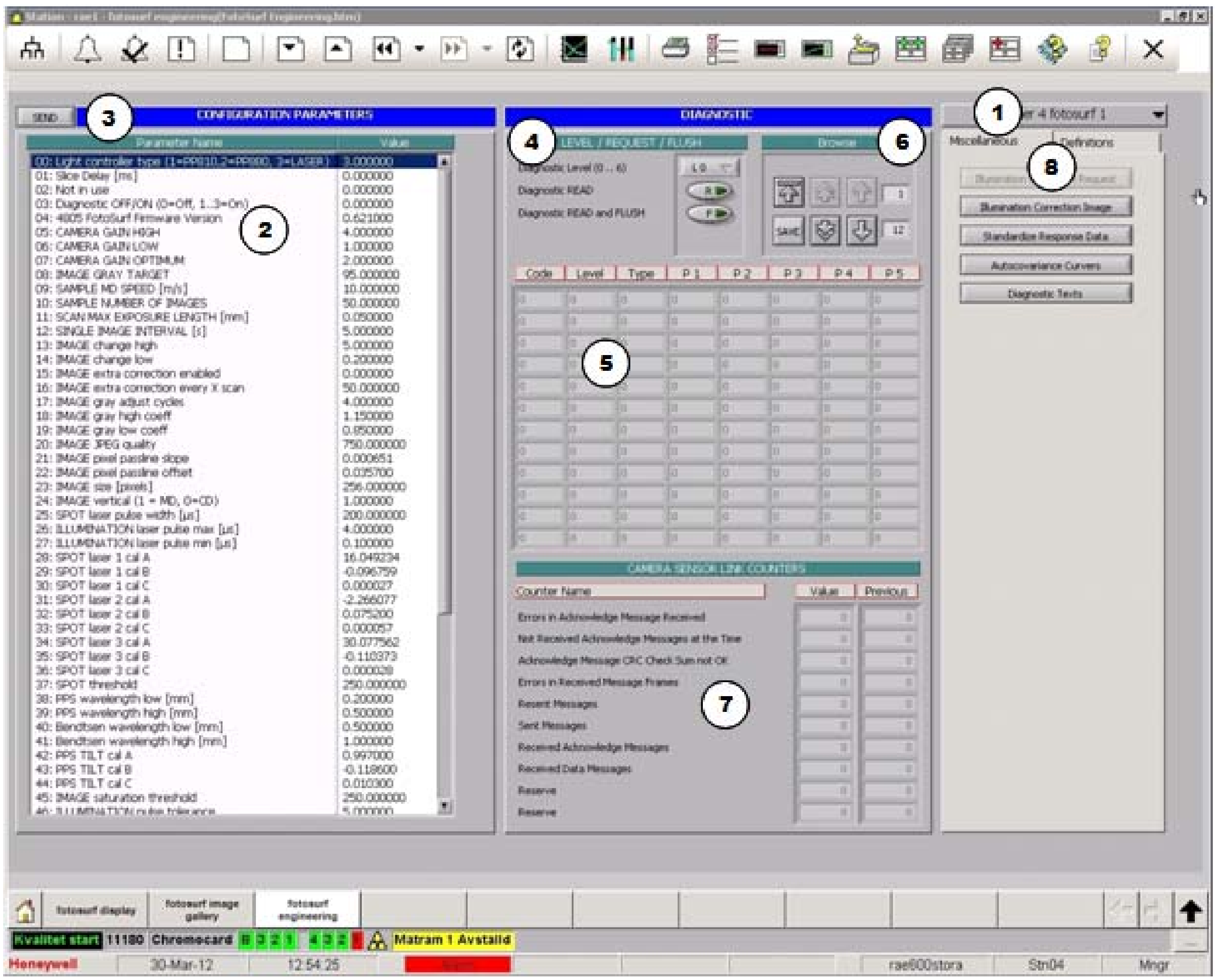


Figure 5-28 fotosurf engineering Display

Table 5-16 lists and describes items labeled in Figure 5-28.

Table 5-16 fotosurf engineering Display Items

Item	Description
1	FotoSurf sensor selection drop-down arrow
2	Configuration parameters
3	The configuration parameters **SEND** button
4	Diagnostic **LEVEL**, **REQUEST**, and **FLUSH** controls
5	Diagnostic data
6	Diagnostic **Browse** directional buttons and the **SAVE** button
7	CSL counters
8	**Miscellaneous** and **Definitions** sub-tabs

The **Miscellaneous** and **Definitions** sub-tabs are shown in Figure 5-29.

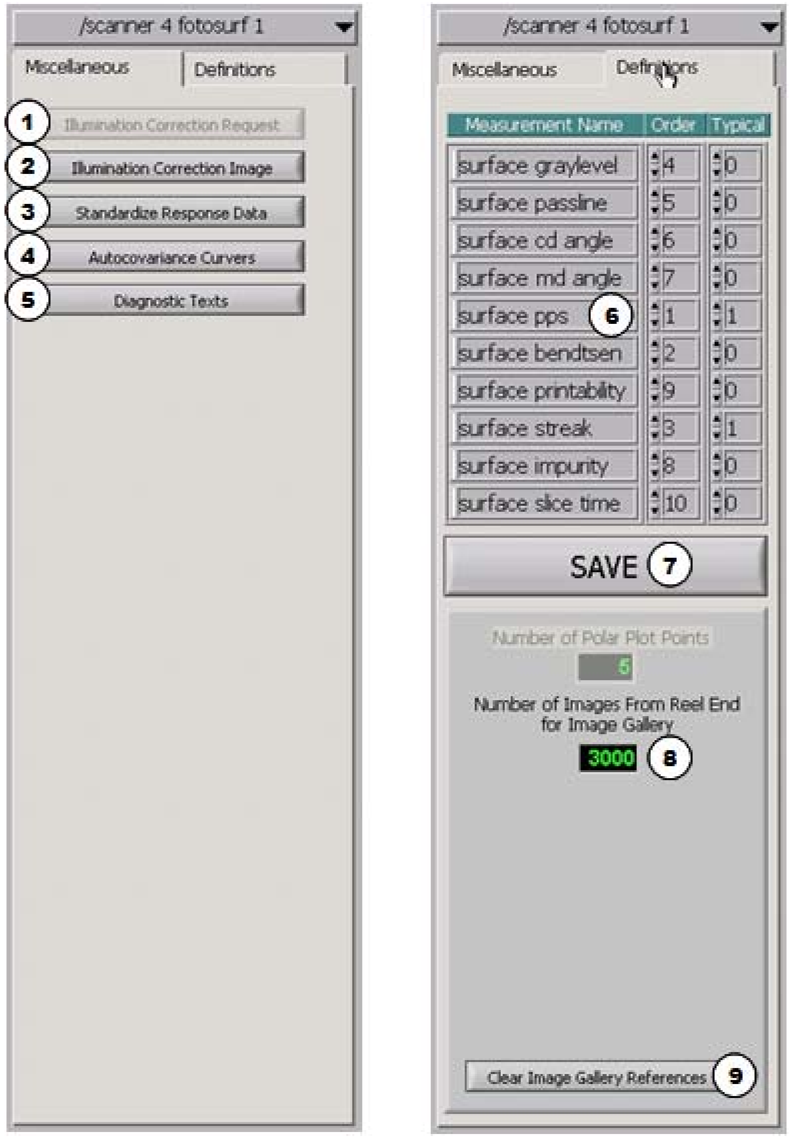


Figure 5-29 fotosurf engineering Display: Miscellaneous and Definitions Sub-tabs

Table 5-17 lists and describes items labeled in Figure 5-29.

Table 5-17 fotosurf engineering Display: Miscellaneous and Definitions Sub-tabs Items

Item	Description
1	**Illumination Correction Request** button
2	**Illumination Correction Image** button

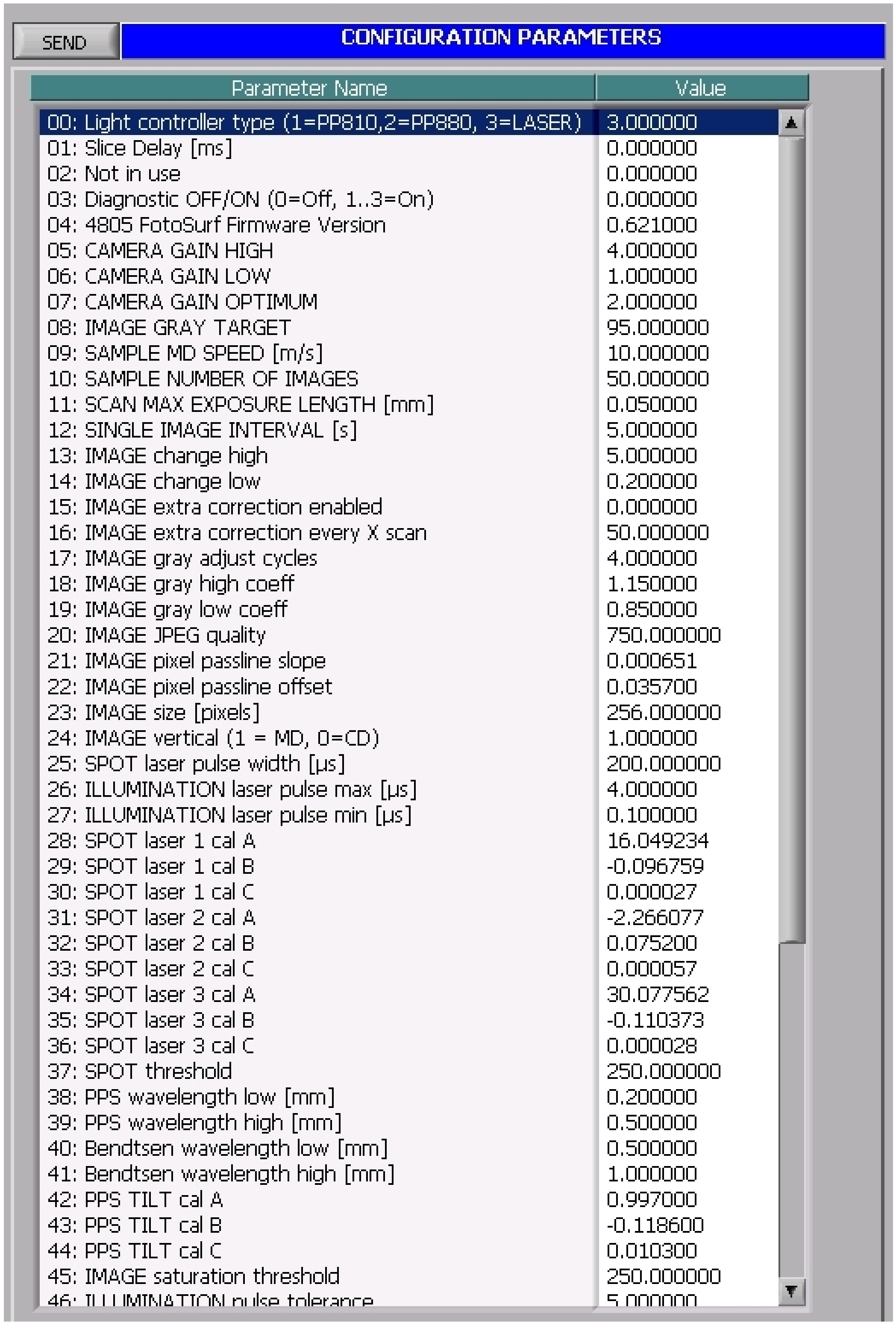
Item	Description
3	**Standardize Response Data** button
4	**Autocovariance Curves** button
5	**Diagnostic Texts** button
6	**Measurement / Order / Typical** image criterion definition table
7	The definitions **SAVE** button
8	**Number of Images From Reel End for Image Gallery** to typical Image selection
9	**Clear Image Gallery References** button

5.3.5.1. Configuration parameters

FotoSurf sensor functionality can be adapted and customized through the configuration parameters on the **fotosurf engineering** display (see Figure 5-28). Configuration parameters are sent to the sensor automatically during FotoSurf sensor startup. When FotoSurf is already running, configuration parameters can be sent to the sensor by clicking **SEND**. This needs to be done after making changes to the parameters.

A closer look at the configuration parameters is shown in Figure 5-30. There are 64 parameters that can be configured in this window. The first five parameters on the list are not shown when you call up the **fotosurf engineering** display, but you can scroll up the list to show all of them. The value of any parameter, except 01 or 04, can be changed by double-clicking the value field, which launches a pop-up in which the new value can be entered.

The FotoSurf configuration parameters are divided into four categories, and are described in detail in Subsections 5.3.5.2 through 5.3.5.4.



SEND CONFIGURATION PARAMETERS

Parameter Name	Value
00: Light controller type (1=PP810,2=PP880, 3=LASER)	3.000000
01: Slice Delay [ms]	0.000000
02: Not in use	0.000000
03: Diagnostic OFF/ON (0=Off, 1..3=On)	0.000000
04: 4805 FotoSurf Firmware Version	0.621000
05: CAMERA GAIN HIGH	4.000000
06: CAMERA GAIN LOW	1.000000
07: CAMERA GAIN OPTIMUM	2.000000
08: IMAGE GRAY TARGET	95.000000
09: SAMPLE MD SPEED [m/s]	10.000000
10: SAMPLE NUMBER OF IMAGES	50.000000
11: SCAN MAX EXPOSURE LENGTH [mm]	0.050000
12: SINGLE IMAGE INTERVAL [s]	5.000000
13: IMAGE change high	5.000000
14: IMAGE change low	0.200000
15: IMAGE extra correction enabled	0.000000
16: IMAGE extra correction every X scan	50.000000
17: IMAGE gray adjust cycles	4.000000
18: IMAGE gray high coeff	1.150000
19: IMAGE gray low coeff	0.850000
20: IMAGE JPEG quality	750.000000
21: IMAGE pixel passline slope	0.000651
22: IMAGE pixel passline offset	0.035700
23: IMAGE size [pixels]	256.000000
24: IMAGE vertical (1 = MD, 0=CD)	1.000000
25: SPOT laser pulse width [µs]	200.000000
26: ILLUMINATION laser pulse max [µs]	4.000000
27: ILLUMINATION laser pulse min [µs]	0.100000
28: SPOT laser 1 cal A	16.049234
29: SPOT laser 1 cal B	-0.096759
30: SPOT laser 1 cal C	0.000027
31: SPOT laser 2 cal A	-2.266077
32: SPOT laser 2 cal B	0.075200
33: SPOT laser 2 cal C	0.000057
34: SPOT laser 3 cal A	30.077562
35: SPOT laser 3 cal B	-0.110373
36: SPOT laser 3 cal C	0.000028
37: SPOT threshold	250.000000
38: PPS wavelength low [mm]	0.200000
39: PPS wavelength high [mm]	0.500000
40: Bendtsen wavelength low [mm]	0.500000
41: Bendtsen wavelength high [mm]	1.000000
42: PPS TILT cal A	0.997000
43: PPS TILT cal B	-0.118600
44: PPS TILT cal C	0.010300
45: IMAGE saturation threshold	250.000000
46: ILLUMINATION pulse tolerance	5.000000

Figure 5-30 CONFIGURATION PARAMETERS Display

Table 5-18 lists and describes the configuration parameters shown in Figure 5-30. The parameters are divided into four categories, which are described in Subsections 5.3.5.2 to 5.3.5.4.

Table 5-18 FotoSurf Configuration Parameters

Number	Name	Value	Range	Note
0	Light controller type (1=PP810,2=PP880, 3=LASER)	3		Always use value 3 if not instructed otherwise
1	Slice Delay [ms]	0		Copied from MSS Job Set IO Setup
2	Not in use			Future use
3	Diagnostic OFF/ON (0=Off, 1…3=On)	0		Extra diagnostics: 0 = disabled, 1 = VGA only, …)
4	4805 FotoSurf Firmware version	N/A	N/A	Updated by FotoSurf
5	CAMERA GAIN HIGH	4	1–15	
6	CAMERA GAIN LOW	1	1–15	
7	CAMERA GAIN OPTIMUM	2	1–15	
8	IMAGE GRAY TARGET	95	0–255	
9	SAMPLE MD SPEED [m/s]	10	0–35.0	
10	SAMPLE NUMBER OF IMAGES	10	0–50	
11	SCAN MAX EXPOSURE LENGTH [mm]	0.05	0.05–0.5	
12	SINGLE IMAGE INTERVAL [s]	5	5–20	
13	IMAGE change high	5	2–10	
14	IMAGE change low	0.2	0.1–0.5	
15	IMAGE extra correction enabled	0	0 or 1	
16	IMAGE extra correction enabled every X scan	50	1–100	
17	IMAGE gray adjust cycles	4	1–10	
18	IMAGE gray high coeff	1.15	1–2	
19	IMAGE gray low coeff	0.85	0–1	
20	IMAGE JPEG quality	750	0–1000	
21	IMAGE pixel passline slope	0.000651		Fixed by design
22	IMAGE pixel passline offset	0.035700		Fixed by design
23	IMAGE size [pixels]	256	256, 512, or 1024	
24	IMAGE vertical (1=MD, 0=CD)	1	0 or 1	
25	SPOT laser pulse width [µs]	200	100–1000	
26	ILLUMINATION laser pulse max [µs]	5	0.1-5	
27	ILLUMINATION laser pulse min [µs]	0.1	0.1-5	
28	SPOT laser 1 cal A	SPU	-20–20	Specific per unit
29	SPOT laser 1 cal B	SPU	-20–20	Specific per unit
30	SPOT laser 1 cal C	SPU	-20–20	Specific per unit
31	SPOT laser 2 cal A	SPU	-20–20	Specific per unit
32	SPOT laser 2 cal B	SPU	-20–20	Specific per unit

Number	Name	Value	Range	Note
33	SPOT laser 2 cal C	SPU	-20–20	Specific per unit
34	SPOT laser 3 cal A	SPU	-20–20	Specific per unit
35	SPOT laser 3 cal B	SPU	-20–20	Specific per unit
36	SPOT laser 3 cal C	SPU	-20–20	Specific per unit
37	SPOT threshold	250	0-255	Graylevel threshold for spot laser
38	PPS wavelength low [mm]	0.2	0.05–7.5	
39	PPS wavelength high [mm]	0.5	0.05–7.5	
40	Bendtsen wavelength low [mm]	0.5	0.05–7.5	
41	Bendtsen wavelength high [mm]	1.0	0.05–7.5	
42	PPS TILT cal A	0.997		
43	PPS TILT cal B	-0.1186		
44	PPS TILT cal C	0.0103		
45	IMAGE saturation threshold	250		
46	ILLUMINATION pulse tolerance	5		
47	PPS PASSLINE cal A	0.914		
48	PPS PASSLINE cal B	0.1322		
49	PPS PASSLINE cal C	-0.028		
50	PPS PASSLINE cal D	0.001		
51	ROI left	SPU		Specific per unit
52	ROI up	SPU		Specific per unit
53	ROI size	370		
54	SPOT left vertical border	SPU		Specific per unit
55	BENDTSEN TILT cal A	0.997		
56	BENDTSEN TILT cal B	-0.1186		
57	BENDTSEN TILT cal C	0.0103		
58	BENDTSEN PASSLINE cal A	0.914		
59	BENDTSEN PASSLINE cal B	0.1322		
60	BENDTSEN PASSLINE cal C	-0.028		
61	BENDTSEN PASSLINE cal D	0.001		
62	Reset Interval [min]	9999999		
63	Web Angle	0.0		Specific per unit
64	TBD			Future use

5.3.5.2. Grade and scanner adaptation parameters

This subsection describes in detail some of the parameters listed in Table 5-18.

ATTENTION

> Configuration parameters 6–13 may need to be adjusted in order to make FotoSurf work properly with paper grades that have high light absorbency.

5: CAMERA GAIN HIGH

The maximum camera signal amplification factor to be used. Making this parameter higher amplifies the signal (doubling the value doubles the signal), but also adds image noise.

6: CAMERA GAIN LOW

The minimum camera signal amplification factor to be used. There is usually no need to change from the default.

7: CAMERA GAIN OPTIMUM

The optimum (control target) camera signal amplification factor to be used. Assign this parameter a value between CAMERA GAIN LOW and CAMERA GAIN HIGH. Preferably, these ratios should be equal:

$$\frac{\text{CAMERA GAIN HIGH}}{\text{CAMERA GAIN OPTIMUM}} = \frac{\text{CAMERA GAIN OPTIMUM}}{\text{CAMERA GAIN LOW}}$$

8: IMAGE GRAY TARGET

The goal for the mean graylevel of the image. This may be lowered if light absorbency is too high (halving the value doubles the signal).

9: SAMPLE MD SPEED [m/s]

The virtual machine direction speed in meters per second to control light output in sample measurement. Make this value close to the actual machine direction speed of the paper machine that produced the paper.

10: SAMPLE NUMBER OF IMAGES

The number of images to be used in sample measurement averaging.

11: SCAN MAX EXPOSURE LENGTH [mm]

The length that the web can move in the machine direction during image exposure–the default is approximately one pixel. This parameter fixes the amount of motion blur for all machine direction speeds of the web. If an acceptable signal level cannot be reached, and larger machine direction blur is tolerable, this parameter can be made larger (doubling this parameter doubles the signal level).

12: SINGLE IMAGE INTERVAL [s]

The on-line image update interval in single mode for the **fotosurf display**.

24: IMAGE vertical (1=MD, 0=CD)

The orientation of the FotoSurf sensor with respect to the machine direction. It is strongly recommended that the FotoSurf sensor always be mounted in a way that the machine direction coincides with the vertical direction of the image. However, if the sensor can only be mounted in the perpendicular direction (cross direction coincides with the vertical direction of the image), this parameter must be adjusted.

5.3.5.3. FotoSurf reporting parameters

This subsection describes in detail some of the parameters listed in Table 5-18.

ATTENTION

Parameters 2, 5, 32, and 35 are used for reporting, not for configuration.

1: Slice Delay [ms]

This parameter value is automatically copied from **MSS Job Set IO Setup**.

4: FotoSurf Firmware version

The version number of the FotoSurf firmware. This parameter is received from FotoSurf at every standardize. The value of this parameter can not be edited.

5.3.5.4. FotoSurf internal parameters

This subsection describes in detail some of the parameters listed in Table 5-18.

ATTENTION

Parameters 1, 14–23, 25–30, and 33 control internal processing of the FotoSurf sensor. In normal conditions these parameters should not be changed. Changes to them might be necessary only in special situations such as temporary fixes in the case of hardware malfunction, upgrade of hardware, or in-depth troubleshooting.

0: Light controller type (1=PP810, 2=PP880)

This parameter tells FotoSurf which strobe controller it has. Always use a value of 1, if not instructed otherwise. A wrong value might damage the FRIM. The default value of this parameter is set at the build of the RTDR to the record (*/scannerX/mss/ssX FotoSurf X processor/configuration parameters/cnfg parameters: index 0 = Light controller type*).

13: IMAGE change high

The maximum relative change of graylevel in one light control step. This parameter limits the change in the case of a very large absorbency decrease of paper (the required amount of light intensity increases a lot) to reduce oscillation (*hunting*) in light control. For example, if IMAGE change high = 3, one light control step can triple the light intensity at maximum.

14: IMAGE change low

The minimum relative change of graylevel in one light control step. This parameter limits the change in the case of very large absorbency decrease of paper (required amount of light intensity increases a lot) to reduce oscillation (hunting) in light control. For example, if IMAGE change low = 0.5, one light control step can halve the light intensity at minimum. Usually, this rule should be employed:

$$\text{IMAGE change low} = \frac{1}{\text{IMAGE change high}}$$

15: IMAGE extra correction enabled

Zero = disable (default), 1 = enable extra illumination correction updates. This parameter must be set to 1 (enabled) if the illumination correction image has to be updated more regularly than once between two standardizations. This would be needed only in the case of extremely rapid dirt accumulation.

16: IMAGE extra correction enabled every X scan

The number of scans between extra illumination correction updates. This parameter only has an effect if IMAGE extra correction enabled = 1. For example, if IMAGE extra correction enabled every X scan = 3, the illumination correction image will be recalculated at the end of every third scan.

17: IMAGE gray adjust cycles

The upper limit of the number of graylevel adjustment cycles in sample measurement, and in entering single point mode. If the current graylevel does not meet validity limits defined by IMAGE GRAY TARGET, IMAGE change high, and IMAGE change low, up to this many control steps are performed.

18: IMAGE gray high coeff

The upper relative validity limit of mean graylevel. If mean graylevel of a scan exceeds this limit, a light control action is performed at the end of scan. For example, if IMAGE GRAY TARGET = 128 and IMAGE change high = 1.15, the highest valid mean graylevel is 128 * 1.15 = 147.2. If the dead zone of light control has to be widened. or narrowed, change the value of this parameter.

19: IMAGE gray low coeff

The lower relative validity limit of mean graylevel. If mean graylevel of scan is below this limit, a light control action is performed at end-of-scan. For example, if IMAGE GRAY TARGET = 128 and IMAGE change low = 0.85, the lowest valid mean graylevel is 128 * 0.85 = 108.8. If the dead zone of light control has to be widened, or narrowed, change the value of this parameter.

20: IMAGE JPEG quality

The JPEG quality of images sent from FotoSurf to Experion MX. The JPEG compression is done to save CSL bandwidth and storage space on the QCS server. The default value 520 means 1:10 compression, which is still not visually noticeable in surface images. Higher values mean higher quality and less compression. Lower values mean lower quality and more compression. Using very high quality may congest the CSL.

21: IMAGE pixel passline slope

The sensor determines pixel size in the surface image. Due to optical reasons, pixel size varies with web passline. Pixel size depends linearly on passline. The slope and offset of the linear correlation is determined for the sensor geometry in the factory, and does not vary between sensors:

pixel size[mm] = (IMAGE pixel passline slope) x passline[mm] + (IMAGE pixel passline offset)

22: IMAGE pixel passline offset

See 21: IMAGE pixel passline slope.

23: IMAGE size [pixels]

The size of the image in pixels. The surface image has equal dimensions in both the machine direction and the cross direction. The default value is 256, which should always be used in normal operation of the sensor. However, if higher resolution images are needed, for example, when making special reports, this value can be changed temporarily to 512 (the image size must be a power of 2).

Higher values are not recommended. Notice that when you change the IMAGE size parameter, you must also scale the IMAGE pixel size parameter in order to get the right floc size measurement results.

25: SPOT laser pulse width [µs]

The maximum allowed current supplied by the light pulse driver (specific to the pulse driver type).

26: ILLUMINATION laser pulse max [µs]

The maximum pulse length of the illumination laser for illumination control.

27: ILLUMINATION laser pulse min [µs]

The minimum pulse length of the illumination laser for illumination control.

28–30: SPOT laser 1 calibration parameters

The second order polynomial coefficients for distance calibration of spot laser 1. This parameter is tuned during factory calibration.

31–33: SPOT laser 2 calibration parameters

The second order polynomial coefficients for distance calibration of spot laser 2. This parameter is tuned during factory calibration.

34–36: SPOT laser 3 calibration parameters

The second order polynomial coefficients for distance calibration of spot laser 3. This parameter is tuned during factory calibration.

37: SPOT threshold

The intensity (graylevel) threshold for laser spot thresholding.

38-39: PPS wavelength interval [mm]

The lower and higher boundaries for spatial wavelength in PPS measurement.

40-41: Bendtsen wavelength interval [mm]

The lower and higher boundaries for spatial wavelength in Bendtsen measurement.

42-44: PPS TILT calibration

The second order polynomial calibration coefficients for tilt compensation of PPS.

45: IMAGE saturation threshold

The limit for illumination saturation (graylevel).

46: ILLUMINATION pulse tolerance

The line speed checkup: if pulse width over maximum allowed for pulse length, set to maximum minus tolerance.

47–50: PPS PASSLINE calibration

The third order polynomial calibration coefficients for passline compensation of PPS.

51–53: ROI definition

The region of interest for surface topography measurement (in pixels). These parameters are tuned during factory calibration.

54: SPOT left vertical border

The vertical centerline (in pixels) between left side laser spots. This parameter is tuned during factory calibration.

55–57: BENDTSEN TILT calibration

The second order polynomial calibration coefficients for tilt compensation of Bendtsen.

58–61: BENDTSEN PASSLINE calibration

The third order polynomial calibration coefficients for passline compensation of Bendtsen.

62: Reset Interval [min]

If the firmware update is suspected to be unstable in the longer term, this parameter may be used. It defines the interval between automatic reboots of the sensor. Typically, this is set to very high value, for example, 9999999 for a stable firmware.

63: Web Angle [degrees]

The angle between the vertical direction of the surface image and the machine direction of the web.

64: TBD

For future use.

5.3.5.5. Illumination correction image

Clicking on **Illumination Correction Image** on the **fotosurf engineering** display (item 8 in Figure 5-28), calls up the **Illumination Correction Data** pop-up (see Figure 5-31).

Figure 5-31 Illumination Correction Data Pop-up

The current illumination field is shown as an image in this pop-up. The illumination field is the average spatial distribution of light coming to the CCD sensor on the camera. The darker areas in this image receive less light than the lighter areas. Uneven light distribution is caused by several effects, such as unevenness of light source, or vignetting of the lens, and dirt accumulation on the FSMM window.

The FotoSurf sensor automatically compensates for the unevenness by using illumination correction data to get high-quality images and data. This helps to reduce maintenance work in the case of paper grades that produce dust and dirt. Manual cleaning of the window is needed less often.

The amount of correction that can be automatically made by the FotoSurf sensor is limited. Graylevel of the dark areas can be 50% of the lighter areas, for example, 200% compensation in signal level is maximum. If this level is exceeded (correction is saturated), the images and surface topography characters will not be fully corrected. Percentage of the saturated area is shown in the **Illumination Correction Data** pop-up. If this value deviates from zero, the FSMM window should be cleaned manually as soon as possible. If a corner of the illumination correction image is dark, and the saturated area value is high even after cleaning the window, there might be a light source failure, in which case you should consult service.

5.3.5.6. Diagnostic texts

Diagnostic messages sent by the Surface Topography sensor can be read by clicking **Diagnostic Texts** under the **Miscellaneous** sub-tab on the **fotosurf engineering** display (item 5, Figure 5-29). This will call up the **Diagnostic Texts** pop-up window (see Figure 5-32). The update interval and content of the diagnostic messages is dependent on the firmware version of the Surface Topography sensor. These messages are useful for troubleshooting performed by service.

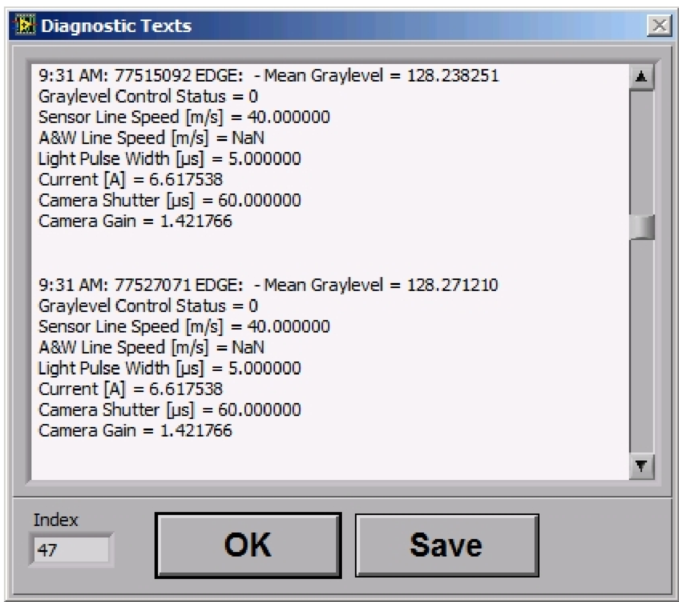


Figure 5-32 Diagnostic Texts Pop-up

5.3.5.7. Measurement order and typical criteria

There is a definition table on the upper part of the **Definitions** sub-tab of the **fotosurf engineering** display (see Figure 5-29). Measurement names are listed in the first column.

The second column contains the display order of the measurements as ordinals from 1–10. This order is used to show all measurements on the **fotosurf display**, single on-line surface topography properties (see Subsection 5.3.1.7). Also, measurements with ordinals 1–5 are selected for displaying data on the polar plot on the **fotosurf display** (see Subsection 5.3.1.3), and the **fotosurf image gallery** (see Subsection 5.3.3.6). The same five measurements are also shown in the display of multiple on-line surface images and data (see Figure 5-9).

The third column contains flags for inclusion (value = 0 ⇔ do not include, 1⇔ include) of measurement into the most typical image calculation at end-of-roll (see Subsection 5.3.3.1). This means that only those measurements are taken into account for which the value in the **Typical** column is one.

5.3.5.8. Save definitions

All values entered on the **Definitions** sub-tab of the f**otosurf engineering** display can be saved by clicking **SAVE** (item 7, Figure 5-29). Remember to click **SAVE** before exiting the display if you want your changes to take effect.

5.3.5.9. Number of images from reel-end for image gallery control

Sometimes you may want to select the typical image of the roll near reel-end (not based on the whole roll) in order to better link surface topography sensor measurements to laboratory measurements, which are only taken from reel-end cross direction strips of the web. This can be achieved by entering a suitable value into **Number of Images From Reel End for Image Gallery** control (item 8, Figure 5-29). If four imaging positions are defined (see Subsection 5.3.1.4), setting this value to 40 means that only 10 last scans of the roll are taken into account when the most representative image is selected.

5.3.5.10. Clear image gallery references

When the automatic grade reference feature is enabled (see Subsection 5.3.3.3), the QCS saves the most representative image of the first roll of a grade as the reference image of the grade. Sometimes it may be desirable to reset all grade references, for example, after a major overhaul of the paper machine, which may change surface topography of all grades dramatically. Image gallery references can be reset by clicking **Clear Image Gallery References** (item 9 in Figure 5-29).

6. Introduction to Measurement

Surface roughness is one of the most important paper quality factors in the printability of paper. It is especially crucial for printing high-quality papers and boxboard. Small-scale topography variation is labeled with two terms:

- smoothness
- roughness

They both describe the same paper property as measured with different methods.

Smooth surface is a desirable property of paper and board. The smoother the base paper is, the easier it is to be prepared to a high-quality printing surface.

Rough base paper needs more coating than smooth paper to reach the same smoothness goal, which adds energy and material costs.

6.1. Paper roughness and measurement

It has been proposed that the surface height of the paper surface, normally distributed fibers, which are the biggest components of paper, have the largest impact on surface topography. Assuming that every fiber has an equal effect on paper thickness, and that paper thickness is linearly dependent on local grammage, the RMS roughness R_{RMS} of paper may be estimated with the formula:

$$R_{RMS} = \frac{d_{eff}}{\sqrt{N}} = d_{eff}\sqrt{\frac{m_f}{Ab}}$$

where N is average number of fibers per area A, b is grammage of paper, d_{eff} is effective thickness of paper and m_f is fiber weight.

An estimate of the effect of various properties on paper roughness can be based on the preceding formula. For a given grammage, paper surface roughness increases if the fiber weight of effective thickness of paper increases. For example, if the fiber length increases, the weight increases. Thickness of paper may increase if more rigid fibers are used. This means that it is possible to make smoother paper from short-fiber hardwood pulp than from long-fiber softwood pulp. Refining of chemical pulp makes fibers more flexible, which leads to smaller effective thickness and lower surface roughness. As fibers are dominantly oriented in the machine direction, the surface height variation (roughness) is larger in the perpendicular cross direction.

Roughness can be decreased by increasing fines and fillers in the surface layers of paper. Layered distributions of fines and fillers are created in the wire section of the paper machine. Wire marking may increase macroroughness. In the beginning of the dryer section, surface fibers may stick to the drying cylinder if moisture and temperature are in a certain region. This phenomenon may increase the roughness of the paper. With proper control and optimization of the dryer section, this can be avoided.

Calendering is a way to change caliper, roughness, gloss, and porosity of paper by compressing it by means of leading the web through a system of nips between two or more rolls. High-grammage, thick areas, for example, flocs, are compressed more than areas of low caliper. Roughness of the surface may decrease a lot in the thicker areas, while it may stay unchanged in the thinner areas. Areas of different thicknesses may be better smoothened by using soft-nip calender rather than hard-nip calender.

Coating is another way of making paper surface smoother. The most commonly used coater is a blade coater, which smoothes the surface effectively if enough coating color is used. The drawback is uneven coating layer thickness arising from roughness of base paper. Film-transfer coating leads to uniform coating thickness, but it may not lead to as flat a surface.

A special feature of paper surface roughness characterization is the definition of the surface which is not as unambiguous as the surface of a metal plate. The porous structure of paper, especially base paper (see Figure 6-1 and Figure 6-2) makes it difficult and method-dependent to define where the surface is.

Figure 6-1 Microtome Cross Section of Base Paper

Figure 6-2 Microtome Cross Section of Coated Fine Paper

Out-of-plane deviations of paper surface can be divided into three in-plane length scales:

- roughness (small scale)
- waviness (medium scale)
- shape error (large scale-like curl)

Surface roughness can be further divided into three components based on in-plane scale:

- optical roughness: < 1 µm
- microroughness: 1–100 µm
- macroroughness: 0.1–1 mm (< 0.01–0.04 in.); FotoSurf sensor measures this scale of topography

Optical roughness of paper is dependent on properties of pigment particles and surface properties of fibers on the surface of the paper. Gloss and fluid absorption are influenced by optical roughness. Microroughness is dependent on fiber, fine, and filler distributions in the paper. The formation of paper has a significant effect on macroroughness. Both microroughness and macroroughness contribute to the gloss of the paper surface, and especially to spatial variation of gloss.

6.2. Characterization of topography

All points of a completely smooth surface are in the same plane. Surface topography can be characterized by defining parameters that describe deviations from the planar surface.

In Figure 6-3 the height of point *i* of the profile is Z_i and the mean height is Z_m. The arithmetical average of deviations from mean height is R_a.

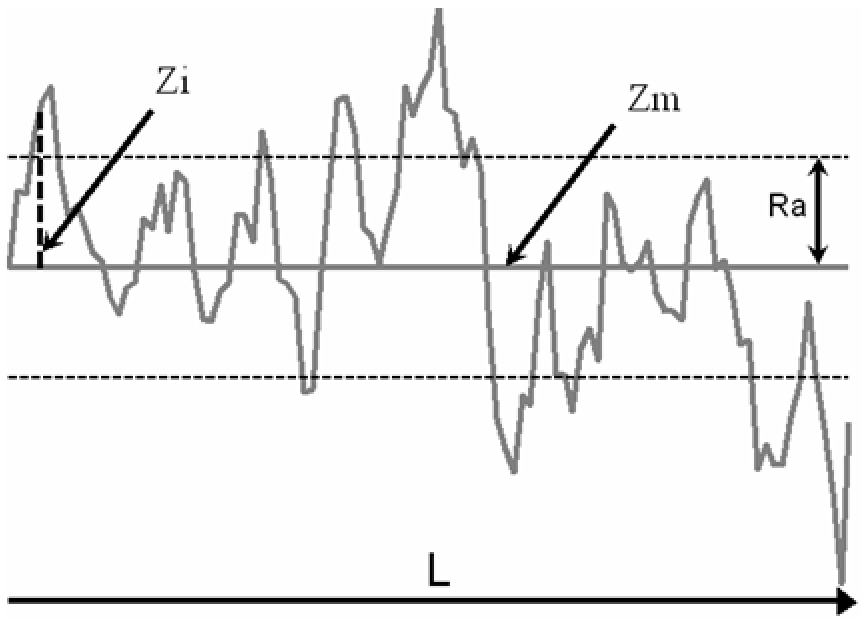


Figure 6-3 Height Profile of a Surface and Mean Level of the Profile *m*.

Two commonly used definitions:

- arithmetical mean of absolute deviations from mean profile height R_a [μm]:

$$R_a = \frac{1}{N}\sum_{i=1}^{N}\left|z_i - z_m\right|$$

- RMS deviation from mean profile height R_q [μm]:

$$R_q = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(z_i - z_m\right)^2}$$

Both of these parameters describe the average deviations of the surface, and they usually correlate strongly with each other. However, R_q is more sensitive to extreme values of the profile.

There are a number of other definitions in common use, which define variation from plane in different ways. For example, maximum height, minimum depth, skew, and kurtosis of height distribution.

An alternative way is to define topography parameters based on deviations from ideal plane placed on top of the surface. Figure 6-4 shows various alternatives of surface topography parameters calculated from ideal plane:

- contact fraction percentage
- surface volume
- surface pit distribution
- mean separation

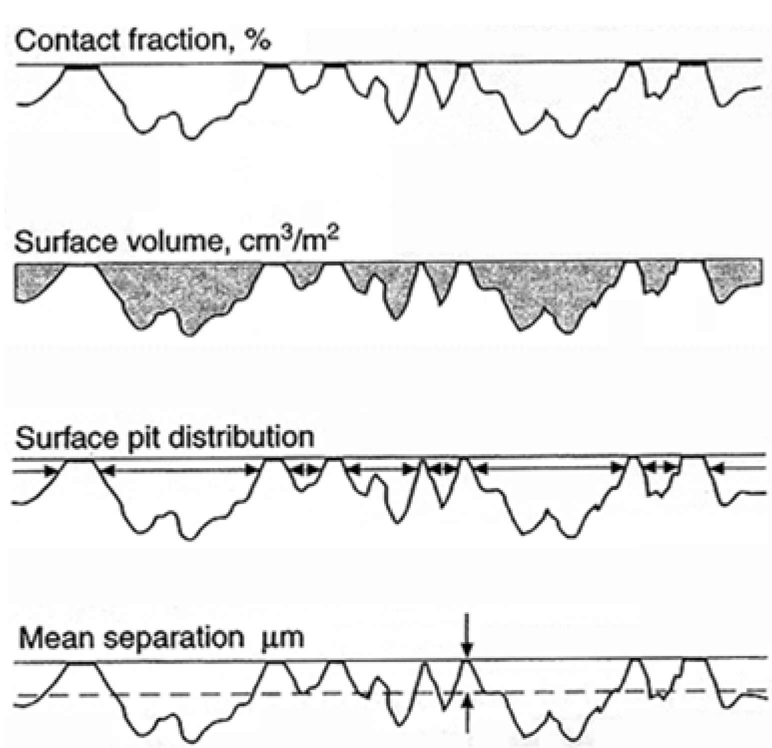


Figure 6-4 Surface Topography Parameters

It is clear that these parameters depend on the compressibility of the paper and the pressure that the plane exerts on the paper, while previously introduced parameters described uncompressed paper surface.

6.2.1. Optical methods

There is a multitude of optical methods to measure surface roughness. These methods include:

- interferometric
- triangulation
- light scattering
- laser speckle-based
- focus methods
- imaging

A quantitative topographic map can be obtained from interferometric, triangulation, and focus methods. The other methods correlate with topography, but they are not able to directly measure surface heights in micrometers.

For paper surface characterization in the laboratory, both interferometric and triangulation methods are used quite commonly. However, the paper industry does not use optical methods in their daily quality control mainly due to slow measurement speed. That is why traditional air-leak methods are still the most commonly used.

Some imaging methods, such as shadow-moiré, may also lead to a real topographic map, but their accuracy is not as good as interferometric methods. Very fast and accurate results can be obtained using imaging with directional illumination. The FotoSurf sensor employs this technology.

6.2.2. Contacting methods

It is very common to measure surface topography by contact, either mechanical or through interaction forces. These methods include stylus profilometry and Atomic Force Microscopy (AFM). Contact topography measurements are commonly used in many industries, and many standards are based on those.

A stylus profilometer moves a stylus vertically in contact with a sample with specified contact force. The stylus is then moved along a straight path, and vertical deviations of the stylus are recorded while keeping contact force at the specified setpoint. A topographic map may be obtained by scanning adjacent lines in a similar manner. There are some manufacturers who make stylus profilometers for the paper industry. Realistic sample sizes, for example, A4, may be measured, but measurement speed is not fast enough for routine use.

In AFM, the surface is also profiled with a very small stylus (diameter less than 20 nm). The deflection of the stylus cantilever is measured with high accuracy while scanning the surface with the stylus. The forces that affect AFM reading include:

- mechanical contact
- van der Waals
- capillary
- chemical bonding
- electrostatic
- magnetic

Vertical resolution of AFM can be better than 0.1 µm, which makes it possible to analyze paper samples at scales smaller than fibers. However, maximum sample size for AFM is only 150 µm x 150 µm which makes it impractical for macroroughness measurement of paper.

6.2.3. Air-leak methods

Air-leak based gauges dominate daily quality control of paper and board surface roughness in industry. These gauges are easy and quick to use (typically less than 10 seconds per sample). Measurement geometries of Bekk, Bendtsen, Sheffield, and Parker Print-Surf (PPS) gauges are shown in Figure 6-5.

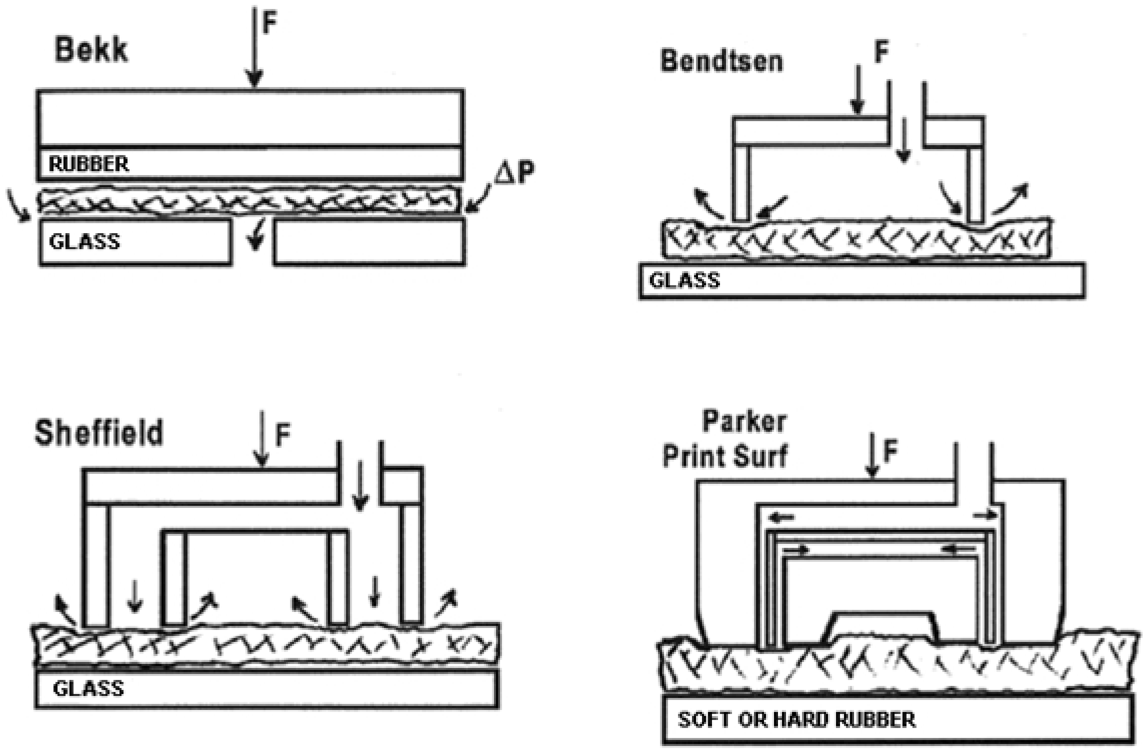


Figure 6-5 Measurement Geometries

The measurement principle of these instruments is similar: air-leak flow rate between a compressing measuring head and paper correlates with roughness of the sample. This is a quick way of indirectly quantifying roughness of paper. However, it is an indirect method and may suffer from flow through the pore structure of paper.

The Bekk instrument was originally designed by Dr Julius Bekk in 1927. His instrument was built around a vacuum chamber. The result was presented as *the time used for a certain reduction of the under pressure due to leakage of air between an annular glass ring and the paper sample*. Measuring very smooth paper samples with this instrument can take a long time, sometimes several minutes. Even with very rough grades, the measurement time is 10–20 seconds.

In 1940, Mr. C. Bendtsen, pointed out that the annular glass ring of the Bekk tester was much bigger than the cavities in the paper surface. He developed a sensing head in which the width of the ring is 0.15 mm (0.01 in.). The rubber behind the test piece used in the Bekk instrument was replaced by a glass plate. The pressure against the paper is 98 kPa, as it is in the Bekk instrument. The measuring results are expressed in terms of air-flow rate, Bendtsen units (mL/min), at a given differential pressure.

A North American improvement of the Bendtsen method is the Sheffield tester developed by Mr. W.I. Wilt and Mr. N.E. Emmons. The air pressure as well as the contact pressure are much higher than with the Bendtsen method. The results are expressed in standard cubic centimeters per minute (SCCM), or in Sheffield units.

The Beck, Bendtsen, and Sheffield instruments were used successfully for many years, but in 1965 Dr J.R. Parker invented a new instrument, the PPS Tester. In this instrument, the major drawbacks of the earlier instruments had been eliminated. The measuring pressure was increased to 490–1960 kPa, which corresponds with the actual nip pressure in a real printing press. The permeability error (air leaking through the paper and not between the measuring head and the paper) was minimized by the design of the measuring head. Another unique feature was that the instrument was calibrated in absolute units (µm).

Table 6-1 lists the basic operating parameters of the Beck, Bendtsen, Sheffield, and PPS instruments.

Table 6-1 Basic Operating Parameters

Instrument	Width of Ring Against Paper	Nip Pressure	Backing Material	Measured Quantity
Bekk	1350 µm	0.1 MPa	Soft rubber	Time (s)
Bendtsen	150 µm	0.1 or 0.5 MPa	Glass	Flow rate (ml/min)
Sheffield	380 µm	0.17 MPa	Glass	Flow rate (ml/min)
Parker Print-Surf	51 µm	0.5, 1.0 or 2.0 MPa	Soft or hard rubber	Roughness (µm)

The PPS method has been improved according to the original patent in a way that was not technically possible at that time. Figure 6-6 shows the measuring head of the PPS Flex method. In this method, the air-leak edge area has been increased by replacing the ring with a series of parallel channels. Every other channel inputs the air, and every other, other channel outputs it. Reliability has been further improved by replacing the rubber backing with a flexible, fluid-filled diaphragm that exerts a uniform hydrostatic pressure on the paper. This effectively helps to prevent larger out-of-plane deformations that may cause leak artifacts.

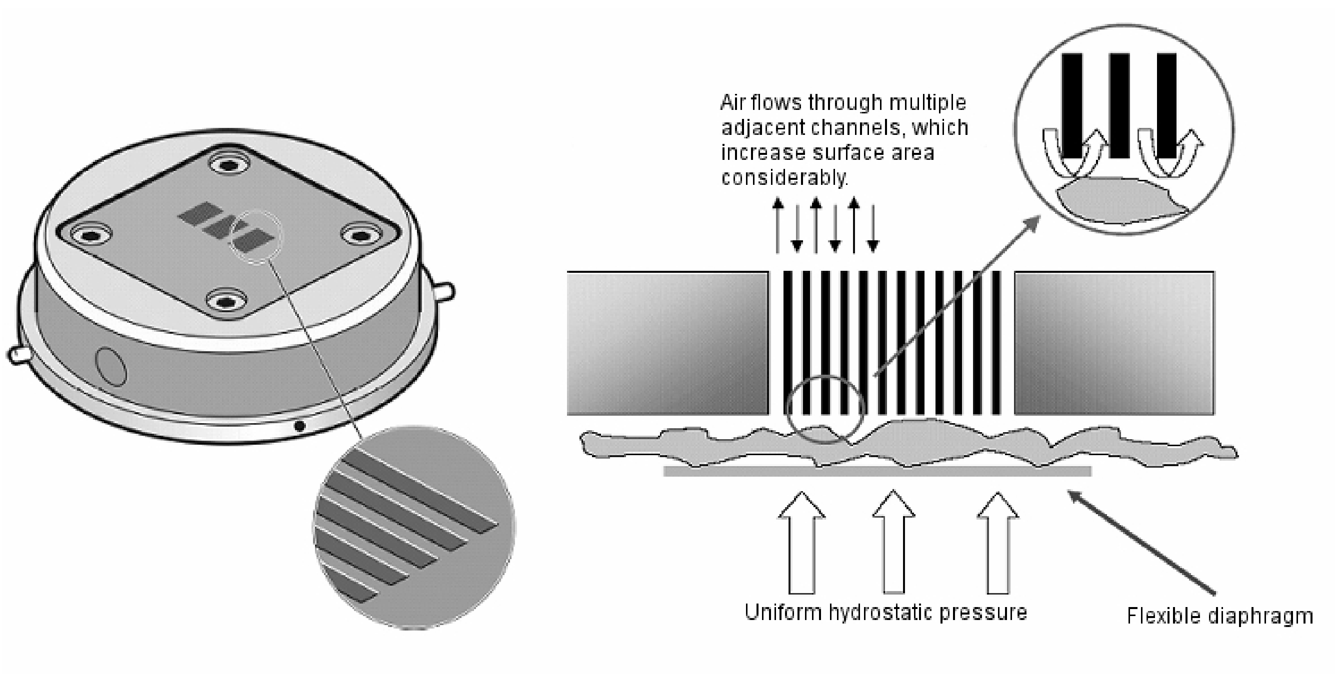


Figure 6-6 PPS Flex Method

6.3. Honeywell surface topography measurement

Honeywell surface topography measurement is an indirect optical measurement of surface topography of macroroughness scale 0.1–1 mm (< 0.01–0.04 in.) as defined in Section 6.1. It is based on oblique illumination and imaging of the surface at surface-normal direction. The acquired image is analyzed by algorithms, which are shown correlate with PPS and Bendtsen measurements. A grade-dependent or machine-dependent calibration is always needed to establish quantitative correlation with the laboratory. Measurements performed by the Surface Topography sensor are summarized in Table 6-2.

Table 6-2 Summary of Surface Topography Measurements

Measurement	Units	Typical Values	Range	Visual Appearance (low value)	Visual Appearance (high value)
Surface PPS	µm	0.8–5.0	0.5–10.0	Silky smooth surface	Small-scale roughness
Surface Bendtsen	ml/min	50–3000	50–5000	Flat	Larger hills and valleys
Surface streak index	-	0–2	0–4	No vertical stripes	Distinct vertical streaks
Surface texture scale	mm	0.1–1.0	0.06–15.0	Fine structure	Large-scale texture
Surface impurity	-	-5.0–5.0	-100 to +100	Dark areas dominate	Bright areas dominate
Surface graylevel	-	70–100	0–255	Dark image	Bright image
Surface passline	mm	3.0–7.0	0.0–10.0	-	-
Surface cross direction angle	degrees	-3.0–3.0	-5.0–5.0	-	-
Surface machine direction angle	degrees	-3.0–3.0	-5.0–5.0	-	-

6.3.1. Imaging setup

Imaging setup of the Surface Topography sensor is shown in Figure 6-7. The paper web is illuminated with a large, unfocused, strobed laser beam at a 15 degree angle with respect to the paper web. The illuminated area is imaged with a camera at a 90 degree angle with respect to the paper web. A low illumination angle makes topography visible. Hills and valleys cause brightness changes in the reflected light.

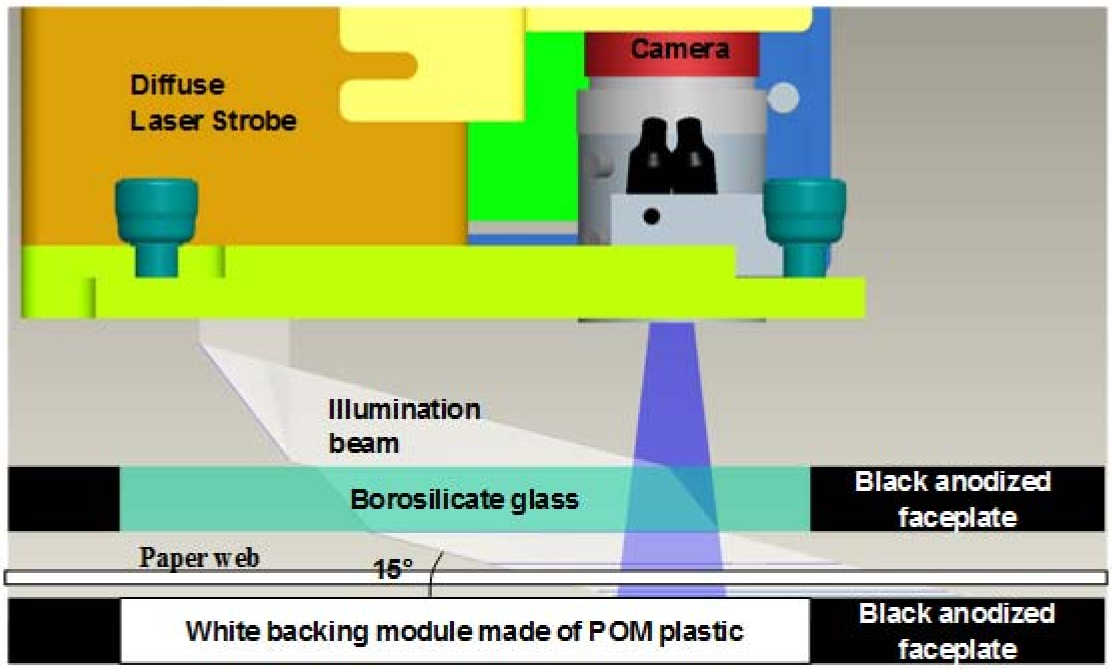


Figure 6-7 Imaging Setup of the Surface Topography Sensor

An example of the camera image is shown in Figure 6-8.

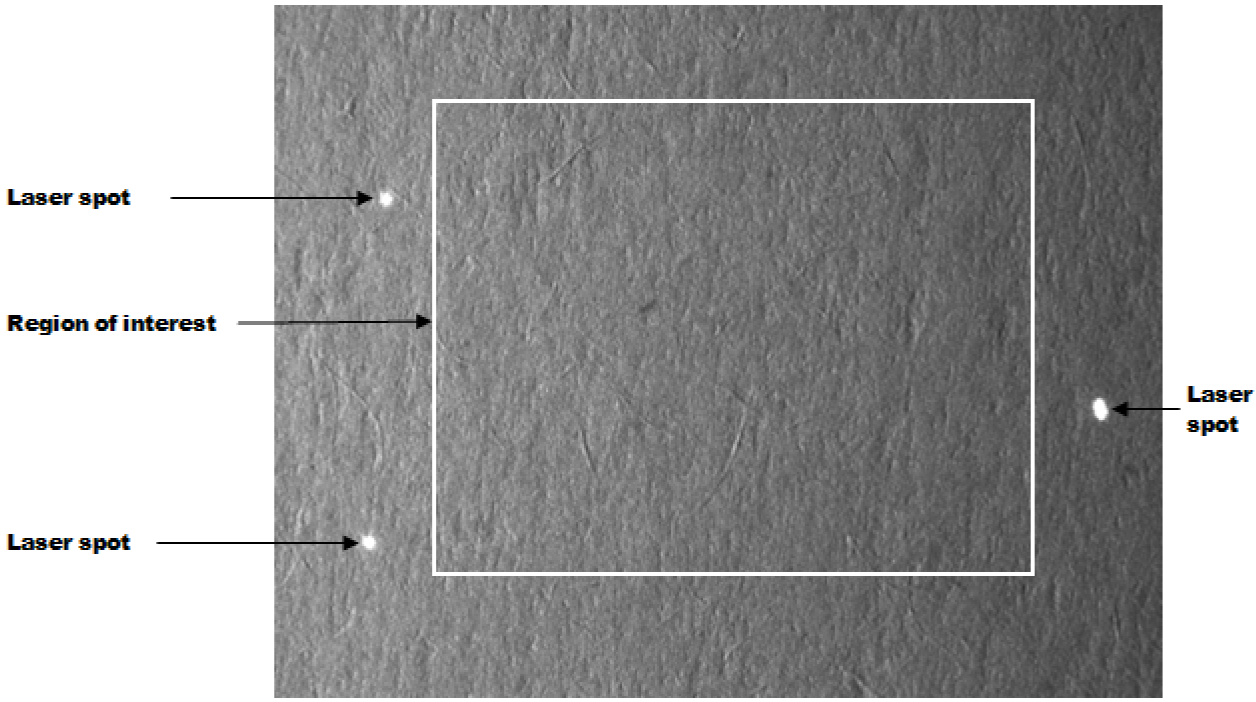


Figure 6-8 Region of Interest and Laser Spots

The central region of interest (ROI) is analyzed for roughness using spectral analysis of certain spatial wavelength bands. On the left and right edges there are three laser spots, which are projected using three small, focused, pulsed lasers at a 75 degree angle with respect to the paper. The positions of the three projected spots change in the camera image when distance of the paper web from the FRMM, or the tilt angles with respect to the FRMM window is changed. The positions are calibrated at the factory, which allows precise distance and tilt angles of the web to be calculated. Using this information, roughness values are compensated, which means that the Surface Topography sensor does not suffer from passline or tilt bias.

6.3.2. Surface PPS

The Surface Topography sensor determines a quantity called *surface PPS* as total graylevel variance in spatial wavelength band 0.2–0.5 mm (0.01–0.02 in.). In studies, this band has proved to correlate best with the laboratory PPS value. In a typical case, a linear correlation between the surface PPS and the laboratory PPS is found. An example of the relationship between the surface PPS and the laboratory PPS is shown in Figure 6-9. Data from hundreds of reels of coated board was collected, and the correlation is very good.

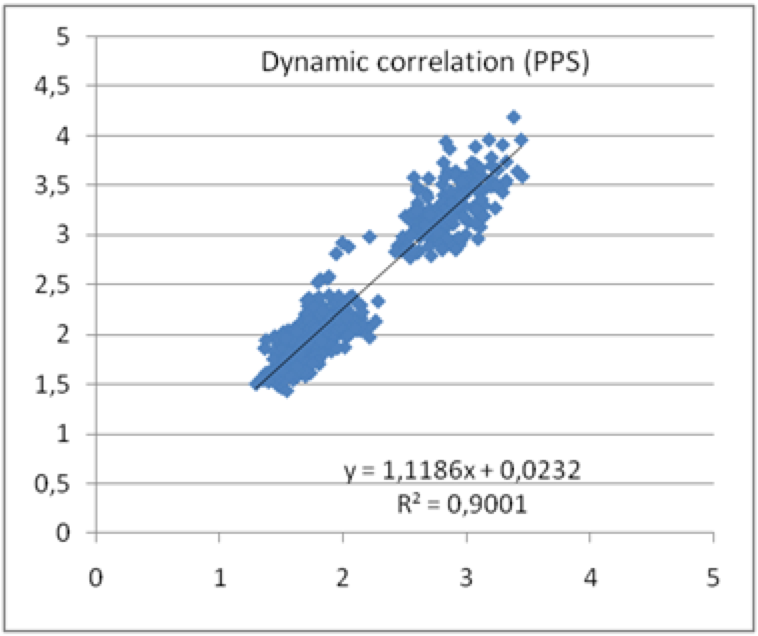


Figure 6-9 PPS Correlation

Figure 6-10 shows typical images taken by the Surface Topography sensor for different levels of the laboratory PPS measurement. It is evident that visual appearance correlates with increasing roughness. The examples in the figure represent images taken by the Surface Topography sensor at laboratory PPS measurements of 1.58 µm, 3.47 µm, 5.67 µm, 10.33 µm.

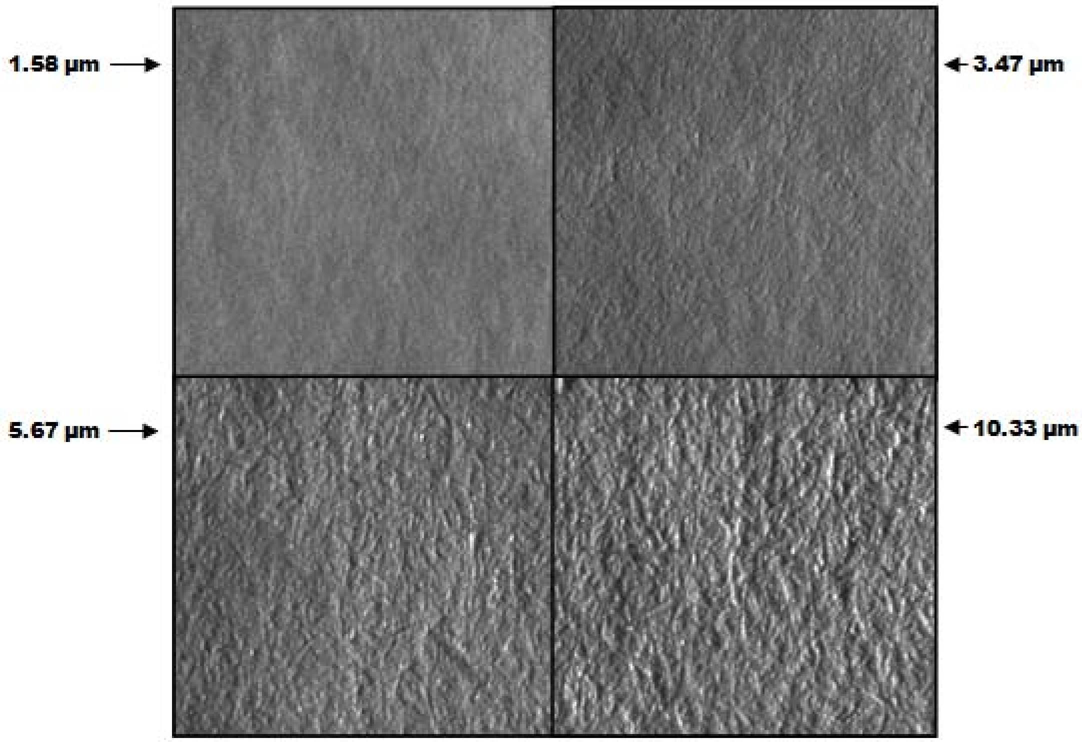


Figure 6-10 Sensor Images

6.3.3. Surface Bendtsen

The Surface Topography sensor determines a quantity called *surface Bendtsen* as total graylevel variance in spatial wavelength band 0.5–1.0 mm (0.02–0.04 in.). In studies, this band has proved to correlate best with the laboratory Bendtsen value. In a typical case, a linear correlation between the surface Bendtsen and the laboratory Bendtsen is found. An example of relationship between the surface Bendtsen and the laboratory Bendtsen is shown in Figure 6-11. Data was collected from a range of paper and board samples measured with both the Surface Topography sensor and the laboratory Bendtsen gauge. Correlation between them is very good.

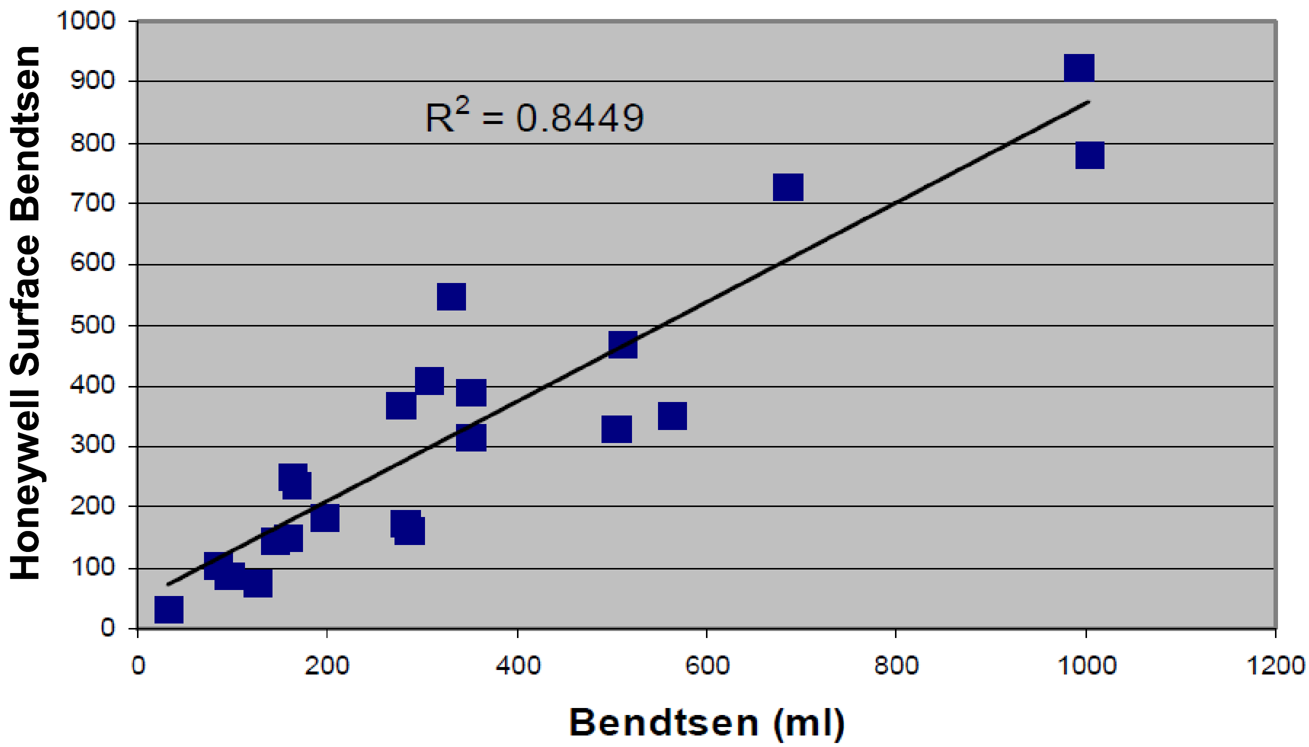


Figure 6-11 Bendtsen Correlation

Figure 6-12 shows typical images taken by the Surface Topography sensor for different levels of the surface Bendtsen measurement. The examples in the figure represent images of samples with Bendtsen levels of 48 ml/min and 90 ml/min (PPS of both samples was 1.9 µm). It is evident that large-scale topography variations (waves) increase with increasing Bendtsen.

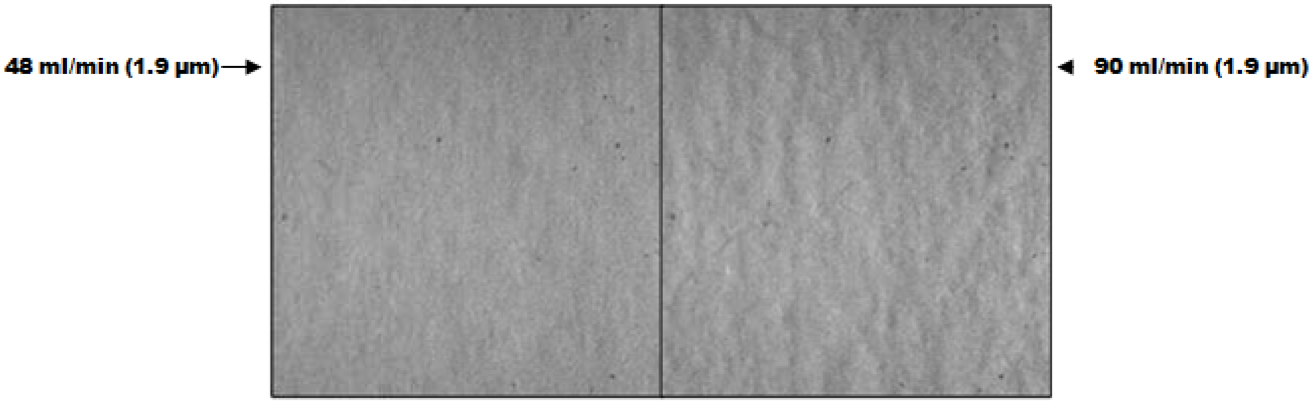


Figure 6-12 Samples With Different Bendtsen Levels

6.3.4. Surface streak index

The surface streak index quantifies the magnitude of streaks in the machine direction. The scale has been calibrated using laboratory values for the range 0–4. If streakiness is extremely strong, the value may exceed 4. Figure 6-13 shows samples with a streak index of, respectively, 0.0, 2.0, and 4.0.

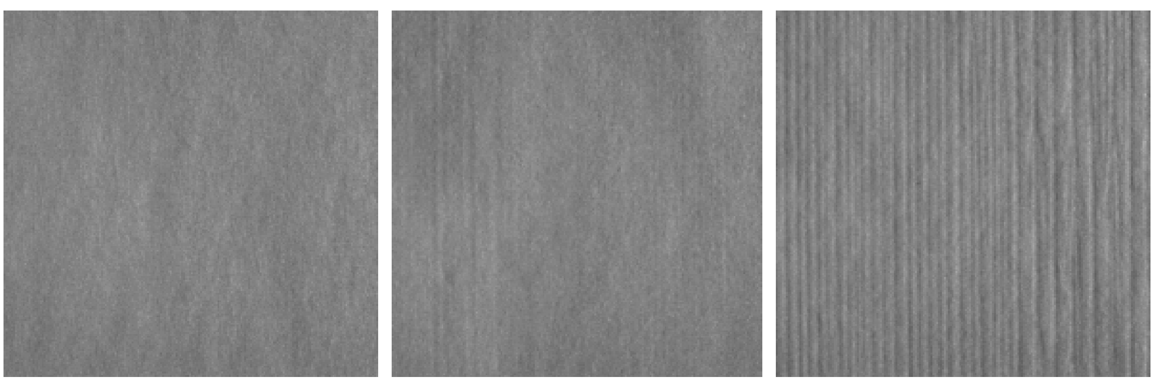


Figure 6-13 Streak Index of (left to right) 0.0, 2.0, 4.0

6.3.5. Surface texture scale

Surface texture scale is defined as the typical scale of cross direction texture in millimeters. Surface images of two different surface texture scale values of 0.13 mm (0.01 in.) and 0.43 mm (0.02 in.) are shown in Figure 6-14. The smaller surface texture value corresponds to fine texture (small features or waves). The larger surface texture value corresponds to smooth, slowly varying texture (large features or waves).

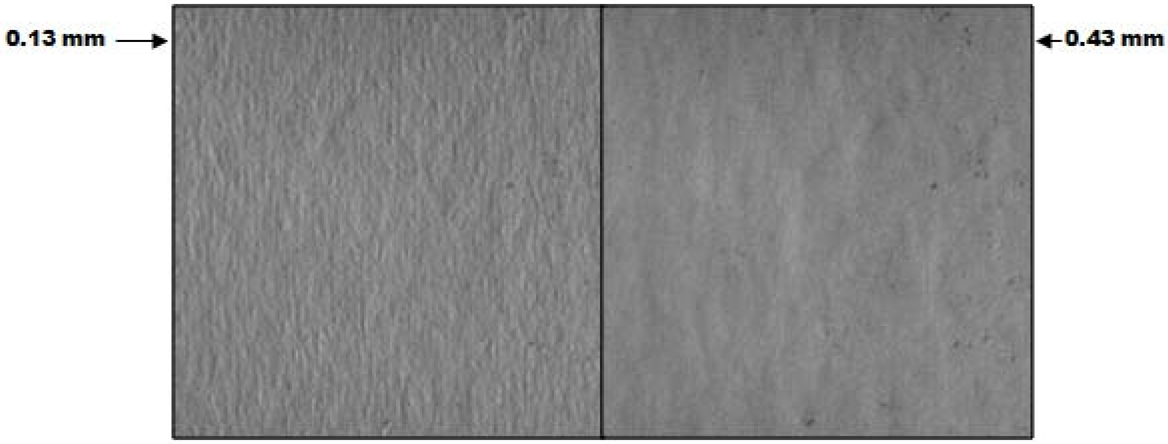


Figure 6-14 Surface Texture Scale

6.3.6. Surface impurity

Surface impurity is defined as the balance between light and dark areas on the surface image. When there are more bright spots than dark spots, surface impurity is positive (see the left-hand image in Figure 6-15). In contrast, surface impurity is negative when dark spots dominate (see the right-hand image in Figure 6-15). Due to the imaging setup (see Section 6.3.1) used in the Surface Topography sensor, negative values are usually an indication of dark shadows cast by high structures on the surface. Another reason for negative values may sometimes be dark dirt particles stuck on the sensor window.

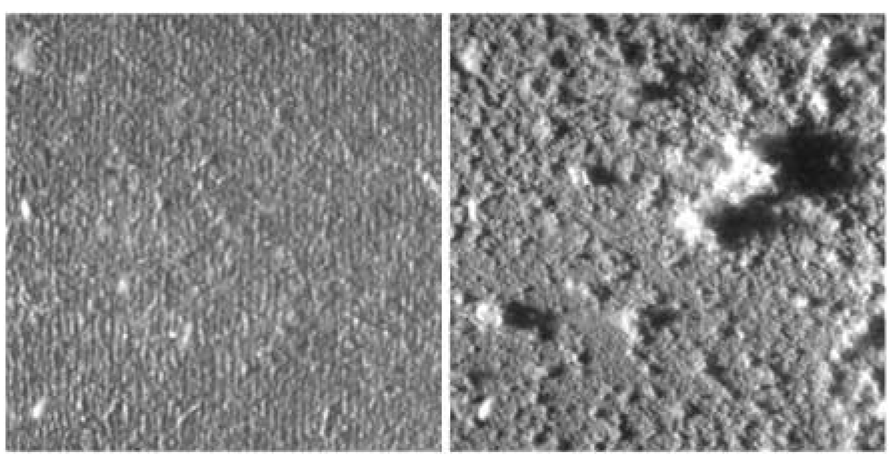


Figure 6-15 Surface Impurity: +28 (left) and -94 (right)

6.3.7. Surface graylevel

Brightness of the surface image is indicated by the surface graylevel, where values range from 0 (totally dark) to 255 (saturated bright). Brightness of the image is controlled automatically by the Surface Topography sensor to the setpoint value given as configuration parameter **IMAGE gray target** (see Subsection 5.3.4.1 and 5.3.4.2). If the value differs from the setpoint by more than the parameters **IMAGE gray high coeff** and **IMAGE gray low coeff** allow, there is a problem with the control mechanism.

6.3.8. Passline, and machine direction and cross direction tilt angle

The Surface Topography sensor measures the distance from the sensor window to the paper web at three points in which the distance laser beams hit the paper (see Figure 6-14). The average value of these distances is called the passline (in millimeters), which the sensor outputs and uses for compensating measured values.

Using trigonometric relationships, the sensor also calculates machine direction and cross direction tilt angles of the web. Trigonometric relationships are also used for output value compensation, and as sensor outputs.

In addition to the value of compensating topography values, passline, machine direction tilt and cross direction tilt can be used to compensate and troubleshoot output from other sensors at the same cross direction position.

7. Preventive Maintenance

Depending on your operating environment, the frequency of preventive maintenance procedures may need to be adjusted.

In Table 7-1, *X* indicates recommended maintenance intervals, and *XX* indicates that the you should adjust the interval on an as-needed basis.

Table 7-1 Preventive Maintenance Internal Checklist

Procedure	Daily	Weekly	Months		Years			Task Details
			1	6	1	2	5	
FSMM								
Clean outer side of FSMM window		XX						Subsection 8.1.2

8. Tasks

This chapter contains procedures for maintaining optimal Surface Topography Measurement performance. Tasks are organized based on mechanical and functional viewpoints.

8.1. FotoSurf measurement module

8.1.1. Check distance calibration

Valid distance calibration is essential for the accuracy of surface topography measurement. If the FSMM window has been replaced, or if the calibration accuracy is in doubt for *any* reason, distance calibration must be checked.

Activity Number:	Q4222-50-ACT-004	**Applicable Models:**	Q4222-50
Type of Procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
Required Parts:	Part Number	Quantity	Lead Time
Required Tools:	Part Number	Quantity	Lead Time
	• distance calibration target (p/n 6581400006)		

To check distance calibration:

1. Command the scanner to offsheet.
2. Make sample measurements (see Section 4.5) using the distance calibration target as the sample. Move different distance areas of the calibration sample to the measurement area.
3. Inspect the sample measurement report, and compare the distance readings to the nominal values of the calibration sample.
4. If significant deviation (more than ± 5%) from the nominal value is found, contact service for recalibration.

8.1.2. Clean outer side of FSMM window

Dirt buildup on the FSMM window may impact FotoSurf sensor performance. Clean the window regularly. For example, if the moisture measurement sensor is installed to the same scanner head, it is useful to clean windows of both sensors at the same time.

Mild build-up is digitally canceled by the FSMM. When dirt build-up is moderate, the FSMM displays the *Clean Soon* indicator on the **fotosurf display**. When more dirt builds up, the indicator changes to *Clean Now*. At that point, dirt build-up begins to have a significant impact on measurement results, and immediate cleaning is mandatory.

Activity Number:	Q4222-50-ACT-001	**Applicable Models:**	Q4222-50
Type of Procedure:	Maintain	**Expertise Level:**	Operator
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	Once per shift up to 1 week
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
Required Parts:	Part Number	Quantity	Lead Time

Required Tools:	Part Number	Quantity	Lead Time
	• clean cloth • window cleaner fluid		

To clean the outer side of the window:

1. Command the scanner to offsheet.
2. Separate the heads.
3. Clean the window using a clean cloth and window cleaning fluid.
4. Close the heads.
5. Put the scanner back to scanning.
6. Look at the **fotosurf display**.
7. Wait until the scanner head has done standardization and a minimum of five scans after that.
8. Verify that *Clean Soon* or *Clean Now* status changes to *Sensor Window OK*.
9. If the status changes to *Sensor Window OK*, the procedure is complete. If the status does not change to *OK*, repeat Steps 1–8. If it still does not change, go to Step 10.
10. Look at the illumination correction image on the **fotosurf engineering** display. Observe where the dirt particles are on the window. If they cannot be cleaned on the outer side, see Subsection 8.1.3.

8.1.3. Clean inner side of FSMM window

If the dirt build-up cannot be cleaned on the outer side of the window, it is likely that the dirt particles are on the inner side of the window.

Activity Number:	Q4222-50-ACT-002	**Applicable Models:**	Q4222-50
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):**	

Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
Required Parts:	Part Number	Quantity	Lead Time
Required Tools:	Part Number	Quantity	Lead Time
	• 2.5 mm hex key • clean cloth • window cleaner fluid		

To clean the inner side of the window:

1. Power off the FSMM.
2. Unmount the FSMM from the sensor head.
3. Unscrew the four hex screws holding the FSMM window assembly.
4. Unmount the FSMM window assembly.
5. Clean the inner side of the window using a clean cloth and window cleaning fluid.
6. Mount the FSMM window assembly and tighten the four hex screws.
7. Mount the FSMM onto the sensor head, and power on the FSMM.
8. Put the scanner back to scanning.
9. Look at the **fotosurf display**.
10. Wait until the scanner head has performed a standardization and a minimum of five scans after that.
11. Verify that *Clean Soon* or *Clean Now* status changes to *Sensor Window OK*.
12. If the status changes to *Sensor Window OK*, the procedure is complete. If the status does not change to *OK*, repeat Steps 1–11. If it still does not change, go to Step 13.
13. Look at the illumination correction image on the **fotosurf engineering** display. Observe where the dirt particles are on the window. If they cannot be cleaned on the inner side, see Subsection 8.1.2.

8.1.4. Replace FSMM window assembly

If there are any cracks in the FSMM window, it must be replaced immediately to prevent any glass fragments getting into paper production, and to properly protect the sensor. Fracture of the window is almost impossible in normal operation, but careless usage of tools, for example, a hammer, can cause fracture.

Severe scratches on the window also make it necessary to change the window because measurement accuracy might be compromised.

Activity Number:	Q4222-50-ACT-003	**Applicable Models:**	Q4222-50
Type of Procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	See Check distance calibration
Required Parts:	Part Number	Quantity	Lead Time
	p/n 08771500: one FSMM window assembly		
Required Tools:	Part Number	Quantity	Lead Time
	• 2.5 mm hex key		

To replace the window:

1. Command the scanner to offsheet, and power off the FSMM.
2. Unmount the FSMM from the sensor head.
3. Unscrew the four hex screws holding the FSMM window assembly.
4. Replace the FSMM window assembly with the new one, and tighten the four hex screws.
5. Mount the FSMM onto the sensor head, and power on the FSMM.
6. Put the scanner back to scanning.

8.1.5. Replace FotoSensor interface board

This task is to be carried out if the FotoSensor interface board fails.

Activity Number:	Q4222-50-ACT-005	**Applicable Models:**	Q4222-50
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	Use proper ESD protection to avoid board damage
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
Required Parts:	Part Number	Quantity	Lead Time
	05444600: one FotoSensor interface board		
Required Tools:	Part Number	Quantity	Lead Time
	• 2.5 mm hex key • 3.0 mm open-end wrench		

To replace the board:

1. Command the scanner to offsheet, and power off the FSMM.
2. Unmount the FSMM from the sensor head, and take it to a clean workbench.
3. Unscrew the four hex screws holding the PCB cover, and detach all cables from the board.
4. Unscrew the four standoffs holding the board in place.
5. Replace the board, and install the standoffs, cables, and PCB cover.
6. Mount the FSMM onto the sensor head, and power on the FSMM.
7. Shoot test samples (see Section 4.5) to determine that the board works.

9. Troubleshooting

In this chapter, possible issues with the FotoSurf sensor are divided into two sections:

- Section 9.1 Alarm based troubleshooting: Troubleshooting steps to be taken in response to a specific alarm generated in the Experion MX system.
- Section 9.2 Non-alarm based troubleshooting: Troubleshooting steps that may not be related to a specific alarm in the Experion MX system.

9.1. Alarm based troubleshooting

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

9.1.1. FotoSurf link down

Alarm	Cause	Solution (Tasks)
FotoSurf sensor does not communicate with MSS	FSMM power switch off	Turn on FSMM power switch
	FSMM fuse blown	Power off FSMM for five minutes and power on again (automatic fuse)
	Ethernet cable loose	Check Ethernet cable connection at the switch and at FSMM
	FotoSensor interface board out of order	See Replace FotoSensor interface board

9.2. Non–alarm based troubleshooting

9.2.1. FotoSurf yellow clean soon indicator on

Symptom	Cause	Solution (Tasks)
Indicator below **fotosurf display** formation is yellow	FSMM window dirty	Clean outer side of FSMM window
		Clean inner side of FSMM window

9.2.2. FotoSurf red clean now indicator on

Symptom	Cause	Solution (Tasks)
Indicator below **fotosurf display** formation is red	FSMM window dirty	Clean outer side of FSMM window
		Clean inner side of FSMM window

9.2.3. Surface image too dark

Symptom	Cause	Solution (Tasks)
Surface image in **fotosurf display** is too dark to be seen	Laser safety interlock	Check status, switches, and cabling of laser safety interlock
	Wrong line speed to FotoSurf	Check line speed (see Subsection 5.2.3)
	Wrong configuration parameters	Check parameters (see Subsection 5.3.4.1)
	FSMM window too dirty, blocks too much light	Clean outer side of FSMM window

9.2.4. Surface image too bright

Symptom	Cause	Solution (Tasks)
Surface image in **fotosurf display** is too bright (details are washed out)	Wrong line speed to FotoSurf	Check line speed (see Subsection 5.2.3)
	Wrong configuration parameters	Check parameters by comparing to Subsection 5.3.4.1

10. Storage, Transportation, and End of Life

This chapter summarizes Honeywell policy with regards to the storage and disposal of components of the FotoSurf Measurement.

10.1. Storage and transportation environment

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

Table 10-1 Storage and Transportation Parameters

Duration of Storage	Acceptable Temperature Range	Acceptable Humidity Range
Short term (less than one week)	-20–60 °C (-4–140 °F)	10–90% non-condensing
Long term	-10–50 °C (14–122 °F)	10–90% non-condensing

10.2. Disposal

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

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

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

Except where identified in this chapter, the scanner does not contain hazardous or restricted materials.

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

10.2.1. Solid materials

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

11. Glossary

Actuator	Mechanical or electronic device that performs the control action in a control loop.
Air Measurement	Reading of the basis weight (BW) receiver when the shutter is opened but there is no sample in the gap. Used to normalize the onsheet measurement. Re-calculated at standardize.
Back Side	See Drive Side.
Background Measurement	Shutter closed BW receiver voltage reading. This measurement reflects only the electronic off-sets and is subtracted from every shutter open reading.
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.
Code	See Recipe.
Cross Direction	Used to refer to those properties of a process measurement or control device that are determined by its position along a line that runs across the paper machine. The cross direction is transverse to the machine that 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.
Experion MX	A quality control system (QCS).
Dirt Frac	Calculated amount of dirt on the sensor. This is calculated from the Flag-to-Air ratio (F/A ratio) .Zero percent means no dirt, and 100% means an amount that corresponds to the dirt sample used in the dirt calibration.
Distant End	The end of the scanner opposite the cable end.
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.
Flag	Mylar™ sample which can be rotated into the beam to simulate a weight measurement. Usually the measurement is used in the dirt correction calculation.
Flag To Air Ratio (F/A ratio)	The signal from the BW receiver with the shutter open, with and without the flag inserted.
Front Side	See Tending Side.
Gauge Support Processor (GSP)	
Green Light	One of the two radiation interlock lights. Green is on when the shutter is physically closed.
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.
High End Calibrate Position	The value of the head position when the sensor head reaches the High End Calibration Position. This is only updated during a scanner calibration procedure.
Human Machine Interface (HMI)	Also referred to as UPI.
KCM	Customer sample calibration constant. A multiplier used to correct the BW calculation if the samples are not Mylar.
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	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)	
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.
MXOpen	Obsolete software QCS.
PHD	Surface topography data can be stored and processed further by external databases such as Honeywell Uniformance® Process History Database (PHD).
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 (with Performance CD being one of them).
Real-Time Data Repository (RTDR)	The database managed by RAE to store system data, and data for individual applications.
Recipe	A list of pulp chemicals, additives, and dyes blended together to make a particular grade of paper.
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.
Thermal Equalization System (TES)	
Time Zero Flag to Air Ratio (T0FA)	The F/A ratio when the system is known to be in a clean state.
Trend	The display of data over time.

A. Part Numbers

Table A-1 lists part numbers and descriptions for the model Q4222-50 Surface Topography sensor for Experion MX.

Table A-1 Part Numbers for MX09422250

Part Number	Description
00283201	Label, assembly no, rev level 1, 1.5 in. length
00285800	O ring,conductive,4.5 in. id
07705000	Pin, cmm mount, pre-cision plus color
08771300	FotoSurf measurement module (FSMM)
08771600	FotoSurf backing module (FSBM)
28504006	Screw, m4 x 10 mm (0.16 x 0.4 in.) capsoc ss
6540310003	Cable tie mt maximum width 0.14 in.
6540310006	Cable tie/nylon 3.9 in.
6580801424	Sensor base, 4 in. hole assembly, Q4000
6580801513	Sensor module, EDAQ bracket assembly
6580801578	Assembly, sensor module, interlock board
6580801596	Cable assembly, blank sensor platform
6580801659	Cable assembly, FotoSurf, Evolution
6581500030	PCBA EDAQ

Table A-2 lists part numbers and descriptions for the FSMM.

Table A-2 FSMM Part Numbers

Part Number	Description
05444600	FotoSensor interface board
06696400	FS PCB stand
06696500	FS chassis frame
06696600	FS pm holder 1
07847500	FS reed sensor holder
07849300	FS PCB cover

Part Number	Description
07849600	FS base plate
07850200	FS camera mounting block
07850300	FS buffer
08771400	FS mirror assembly
08771500	FS window assembly
08771700	FotoSurf processor module w/firmware
08771800	FS harness assembly, pm power supply
08771900	FS harness assembly, pm digital i/o
08772000	FS harness assembly, IEEE1394b
08772100	FS harness assembly, camera trigger
08772300	FS harness assembly, laser power and control
08772400	FS diode laser assembly 1, 2, 3
08773500	FS safety in place interlock assembly
08773600	FS safety plate interlock assembly
28000399	Scr m3x6 low head capsoc din7984
28000441	Standoff m3 female/female hex brass spacer 22 mm (0.87 in.)
28000442	Scr, m3x10 capsoc ss
28011005	Standoff m3 male/male hex brass spacer 3 mm (0.12 in.)
28104001	Scr # 4-40 x 0.25 pan phl ss
28505014	Scr m3x35 capsoc ss
28505015	Scr m4x12 capsoc ss
38002005	Lens, c-mount fl 12.5
38100009	Camera, IEEE 1394b, ccd, b/w, xga
38100017	Laser illuminator, pulsed,100w
6553080128	Screw ss shcs m3 x 12 mm (0.12 x 0.5 in.)
6553780133	Screw m3 x 8 mm (0.12 x 0.31 in.) sh cs t304

Table A-3 lists part numbers and descriptions for the FSBM.

Table A-3 FSBM Part Numbers

Part Number	Description
07844200	FF backing plate flange
07850000	FotoSurf backing plate bushing
16000348	Adhesive, Loctite, prism 460
25000775	Magnet–m3.0
28000431	Scr 10-24 x 0.375 lg capsoc ss