Honeywell

Color Measurement

System Manual

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Color Measurement

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Introduction

The purpose of this manual is to provide an introduction to the Q4215-60 Color Measurement sensor.

Audience

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

About This Manual

This manual contains fourteen chapters and two appendixes.

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 system operations.

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

Chapter 6, **Calibration**, describes the available calibration displays and their function.

Chapter 7, **Introduction to Measurements**, describes the principles and procedures of measurement.

Chapter 8, **Static Cross-adjustment**, describes principles and procedures for static cross-adjustment.

Chapter 9, **Dynamic Cross-adjustment**, describes principles and procedures for dynamic cross-adjustment.

Chapter 10, **Preventive Maintenance**, provides a schedule for recommended ongoing preventive maintenance tasks.

Chapter 11, **Tasks**, describes procedures for maintenance, diagnostic, and troubleshooting tasks.

Chapter 12, **Troubleshooting**, describes symptoms, alarms, possible causes, and links to associated diagnostic or troubleshooting tasks.

Chapter 13, **Storage, Transportation, End of Life**, describes methods for storing, transporting, and disposing sensor components.

Chapter 14, **Glossary**, describes the terms and acronyms used in this manual.

Appendix A, **Part Numbers** provides a list of part numbers for system components.

Appendix B, **Coloring Process Study** provides the Coloring Process Study checklist.

Related Reading

The following documents contain related reading material:

Part Number	Document Title/Description
46028700	Color and Coloring of Paper Reference Manual
6510020381	Experion MX MSS EDAQ Data Acquisition System Manual
6510493004	Procedure for removing and inserting the spare part 09881300 Color sensor Window Assembly
6510493010	Procedure of replacing and adjusting the timing belt, the wheel shaft and the bezel switch in CBM
6510493016	Procedure for replacing the Xenon lamp, Xenon trigger module, Xenon power supply, Xenon lamp holder
6510493040	Color standardization limit changes and color sensor maintenance display changes

Conventions

The following conventions are used in this manual:

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

`Boldface`	Boldface characters in this special type indicate your input.
`Special Type`	Characters in this special type that are not boldfaced indicate system prompts, responses, messages, or characters that appear on displays, keypads, or as menu selections.
Italics	In a command line or error message, words and numbers shown in italics represent filenames, words, or numbers that can vary; for example, filename represents any filename. In text, words shown in italics are manual titles, key terms, notes, cautions, or warnings.
Boldface	Boldface characters in this special type indicate button names, button menus, fields on a display, parameters, or commands that must be entered exactly as they appear.
lowercase	In an error message, words in lowercase are filenames or words that can vary. In a command line, words in lowercase indicate variable input.
Type	Type means to type the text on a keypad or keyboard.
Press	Press means to press a key or a button.
`[ENTER]` or **`[RETURN]`**	**`[ENTER]`** is the key you press to enter characters or commands into the system, or to accept a default option. In a command line, square brackets are included; for example: **`SXDEF 1 [ENTER]`**
`[CTRL]`	**`[CTRL]`** is the key you press simultaneously with another key. This key is called different names on different systems; for example, **`[CONTROL]`**, or **`[CTL]`**.
`[KEY-1]-KEY-2`	Connected keys indicate that you must press the keys simultaneously; for example, **`[CTRL]-C`**.
Click	Click means to position the mouse pointer on an item, then quickly depress and release the mouse button. This action highlights or “selects,” the item clicked.
Double-click	Double-click means to position the mouse pointer on an item, and then click the item twice in rapid succession. This action selects the item “double-clicked.”
Drag X	Drag X means to move the mouse pointer to X, then press the mouse button and hold it down, while keeping the button down, move the mouse pointer.
Press X	Press X means to move the mouse pointer to the X button, then press the mouse button and hold it down.
ATTENTION	The attention icon appears beside a note box containing information that is important.
CAUTION	The caution icon appears beside a note box containing information that cautions you about potential equipment or material damage.
WARNING	The warning icon appears beside a note box containing information that warns you about potential bodily harm or catastrophic equipment damage.

1. System Overview

The color measurement sensor is designed for on-line measurement of color, brightness, fluorescence, and whiteness on a moving paper web. In this manual, model Q4215-60 for Experion MX is discussed.

The color sensor consists of a color measurement module (CMM), as seen in Figure 1-1, and a color backing module (CBM), as seen in Figure 1-2.

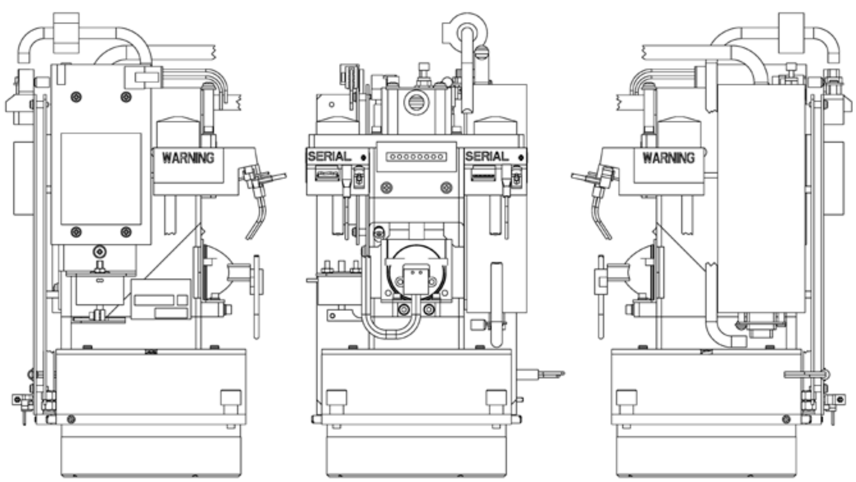


Figure 1-1 Color Measurement Module

The CMM contains the illumination and receiver optics, and the measurement hardware and firmware.

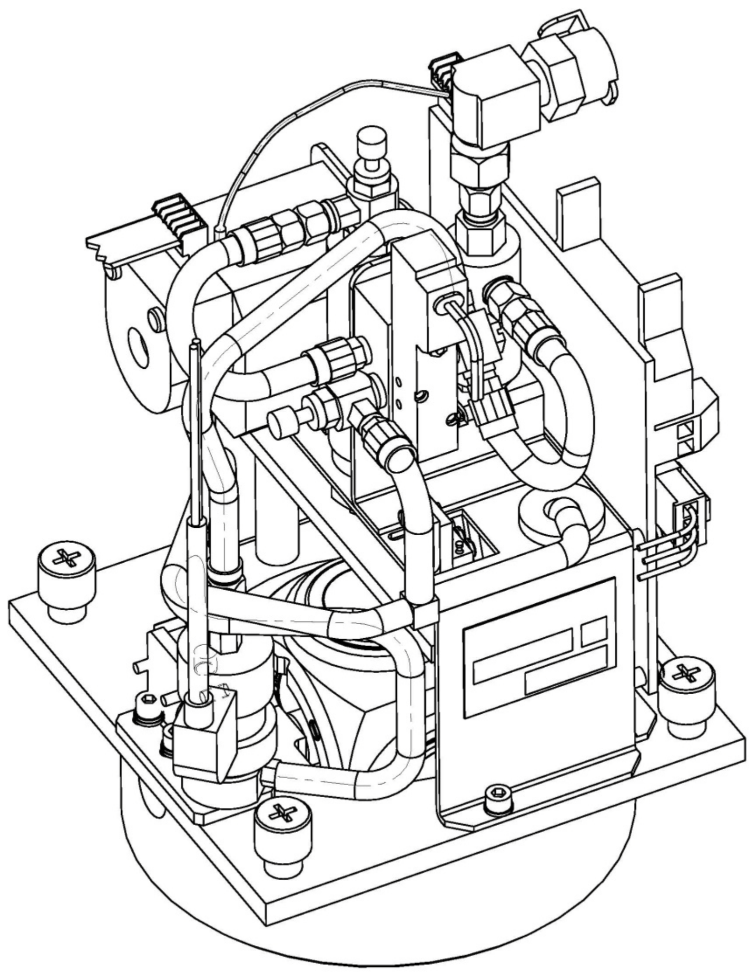


Figure 1-2 Color Backing Module

The CBM contains the standards and the apparatus that controls and backs the paper during on-line measurement.

Figure 1-3 is a schematic view of the color sensor that highlights the principle components of the CMM and CBM. This manual describes these components and their principles of operation.

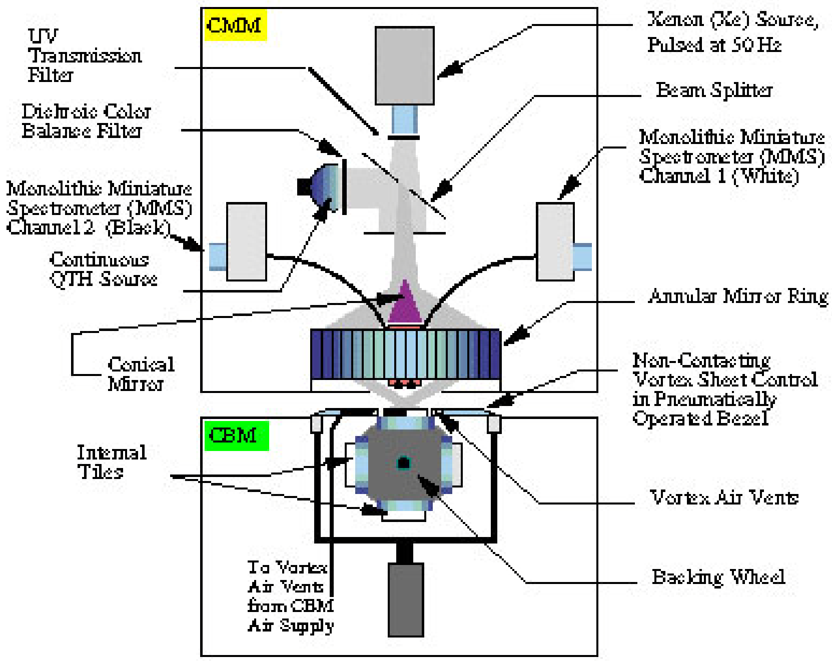


Figure 1-3 Schematic Diagram of the Color Sensor

1.1. Color Measurement Module

The CMM contains:

- two illumination sources
- illumination and receiver optics
- two spectrometers
- the color processor board

Together, these components shine light on a sample, view the reflected and emitted light, compute reflectance and apparent reflectance factors, R(λ) and R'(λ|S), and color coordinates such as L*, a*, b*.

The CMM also communicates with the quality control system (QCS) server via the Measurement Sub System (MSS), and the CBM.

Figure 1-4 and Figure 1-5 show the principal hardware components of the CMM.

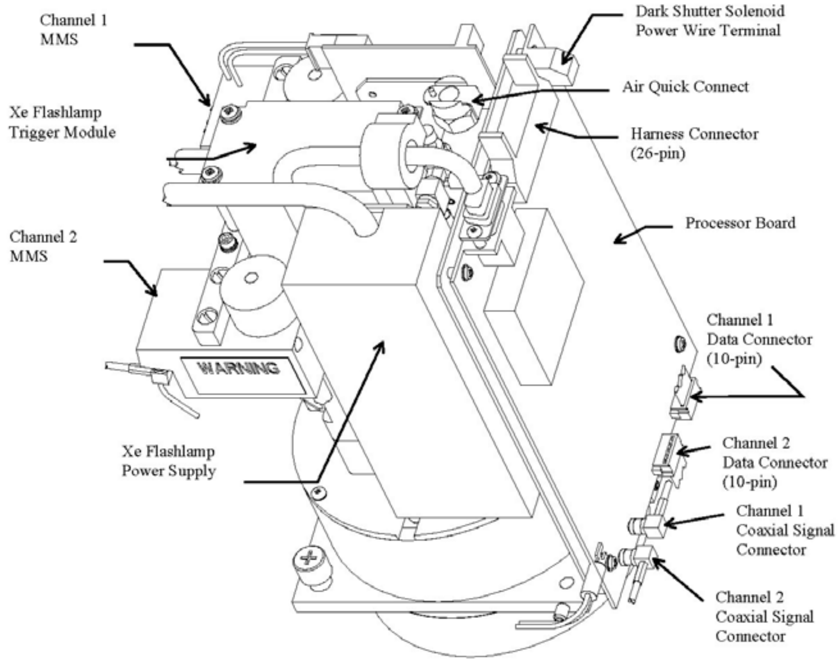


Figure 1-4 Color Measurement Module (right view)

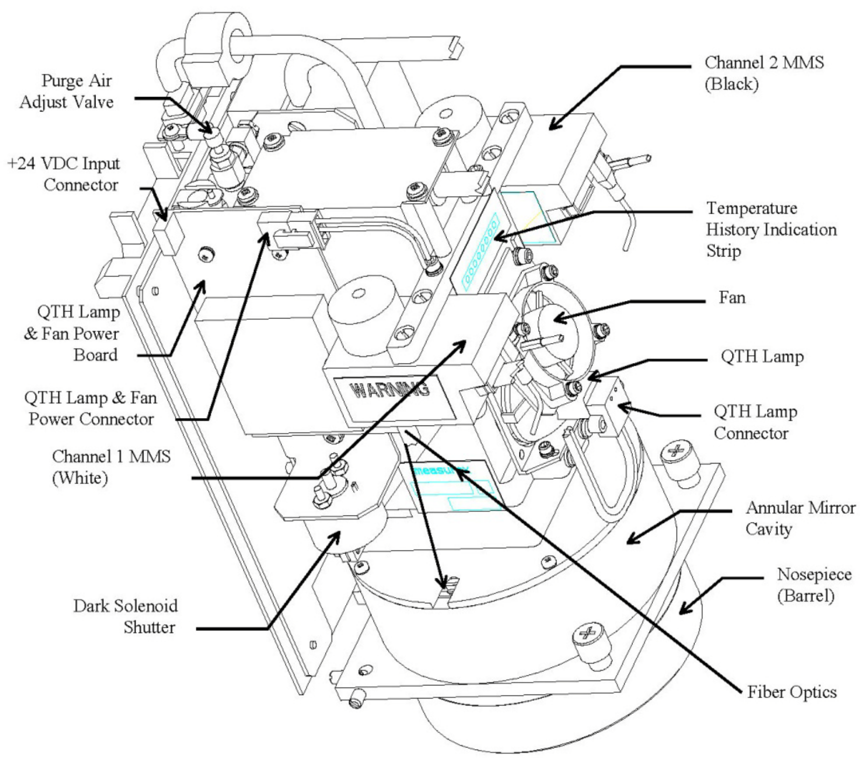


Figure 1-5 Color Measurement Module (left view)

1.1.1. Illumination System

The color sensor contains two physical light sources providing two illumination conditions:

- S1 with lamp 1
- S2 with lamp 1 and lamp 2

Lamp 1 is a quartz tungsten halogen (QTH) lamp that provides the illumination mainly for the visible part of the color measurement. A cold-mirror parabolic reflector is an integral part of the QTH lamp and creates a collimated light beam that passes through a daylight balancing filter (dichroic color balance filter) and projects laterally onto the beam-splitter and then downwards, merging with light from the xenon flash lamp (see Figure 1-1).

Lamp 2 is a xenon flash lamp. A lens assembly in front of the flash lamp collimates the light into a beam. The beam passes through a filter (UV transmission filter) that transmits mainly the UV component of light, but largely blocks the visible component (see Figure 1-3). The filtered UV light passes through the beam-splitter and merges with the visible light from lamp 1. The combined light beam strikes a cone reflector (conical mirror) and is then reflected downward and outward. This diverging cone of light then strikes an annular mirror that re-directs the light to a cone converging on the measurement zone at a 45° angle of incidence. The light provides uniform illumination of a zone approximately 25 mm (1 in) in diameter.

1.1.2. Detection System

The detection system views two separate regions in the sample area. Reflected and emitted light from the white backing region of a backing tile is viewed by measurement channel 1, and light from the black backing region of a backing tile is viewed by measurement channel 2. Focused by a lens, light from each region is imaged onto a fiber-optic bundle and is then transmitted into a monolithic miniature spectrometer (MMS) unit.

1.1.3. Color Sensor Processor

The color sensor processor is the system controller and data processor. The processor controls the flashing of lamp 2 and reads the output of both spectrometers twice during each 20 ms flash interval (once during the flash instant, and once between flashes).

A contact output from the color processor controls the dark shutter, inserted as a phase of the standardize (self-calibration) cycle. The shutter is used to block the light path providing conditions to measure the electrical and ambient light backgrounds of the spectrometers. When the shutter is inserted, it blocks the merged beam of light just before it strikes the cone reflector.

There are two communication ports on the color processor. COM1 provides communication with the host computer, receives commands and configuration data, and sends results. COM2 provides communication with the CBM.

1.2. Color Backing Module

The CBM (see Figure 1-6, and Figure 1-7)serves two main purposes:

- stabilizing and backing the sheet during measurement
- housing and controlling the tiles used to calibrate the sensor during standardization

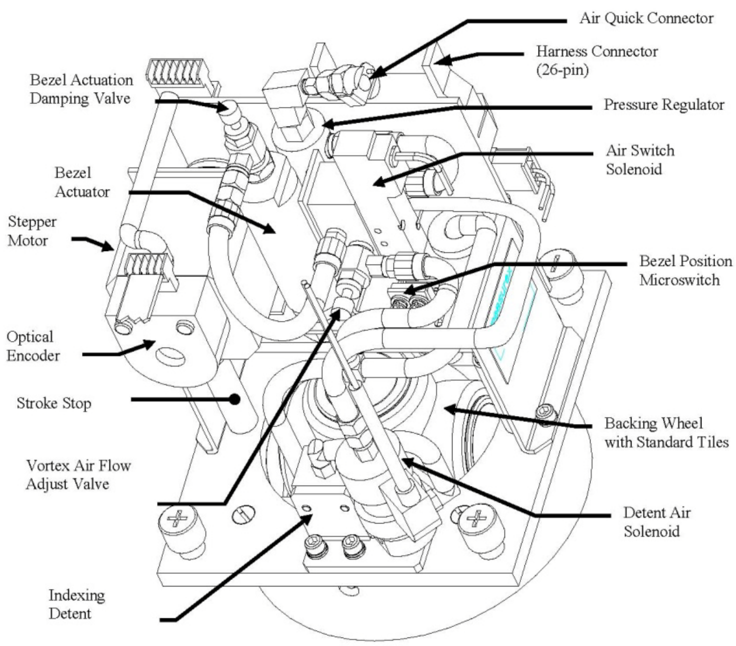


Figure 1-6 Color Backing Module (front view)

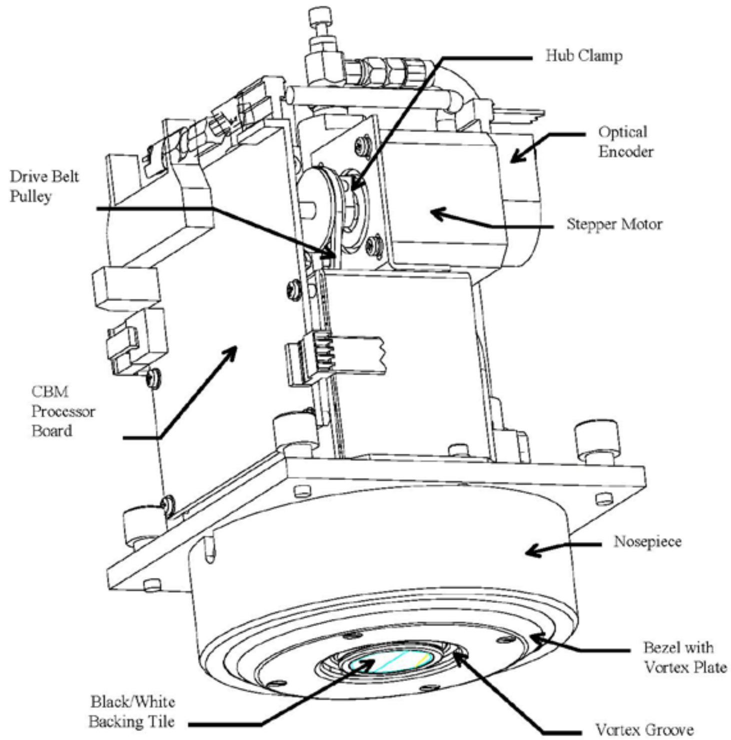


Figure 1-7 Color Backing Module (left view)

1.2.1. Bezel and Actuator

A stainless steel bezel surrounds the black/white backing tile. While the top surface (the vortex plate) of this bezel is normally at the sheet passline (at almost the same height as the exposed tile), the bezel can be raised.

Before the wheel can be rotated, the bezel must be raised by means of an air actuator (pneumatic cylinder) that is controlled by the CBM processor. The bezel can only be fully lowered when the wheel is in its home run-tile position (wheel position 1–black/white backing tile).

1.2.2. Stepper Motor and Optical Encoder

The stepper motor is a four-phase, 200-step per turn motor that rotates the backing wheel between the four tile positions. A toothed drive belt connects the stepper to the backing wheel. The stepper has an integral optical encoder that provides the CBM microprocessor with positive confirmation whenever the stepper and wheel are in one of the four valid tile positions.

The optical encoder also provides a separate confirmation when the wheel is in its home run-tile position (wheel position 1). Power to the stepper motor is switched off when it is in its home run-tile position, lowering the overall heat-load to the enclosure.

1.2.3. Tile Wheel Indexing Detent

The indexing detent is an air solenoid that retracts when the tile wheel is rotating. It inserts when the tile wheel is in position, thereby locking the tile wheel in the correct orientation.

1.2.4. Tile Wheel

The CBM houses a tile wheel that contains four tiles:

- position 1 (North): black/white backing tile
- position 2 (East): white tile
- position 3 (South): fluorescent tile
- position 4 (West): yellow-check tile

The positioning of this tile wheel is controlled by the stepper motor driven by the CBM controller. The tile wheel protrudes through the sheetguide so that the exposed surface of the selected tile is at the mid-line of the gap between the heads, nominally 5 mm (0.2 in) above the sheetguide.

1.2.5. Tiles

With the exception of the backing tile, the tiles are used during the standardize operation, as described in this section. See Chapter 11 for tile cleaning instructions.

1.2.5.1. Black/White Backing Tile (wheel position 1)

During measurement, the black/white tile provides the required backing for Kubelka-Munk-based infinite stack estimation method. When scanning or manually sampling, the paper rides close to the tile, but does not touch it.

The black/white tile is composed of black and white halves. The black half is made from a cover glass painted a flat black on the under surface. The white half is glazed alumina. Both surfaces are smooth and hard, and can be easily cleaned using clean water and a soft cloth.

The white side of the black/white tile should always correspond to measurement channel 1; the black side should always correspond to measurement channel 2.

1.2.5.2. White Tile (wheel position 2)

The white tile is the basic reference against which all other reflectivities and thus color coordinates are measured. The sensor firmware knows the reflectance factor, $R(\lambda)_{Tile\text{-}white}$, of this tile based on information inside the sensor firmware. The white tile is formed from a pressed pellet of a highly reflective white powder enclosed behind a thin cover of glass.

1.2.5.3. Fluorescent Tile (wheel position 3)

The fluorescent tile ensures calibration of the fluorescent-exciting energy of the xenon flash lamp and QTH lamp. The surface of the fluorescent tile is a plastic matrix containing a stable fluorescent material. The tile is made of soft, light-sensitive material.

Keep the fluorescent tile in a protected, dark environment when it is not installed in the sensor. Ultraviolet overexposure is not a problem in normal operation because the tile is exposed to the light for only a few seconds during each standardization interval, which is normally once per hour. Keep this in mind when testing or troubleshooting the sensor, for example, when sampling one tile.

1.2.5.4. Yellow Check Tile (wheel position 4)

The yellow-check tile is fabricated from a disk of yellow-colored ceramic tile. It is used as a verification check of the sensor performance during sensor standardization. It is a known issue that scanner head temperature affects the check tile readings, because it is thermocromic, but it is not a problem if the environment is stable within a degree.

1.2.6. Vortex Sheet Stabilizer

The vortex plate of the bezel contains air ports slotted tangentially into the vortex groove, concentric around the black/white backing tile. When the bezel is down (scanning position), air is ejected from these slots, forming a whirlwind that surrounds the black/white backing tile. If a product sheet is present, within a few millimeters of the bezel, negative pressure pulls the sheet against the bezel and black/white backing tile. An air-bearing effect counters this pulling by pushing the sheet slightly away from the bezel so that the injected air can escape. When the bezel is risen and the color sensor is powered, there is no air-flow through the vortex.

1.2.7. Color Backing Module Processor

The CBM processor controls the stepper motor, indexing detent, and the bezel actuator. It reads the stepper motor encoder and bezel position switch to ensure proper function. The CBM is functionally slaved to the CMM processor. Communication between the CBM and the CMM is performed using a dedicated RS 422 link.

Normally, the CBM initiates actions only when explicitly requested by the CMM. However, there are three exceptions:

- if the CBM determines that the last requested action has not properly executed, it attempts to perform the action one additional time
- if the CBM determines that the bezel is not retracted when it powers up, it will attempt to drop the bezel by rotating the wheel to home position
- if the CBM is in diagnostic mode

1.3. Measurement Principle

In the laboratory, a sample is traditionally backed by an *infinite pad* of the same paper for the color measurements. On the process, where only a single sheet is measured, the color sensor backs the sheet with a half-white and half-black backing. Annular (360°) sheet illumination with the 45/0 measurement geometry provides measurement insensitivity to fiber orientation, where the sheet is illuminated at angle of 45° to the normal of the sheet and viewed at normal to the sheet.

Two fiber optic bundles collect reflected and emitted light from the sheet surface normal to the plane of the sheet. One fiber optic bundle views the black-backed portion of the sheet; and the other views the white-backed portion of the sheet. Using equations based on the Kubelka-Munk model of light absorption and scattering, with proprietary improvements, the black- and white-backed reflectances are used to compute an opacity-insensitive infinite pad color and appearance.

Fast fluorescent color measurement is obtained by merging the beams of a continuous daylight source and a pulsed UV-enrichment source with known properties of the fluorescent tile using proprietary equations.

The QCS server is used to set up and communicate the desired color measurement setup into the color sensor, such as color co-ordinate system and a selected pair of the CIE illuminant and observer. All required tables for CIE illuminants and observers as well as for brightness are stored in the color sensor firmware. Based on this knowledge, the firmware uses correct standard tables and other parameters to be used on the color calculations for CIE tristimulus values X, Y, Z, and brightness. Calculations of other color spaces are done in the QCS server.

During measurement onsheet, the CMM processor acquires color data in two modes:

- averaging a raw spectral data over the measurement interval (normally 100 ms), now, color measurement
- averaging a raw spectral data over the whole scan, end of scan (EOS) color measurement

In the EOS measurement the CIE tristimulus values X, Y, Z are also evaluated for a defined secondary illuminant in the color sensor. Typically this secondary illuminant is CIE illuminant A.

For more details on steps of computing color and appearance values, refer to *Color and Coloring of Paper Reference Manual*.

1.4. Color Sensor Specifications

The color and appearance of a sheet can be different on two sides of the sheet. Usually only a top-side color of the sheet is measured and controlled. A color sensor that is mounted with the CMM in the upper head is referred to as a *top color sensor*. A color sensor with the CMM in the lower head is referred to as a *bottom color sensor*.

Any typical spectrophotometer cannot accurately measure fluorescence produced by the daylight fluors. Such daylight fluors are typical safety colors: yellow and orange. In 2011, all typical spectrophotometers were optimized to measure only non-fluorescent and white fluorescent specimens containing only fluorescent whitening agents (FWAs/FBAs/OBAs).

Table 1-1 contains the specifications and produced onsheet color measurements for a selected pair of the CIE illuminant and the CIE standard observer.

Table 1-1 Q4215-60 Color Sensor Specifications

Instrument	**Specifications**
Measurement geometry	45/0 with circumferential illumination
Wavelength range	350 nm to 750 nm
Wavelength resolution	5 nm
Reflectance range	0–200% R
Reflectance resolution	0.01% R
Opacity range	60–100%
Illuminants	CIE: A, C, D65, D50
Observers	CIE: 2° (1931), 10° (1964)
Each bin measurement: Fluorescence-suppressed of corrected	
Color	CIE L*, a*, b* or Hunter L, a, b or DWL, EP, Y or X, Y, Z
Brightness	GE or TAPPI or ISO or D65
Fluorescence index	ΔBrightness or ΔZ or ΔGE
Appearance	CIE Whiteness
End-of-scan measurement: Fluorescence-corrected and suppressed	
Color	CIE L*, a*, b* or Hunter L, a, b or DWL, EP, Y or X, Y, Z
Brightness	GE or TAPPI or ISO or D65
Fluorescence index	ΔBrightness or ΔZ or ΔGE
Appearance	CIE Whiteness
Total color error	ΔE_{Lab} or ΔE_{CMC}
Spectra	R’(λ|S) fluorescence-corrected (FC) and R(λ) fluorescence-suppressed (FS)

2. EDAQ

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

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

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

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

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

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

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

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

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

2.1. Physical Layout

Figure 2-1 and Figure 2-2 show the EDAQ PCBA (p/n 6581500030) as it is mounted next to a sensor. To the left are the digital and analog I/O, which connect directly to a sensor. Below these two large connectors is a 16-pin expansion connector that is only used when the EDAQ is attached to the frame controller (FC) expansion board (p/n 6581500032).

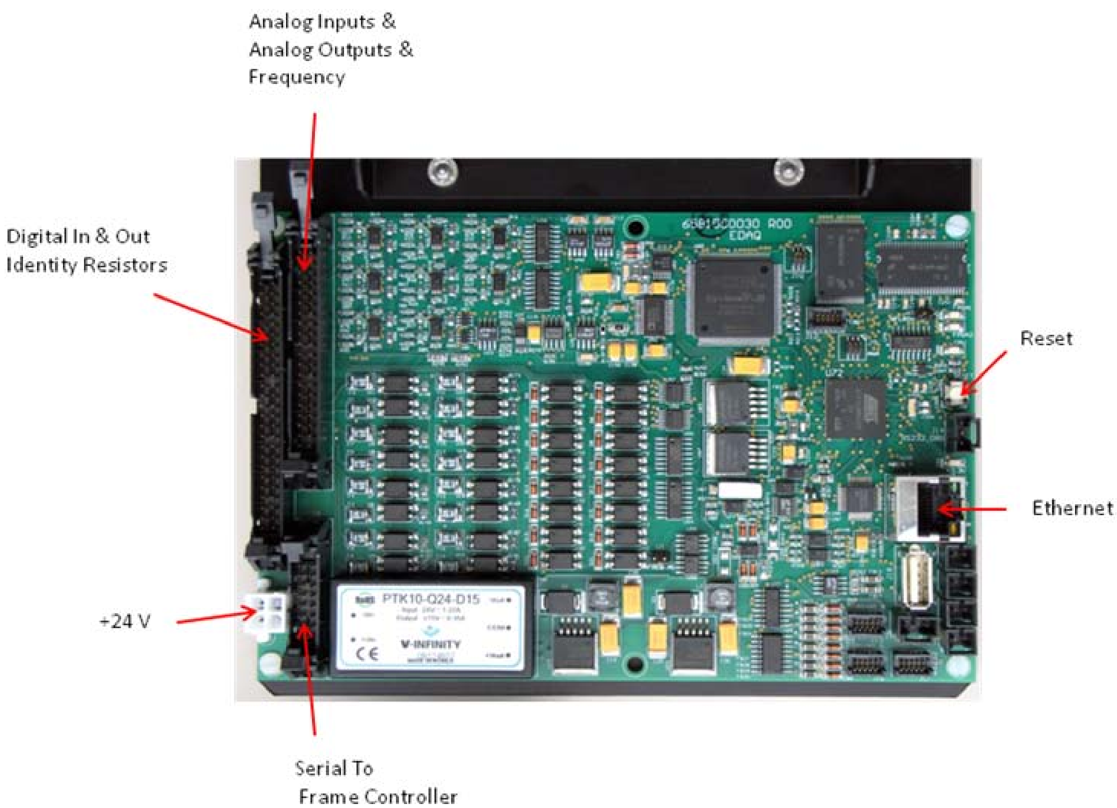


Figure 2-1 EDAQ Board

J1 is the large 50-pin connector on the far left. J2 is the smaller 40-pin connector. J8 on the lower left is used for the FC only.

To the right are the Ethernet port, some diagnostic LEDs, serial connections, and temperature inputs. There are no test points for use in the field. A serial debug port is available (115200 kb/s, no flow control, 8N1) that may be connected to any PC running a serial terminal program. For diagnostic purposes, service personal may be asked to connect a serial cable between this debug port and the RS-232 of any neighboring EDAQ.

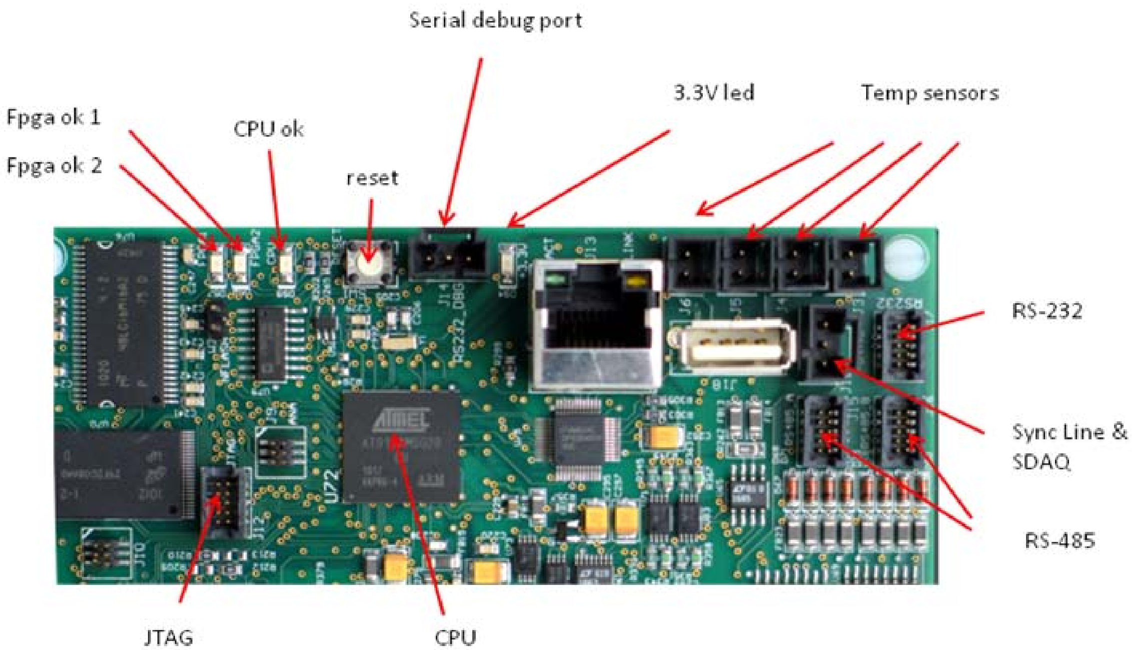


Figure 2-2 EDAQ Board: Ports and Diagnostic LEDs

2.2. Hardware Status Information

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

- The *3.3 V LED*. When lit, this indicates that all power supplies on the board are functional. The signal is derived from the 3.3 V power supply, which in turn is derived from the 15 V power supply, which is derived from the + 24 V input.
- The *CPU OK LED*. This LED is under control of the central ARM CPU. It will be lit when the main sensor application (edaqapp) is running on the CPU.

- The *Fpga ok 1* (not used at present).
- The *Fpga ok 2*. This LED will blink if the FPGA is loaded and running code.

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

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 real-time application environment (RAE) 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 manual to troubleshoot if the EDAQ does not identify itself properly (or to find the correct resistor values).

Every EDAQ has a unique IP address on the scanner network. If the EDAQ can identify its position, it will set its IP address to 192.168.0.*XYZ* (where *XYZ* is the position number in the head. The 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 manual.

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

2.5. Obtain Status Information

2.5.1. Experion MX Platform

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

Figure 2-3 shows, on the left, a list of all expected EDAQs with three types of status indicators (from left to right):

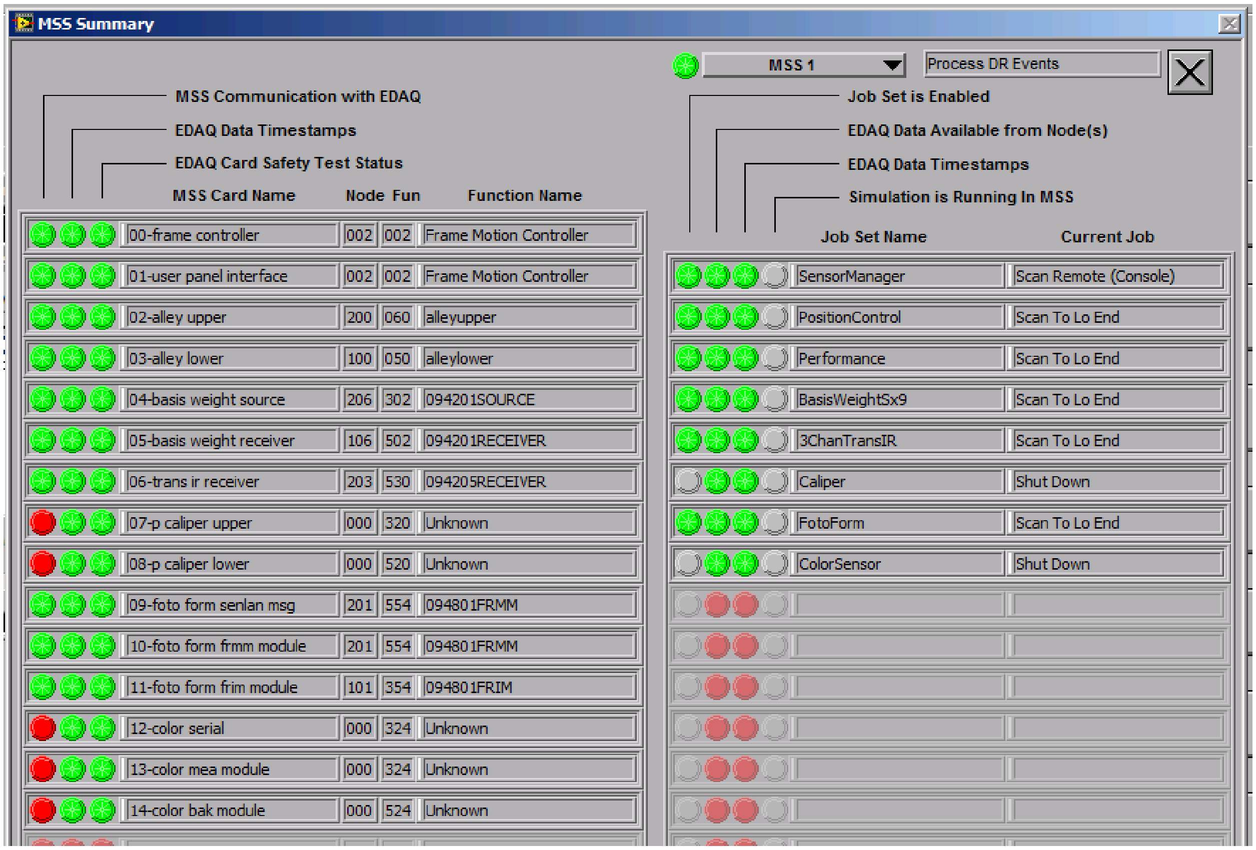


Figure 2-3 MSS Summary

Table 2-1 MSS Summary Display Status Indicators and Descriptions

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

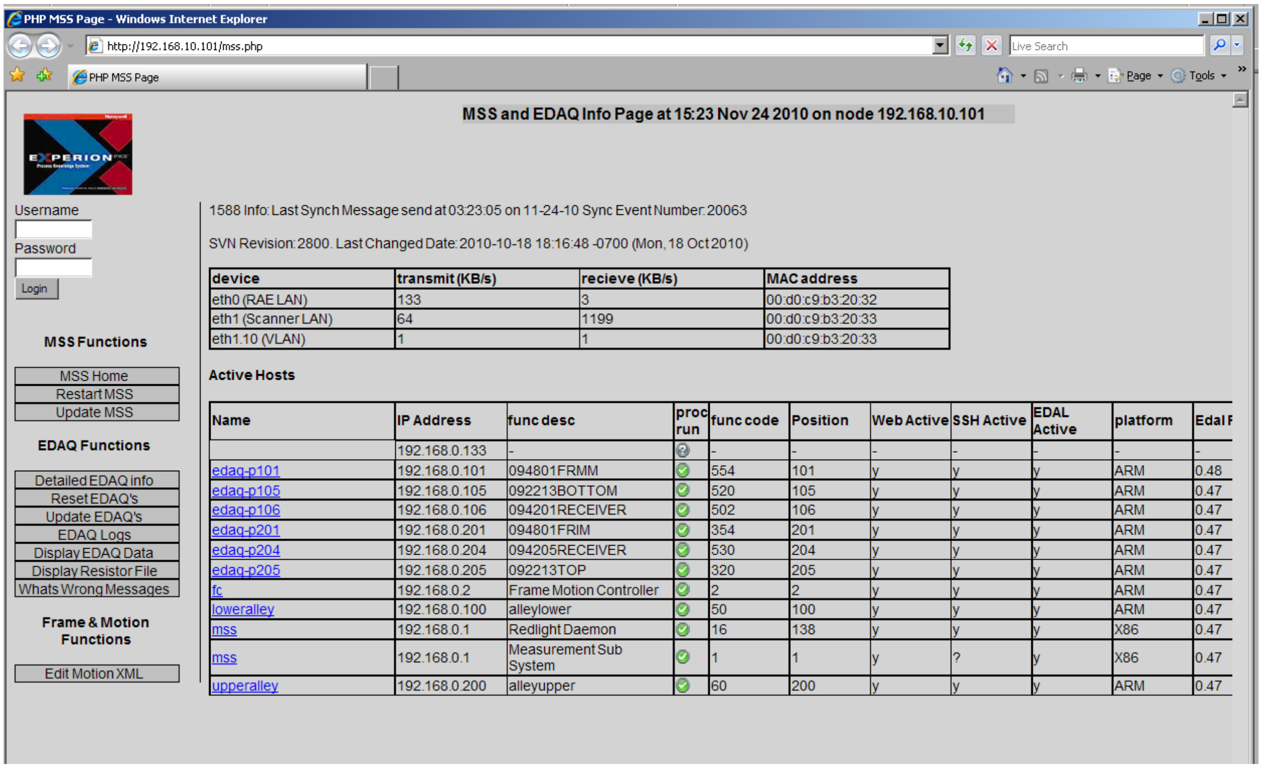
Sensors that are part of the RAE database but are not enabled on the scanner show the left most column indicator as red, for example, *07-caliper upper* in Figure 2-3.

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:

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

Figure 2-4 shows the main MSS Web page (**PHP MSS Page**).



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

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 2-4 PHP MSS Page

The left panel shows a column of options divided into:

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

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

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

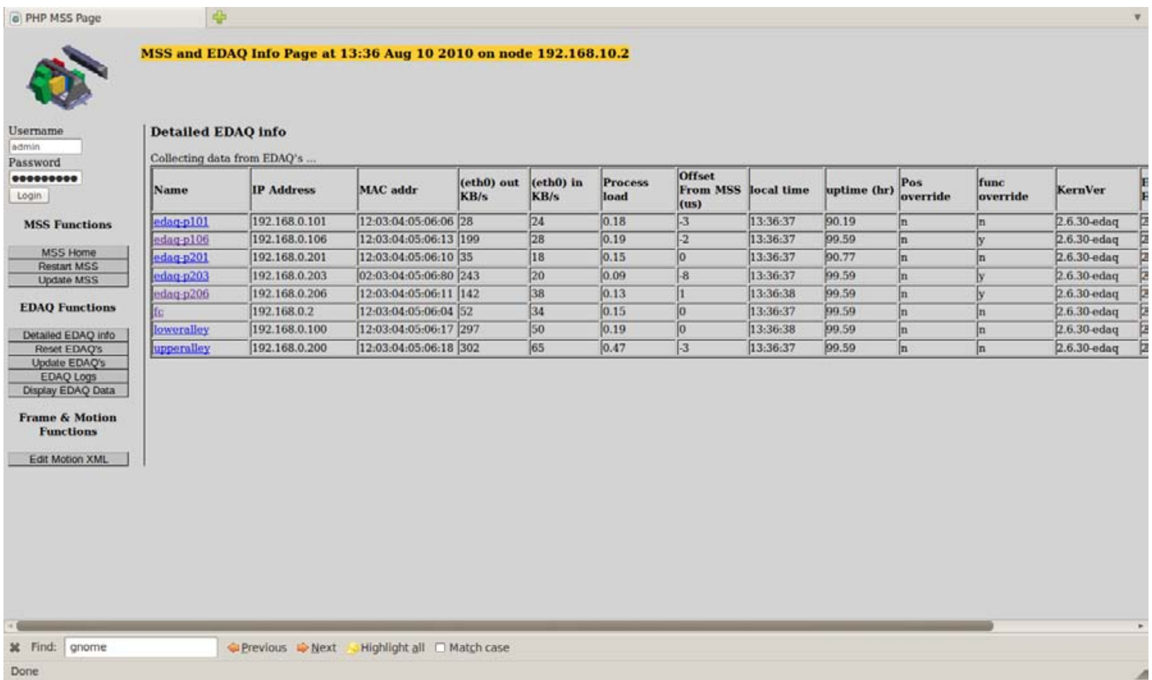
The second table lists all EDAQs discovered on the scanner LAN, their IP numbers, a brief description (related to model number), a program status column, the associated function code and position code, and whether the communication protocols are running (http, ssh and Edal, the proprietary sensor data 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 2-5) 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 2-5 Detailed EDAQ Information: Partial Display

3. Installation

This chapter describes and provides instructions installing the color sensor into the Experion MX Q4000 scanner, including the mechanical and communication aspects.

For information about how to choose a location for the color sensor at a paper machine and tips for possible process challenges, see Subsection 3.2.9.

3.1. Hardware Configuration

The Q4215-60 color sensor is installed into the Experion MX Q4000 scanner as an inboard sensor. The orientation of the color measurement sensor is such that the quartz tungsten halogen (QTH) lamp and the color processor locating at the opposite side of the sensor are lined up with a running web direction.

3.2. Installation Procedure

Do not power-on the color sensor scanner unless instructed.

This procedure includes real-time application environment (RAE) server stops and starts. If there are any special instructions on the site, for example, how to shut down or start the servers, or in which order those steps should be done, follow your local instructions. This situation is met, for example, if there are data collecting systems or links which need special start and stop steps.

There is no on/off switch on the color sensor. When there is a request to power on/off the color sensor, it means that the scanner has to be powered on or off.

CAUTION

Use UV-graded safety goggles if it is necessary to look into the color measurement module (CMM) illumination.

Turn the power off from the color sensor scanner before plugging and/or unplugging, or installing any cables or boards.

Do not attach the cables to the color sensor or turn on the power until you have checked the wiring.

Because of the color backing module (CBM) bezel, the gap of the scanner heads has to be exactly correct and not less than 10.0 mm (0.40 in). If not, the bezel will hit the opposite head with force and break the material.

The color sensor CBM contains the rising bezel that rises to the gap when requested, for example, during standardization. Be careful that there is nothing else in the gap during this installation procedure.

3.2.1. Mounting the Sensor

Power-off the scanner before proceeding. The CMM and CBM 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 CMM into the upper head. If the configuration is to measure the bottom side of the sheet (relative to the scanner), mount the CMM into the lower head.

The CMM and CBM of the color measurement sensor are mounted on the base plate to be easily installed and removed from the scanner head. This assembly includes the EDAQ, which is mounted next to the sensor. See Figure 3-1 and Figure 3-2.

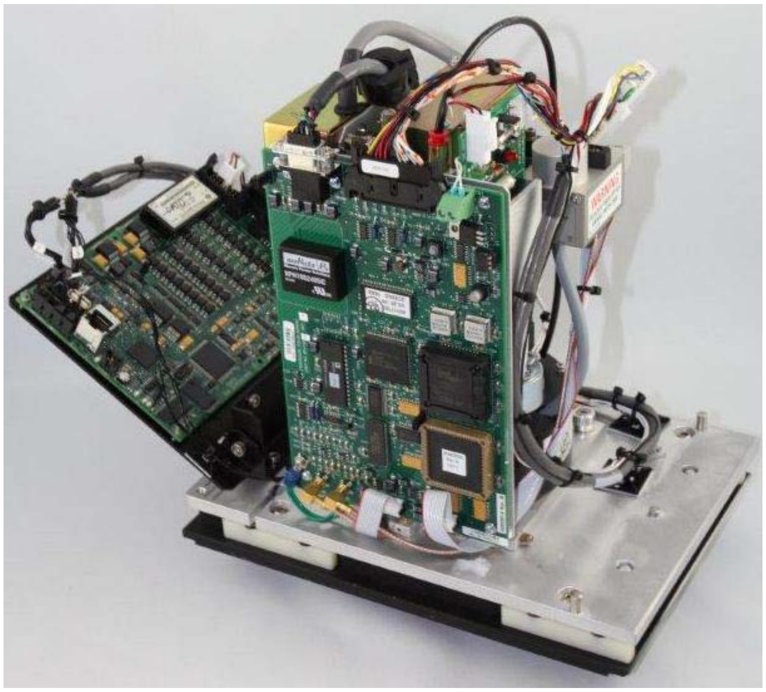


Figure 3-1 Color Measurement Module (on sensor base with EDAQ)

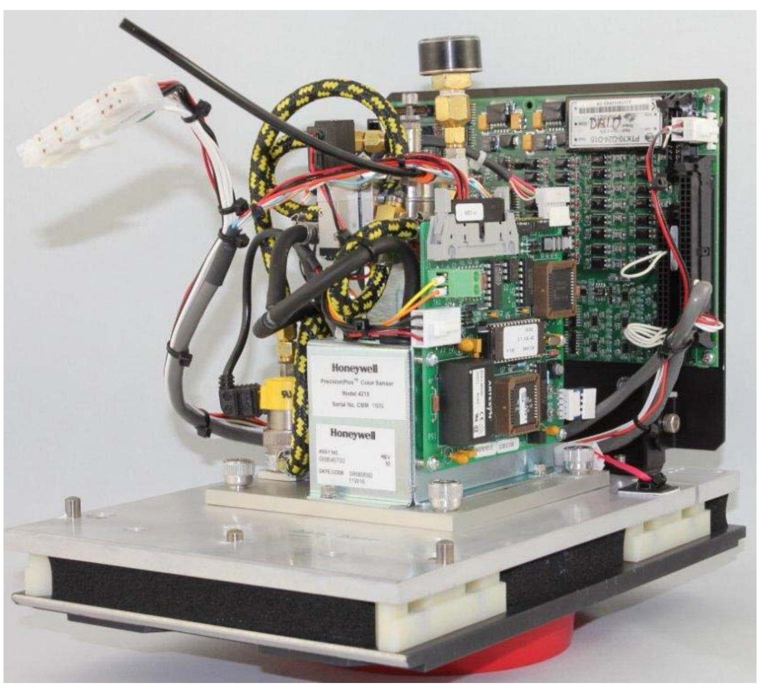


Figure 3-2 Color Backing Module (on sensor base with EDAQ)

The cables and the fiber-optical bundles of the color sensor can be easily damaged. Never use them as handles, nor pull, twist, or bend them sharply. Exercise care when mounting or removing the color sensor. Also take care to avoid unintended detaching of any wires and/or cables.

To mount the color sensor:

1. Record CMM temperature label reading for later use.
2. Record CMM firmware chip label for later use.
3. Record CBM firmware chip label for later use.
4. Record CMM spectrometer serial numbers for later use.
5. Verify that the spectrometer and their calibration record serial numbers match. If you cannot see the model plate clearly, unscrew the spectrometers from the stand before checking the serial numbers.
6. Check any documents coming with the sensor, especially reference correct serial numbers of the spectrometers.
7. Check both the CMM and CBM that there are no visibly broken parts, for example, bad cables.
8. Check that every cable is connected properly.
9. Check that the shutter on the CMM moves freely by finger.
10. Check that the QTH lamp is firmly in-place.
11. Check on the CBM the bezel height and that position lock/adjust is not broken or changed from the original.
12. Do a preliminary air valve adjustment (see Figure 1-4 and Figure 1-6).
13. In the CMM, adjust CMM airflow to half from fully open (Purge Air Adjust Valve).
14. In the CBM, adjust CBM vortex airflow to fully open (Vortex Air Flow Adjust Valve).
15. In the CBM, adjust bezel valve (Bezel Actuation Damping Valve) to fully close.
16. If the installation style is bottom CMM, then mount the CMM with four screws and ensure that there are no studs.

17. Adjust the four set screws on the CMM baseplate so they click firmly around the grooved studs when the sensor is installed and mount the CMM with two finger screws.

18. After mounting, check that the QTH lamp is firmly mounted onto its base. When sliding the lamp in its base, the lamp should click into its groove.

19. Mount the CBM opposite the CMM so that CMM and CBM processor boards face the same direction.

3.2.2. Attaching Air

Proper air supply pressure is essential to the operation of both the CMM and CBM.

To attach air:

1. Use the supplied hoses and attached fittings. Ensure that there is a pressure gauge mounted on both air supply lines for the CMM and the CBM.

2. Connect the air hose to the CMM air connector.

3. Connect the air hose to the CBM air connector.

4. Verify that the pressure gauge on the CMM and CBM enclosures reads a minimum of 40–45 psi under operating conditions. The bezel will not operate properly if the air pressure is lower.

5. Verify that the purge air adjut valve for the CMM optics purge is half open (see Figure 1-4).

6. If there is a dust build-up on the window and lenses, experiment to find a good flow strength.

7. Verify that the vortex flow control valve on the CBM is fully open (see Figure 1-6 for the location of the valve). Close the valve slightly only if experience demonstrates that less air flow is required for adequate sheet stabilization or to reduce dust accumulation for the black/white backing tile.

8. Verify that the bezel valve on the CBM is fully closed (see Figure 1-6 for the location of the valve). Open the valve approximately two rounds. This valve affects how fast the bezel rises to gap.

If the valve is closed too far, the bezel will not rise. If the valve is open too far, the bezel will impact the CMM module nose piece.

When the color sensor is powered on the first time, adjust this valve so the bezel rises smoothly and quickly enough, but without too much force. Valve adjustment depends directly on incoming input pressure.

3.2.3. Power Supply for Color Sensor

The color sensor has an electrical connection to the scanner. Default cables supplied through the EDAQ board are labeled (see Figure 3-3).

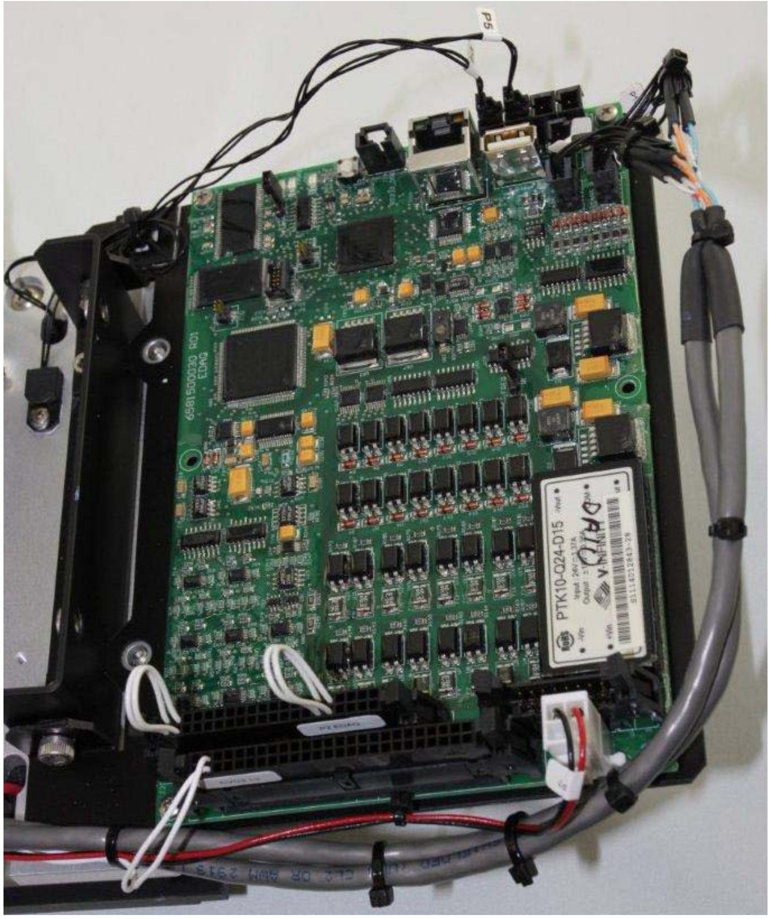


Figure 3-3 EDAQ Board

3.2.4. Checking Installation and Sensor Communication

To verify successful installation and confirm working communication:

1. Power off the sensor and the scanner.
2. Shut down RAE.
3. Shut down quality control system (QCS) server.
4. Wait at least 20 seconds.
5. Power-on the sensor and the scanner.
6. Verify that the tungsten lamp is on in the CMM.
7. Verify that the led DS1 on the CMM processor board is blinking green/red.
8. Restart the QCS server and RAE.
9. On QCS server using the Measurement Sub System (MSS) summary page (**MSS Summary** page), verify that **MSS Communication with EDAQ**, **EDAQ Data Timestamps**, **EDAQ Card Safety Test Status** have green status.
10. On QCS server using **MSS Summary** page verify that **ColorSensor's Job Set** is **Enabled**, and **EDAQ Data Available from Node(s)**, **EDAQ Data Timestamps** have green status.
11. Navigate to **Color → Color Space Window → Color Diagnostic**.
12. Select **Request CMM Board Temp/Reference Voltage** and click **HW Request**.
13. Verify that board temperature is below 42 °C (107.6 °F).
14. Verify that **CMM Revision** match to FW-chip label and it is the correct one for your QCS system.
15. Select **End Diagnostic Return** to **Normal Condition** and click **HW Request**.

3.2.5. Checking Sensor Functions

Using the database browser, check and save to permanent, if needed, so that:

1. *./Scanner #/Mss/Ss# color/Setup/Reference* time ms = 37000 and *./Scanner #/Mss/Ss# color/Setup/Sample* time ms = 6000

2. Power-off the sensor and the scanner.

3. Navigate to **Color Space Window → Color Firmware errors** and click **Press to Clear** to clear the error table.

4. Wait and power-on the sensor and the scanner.

5. Perform two consecutive standardizations using the scanner onsheet/offsheet or **manual stdz** function. Do not be concerned about bad standardize at this point.

6. Perform a standardization using the scanner onsheet/offsheet or **manual stdz** function.

7. Check messages on **Color Firmware Errors**. There should be no error messages, only information messages such as **Reset occur**, **Reconfig occur.** For more details on error messages, see Table 4–2.

8. Check **Scanner Sensor Status** display for bad standardizations.

9. Check **Sensor Reporting** display for **COLORP Standardize Report** that there is a last standardize with non-zero numbers.

If you find any errors during this procedure, see Chapter 12 for troubleshooting assistance.

3.2.6. Scanning Without the Color Backing Module

If it is necessary to remove the CBM from the scanner, you cannot scan unless you short out the following two pins on the 26-pin cable connector that normally go to the CBM board:

- Pin 10 GND

- Pin 12 SCAN OK

A shorting plug is attached to the CBM cable for this purpose.

3.2.7. Default Configuration and Calibration Values

All user-configurable configuration or calibration parameters for the color sensor are stored in *QCS Recipe* database. Some system configuration values will be in the *Permanents* database. Create the recipe called **COL_CHECK** (general grade code) and color recipe called **COLOR_INS** (installation) at this point, and use during basic checking. This recipe is not dependent on the customer settings. Set offsets to zero.

3.2.8. Primary Performance Evaluation

Check the standardization values of the color sensor and also its preliminary stability:

1. Load grade code **COL_CHECK**.
2. Do a manual standardization.
3. Enter maintenance mode using grade code **COL_CHECK** and color grade code **COLOR_INS**.
4. Perform 30 references.
5. Perform 30 samples (with empty gap) using the white tile.
6. Navigate to the **Sensor Report** display.
7. Check nominal ranges of standardization and reference values using Table 3-1.
8. Check that achieved standardization values are not too close to the standardization check limits values using Table 3-2.
9. If a problem arises, see Chapter 12.

Table 3-1 Nominal Ranges of Standardization and Reference Readings

Description	Nominal Range
Channel 1, 2 Maximum	50–85
Channel 1, 2 Minimum	≤ 8
Channel 1, 2 Noise	< 0.2
Blue intensity (tungsten)	> 35
UV intensity (xenon)	> 7
Stability (tungsten)	< 0.25
Stability (xenon)	< 0.4

Description	Nominal Range
Blue channel balance (tungsten)	0.85–1.15
Xenon lamp UV balance	0.85–1.15
Check tile channel balance	< 0.39
Fluor Std Emission(Fl (xenon)	> 7
Check tile X	50–75
Backing tile Y (white)	> 75
Backing tile Y (black)	< 5
CMM board temperature	38–42 °C (100.4–107.6 °F), and stays within one degree
2σ of channel 1 or 2 Maximum	≤ 0.03 or 1% of the average reading, whichever is greater
2σ of Channel 1 or 2 noise	≤ 0.03
Color sensor error messages	None

Table 3-2 Standardization Check Limit Values

Line	Description	Limit Value
1	Channel 1 Noise	< 0.2
2	Channel 2 Noise	< 0.2
3	Channel 1 Maximum	50–85
4	Channel 2 Maximum	50–85
5	Blue intensity (tungsten)	> 35
6	UV intensity (xenon)	> 7
7	Stability (tungsten)	< 0.25
8	Stability (xenon)	< 0.4
9	Blue channel balance (tungsten)	0.85–1.15
10	Check tile channel balance	< 0.39
11	Fluor Std Emission Fl (xenon)	> 7
12	Check tile X	50–75
13	Backing tile Y (white)	> 75
14	Backing tile Y (black)	< 5
15	CMM Board temperature	38–42 °C (100.4–107.6 °F), and stays within one degree

For more information, see *Honeywell Technical Bulletin (p/n 6510493041)*.

Table 3-3 Standardization and Reference Limit Values in the Color Sensor Firmware

Description	Limit Value	
	Soft Limit	Hard Limit
Channels Dark average	< 10.0	< 15.0
Tungsten Lamp blue	> 15.0	> 10.0
Xenon lamp UV	> 2.0	> 1.0
Channel Noise	< 0.25	< 0.5
Channel minimum	> 0.25	> 0.05
Channel maximum	< 95.0	< 99.5
Tungsten noise	< 0.3	< 0.6
Xenon noise	< 0.5	< 0.8
Check tile FI	< 0.5	< 1.0
Check tile balance	< 0.4	< 1.0

3.2.9. Choosing Color Sensor Location

Choosing a location for the color sensor at a paper machine begins by understanding what color and appearance property and in which state of the produced product is wanted to be monitored and controlled.

Nearly all paper shading and dyeing is done as batch and/or continuous stock coloring affecting produced base paper. In addition to this, at size-press typically only fluorescent whitening agents are added.

In most cases, the main interest is to monitor and control the quality of the produced base paper. If the physical properties of the sheet are not changed during the papermaking process, which often is the case for most fine papers, the color sensor can be located in a scanner at the reel.

Paper making processes such as coating, crepping, calandering, super calandering and so on alter the structure of the sheet or the physical properties of the sheet surface. The effects of these processes on the color of the sheet cannot be modeled or separated from the coloring effect on the base sheet. This means that the color sensor needs to be located in a scanner before any of these kinds of paper making processes.

This may lead to different challenges between online and offline color measurement, for example, if the moisture content of the sheet is very low when the color is measured online. Unfortunately, color of the paper depends on its moisture and temperature condition.

3.2.9.1. Quality of Paper

The better the formation and general homogeneity of the paper, the easier the sampling between the online and offline will be.

If the paper contains water markings, small dirt particles, or any patterns, this makes sampling between the online and the offline very unreliable.

3.2.9.2. Ambient Conditions

The installed color sensor is protected in the head of the scanner. However, be concerned about these ambient conditions:

- high static electricity produced by the moving web causes dust accumulation and is a risk for the sensor electronics
- excessive dust from the web is a risk for well-performing color measurement
- excessive moisture is a risk for well-performing color measurement
- excessive temperature may be a risk for optical components

3.2.9.3. Passline Issues

The color sensor is designed to have the web running just on top of its black/white backing tile. If a spreader banana roll is installed before the scanner with the color sensor, it often forces the web in a specific profile such as *smile* or *frown*. This causes the running web to deviate from the backing tile, especially at the edges.

If the machine directional web tension varies significantly for any reason, this may also force the web to deviate from the backing tile.

4. Operation

This chapter assumes your system is based on the 3.2 or 3.3 firmware versions for Experion MX and Da Vinci of the color processor, and color backing module (CBM) firmware 15.0.

4.1. Operation Modes

The color sensor has eight operation modes. The operation mode changes either by user and/or system request, or by the color sensor internal software (firmware) request.

The modes are:

- wait for configuration data
- offline
- standardization (reference)
- idle
- scan
- sample
- diagnostic
- firmware error checking

4.1.1. Wait for Configuration Data

The wait for configuration data mode will occur only after the color sensor is powered up, or after the color sensor is reset. In this mode, the color sensor waits for the configuration data to be downloaded from the quality control system (QCS) server into the sensor.

The configuration data downloading can be done either manually or automatically depending on the system. After the configuration data is successfully downloaded, and the downloaded data has passed the configuration data checking done by the sensor firmware, the color sensor is ready for standardization. The color sensor must be standardized before it can measure.

Every time the color sensor is powered off and/or on, or the color measurement module (CMM) processor board reset-button is pressed, the color sensor loses the downloaded configuration data.

In some systems there may be a need to make two successful standardizations after the power-up of the color sensor.

4.1.2. Offline

The color sensor may be in offline mode after power-up and before a successful downloading of the configuration data. Offline mode can also occur at the time when the downloaded configuration data checking done by the sensor firmware fails (fatal error).

Offline mode does not prevent the usage of some diagnostics commands. To get the color sensor on-line, it has to perform a successful standardization.

4.1.3. Standardization

Standardization is a self-checking routine of the color sensor. During standardization mode, the color sensor configures and calibrates itself and completes some checking to secure good on-line color measurements.

The downloaded configuration parameters are taken in use in the color sensor colorimetric calculation during the standardization procedure. Thus standardization is required to take the downloaded color grade parameters in use. If new configuration parameters are downloaded after the standardization has started, they will be taken in use during the next standardization.

Unlike some other sensors, the main system only commands the color sensor to standardize. The color sensor internal firmware takes care of performing the standardization routine and actions included in it, for example, insert shutter.

When the standardization routine is finished by the color sensor, it only sends a report to the main system. The main system takes care of checking standardization limits and declaring bad standardization if needed.

The main system builds its own standardization report based on the values sent by the color sensor. From this final standardization report, you can see and follow up variables, for example, the QCS grade code or bad standardization.

Standardization triggers the color sensor firmware error checking routine. This means that possible fatal errors are caught during standardization (see Section 4.2).

The color sensor views reference as the same function as standardization.

The standardization procedure includes these automated main steps:

1. The black/white backing tile is on.
2. The shutter will be closed.
3. The dark spectra is collected and stored.
4. The shutter opens.
5. The bezel is inserted.
6. The backing wheel rotates until home position of the tile wheel is found.
7. The white tile is on.
8. The raw white tile spectra are collected and stored.
9. The fluorescent tile is on.
10. The raw fluorescent tile spectra are collected and stored.
11. The check tile is on.
12. The raw check tile spectra are collected.
13. The black/white backing tile is on.
14. The raw spectra of white and black part of the black/white backing tile are collected.

15. The bezel is lowered.

The color sensor always continues the standardization to the end even if the system may request something else during standardization.

If the color sensor does not have enough time for the standardization routine, the system will time-out the color sensor. How the main system reacts depends on the system design.

Table 4-1 contains the standardization report with item descriptions.

Table 4-1 Color Sensor Standardization Report

Parameter	Explanation
RedordRefnum	
Bad DataBase	
Bad Input	
Channel 1 Minimum	Maximum raw signal level at some wavelength when the white tile is illuminated, given as percent of the full A/D scale
Channel 1 Maximum	Maximum raw signal level at some wavelength, when the white tile is not illuminated (dark shutter closes the light path), given as percent of the full A/D scale
Channel 1 Dark Average	Average over the spectrum of the raw signal level, when the white tile is not illuminated (the dark shutter closes the light path), given as percent of the full A/D scale
Channel 1 Noise	This is sigma of the dark average measurements
Channel 2 Minimum	Maximum raw signal level at some wavelength when the white tile is illuminated, given as percent of the full A/D scale.
Channel 2 Maximum	Maximum raw signal level at some wavelength, when the white tile is not illuminated (the dark shutter closes the light path), given as percent of the full A/D scale
Channel 2 Dark Average	Average over the spectrum of the raw signal level, when the white tile is not illuminated (the dark shutter closes the light path), given as percent of the full A/D scale
Channel 2 Noise	This is sigma of the dark average measurements
L1 (Tungsten Lamp) Blue	This is the calculated tristimulus Z-estimation, when the white tile is illuminated based on the raw signal spectrum
L1 (Tungsten Lamp) UV	This is the calculated UV estimation, when the white tile is illuminated only with tungsten based on the raw signal spectrum
L1 (Tungsten Lamp) Stability	This is sigma of Tungsten Lamp Blue value measurements
L1 (Tungsten Lamp) Blue Balance	This is the ratio between Channels 1 and 2 tungsten blue values
L2 (Xenon Lamp) UV	This is the calculated UV estimation, when the white tile is illuminated with xenon and tungsten and the effect of tungsten is removed based on the raw signal spectrum
L2 (Xenon Lamp) Stability	This is sigma of the xenon lamp UV value measurements
L2 (Xenon Lamp) UV Balance	This is the ratio between channels 1 and 2 xenon lamp UV values
Tile-F (Fluor tile) Green	This is like tristimulus Y-estimation of the white fluorescent tile (sort of fluorescent compressed value)

Tile-F (Fluor tile) Blue	This is like tristimulus Z-estimation of the white fluorescent tile (sort of fluorescent compressed value)
Tile-F FI L1 (Fluor tile FI activated by Tungsten)	This describes the fluorescent index (FI) produced by tungsten illumination on the white fluorescent tile
Tile-F FI L2 (Fluor tile FI activated by Xenon)	This describes the fluorescent index (FI) produced by xenon illumination on the white fluorescent tile. In general, when this value decreases, the UV output of xenon decreases.
Tile-F FI Bal. (Fluor tile FL Balance)	This is the ratio between channels 1 and 2 fluor tile green values
Tile-Y X (Check Tile X)	Measured CIE X-value of the yellow tile under D65/10°
Tile-Y Y (Check Tile Y)	Measured CIE Y-value of the yellow tile under D65/10°
Tile-Y Z (Check Tile Z)	Measured CIE Z-value of the yellow tile under D65/10°
Tile-Y FI. (Check Tile FI)	Fluorescence index of the yellow check tile
Tile-Y Bal. (Check Tile Balance)	Calculated color difference between channel 1 and 2 measurements of the yellow tile
Tile-b/w X (Backing Tile X)	Measured CIE X-value from the white part of the black/white backing tile under D65/10°
Tile-b/w Y (Backing Tile Y)	Measured CIE Y value from the white part of the black/white backing tile under D65/10°
Tile-b/w Z (Backing Tile Z)	Measured CIE Z value from the white part of the black/white backing tile under D65/10°
Tile-b/w Y(blk) (Backing Tile Y Black)	Measured CIE Y value from the black part of the black/white backing tile under D65/10°
Tile-Y L (Check Tile L*)	Measured CIE L* value of the yellow tile under D65/10°
Tile-Y a (Check Tile a*)	Measured CIE a* value of the yellow tile under D65/10°
Tile-Y b (Check Tile b*)	Measured CIE b* value of the yellow tile under D65/10°
Tile-b/w L (Backing Tile L*)	Measured CIE L* value from the white part of the black/white backing tile under D65/10°
Tile-b/w a (Backing Tile a*)	Measured CIE a* value from the white part of the black/white backing tile under D65/10°
Tile-b/w b (Backing Tile b*)	Measured CIE b* value from the white part of the black/white backing tile under D65/10°
CMM Refr Voltage	Used reference voltage on the color processor. Stays stable.
CMM Board Temperature	Temperature on the CMM board, between 38–42 °C (100.4–107.6 °F), and stay within one degree
CMM Revision	Firmware version of the color measurement module
CBM Revision	Firmware version of the color backing module

4.1.4. Idle

The idle mode is the default waiting mode for the color sensor when it is online and has finished an earlier request. This mode always occurs after the first standardize before starting to scan. It also occurs after every standardization or scan.

4.1.5. Scan

The scan mode occurs when the QCS requests the color sensor to the scan mode. The color sensor then performs a scanning measurement. In a normal situation, this means that the scanner head is onsheet and the color sensor will measure onsheet readings.

4.2. Firmware Error Checking

This is not an actual mode of the color sensor, but its functionality is important to understand.

The color sensor firmware performs some error checking routines. Those routines are run-time based and also contain some special cases such as routines during standardization.

In principle there are two levels of the error checking in use:

- alarms
- fatal errors

Alarms occur if, for example, a standardization value is outside its limit but has not yet crossed the critical deviation. If the quartz tungsten halogen (QTH) lamp starts to approach its end of life, a warning will occur to signal that it is time to change the lamp, for example, *Lamp 1: Low lamp intensity*. An alarm can also be more like a notice, such as color sensor reconfiguration.

A fatal error will occur if a far more critical error occurs, for example, if the downloaded configuration data contains parameters outside defined limits by the firmware. An error can occur, stating that this parameter is bad, such as configuration parameter error. In this case, you must enter a new suitable configuration data, inside limits, before standardization can proceed.

Firmware errors are reported to the main system independently at specific time interval. There is a configuration parameter to identify the report frequency. In some systems this parameter is called *Error Report Time Interval ms*. The default value for this parameter should be always 18000, and should not be changed unless new recommendations come from a Honeywell developing or support organization.

It is a known issue that some systems display multiple times (as many as two to five times) the same error message one after another with same error count or similar. The repeats of an error can be ignored.

See Table 4-2 for active error messages that the color sensor can generate.

Table 4-2 Firmware Error Messages

Message	Message Number	Description	Check Limit (firmware)
CBM WHEEL POSITION ERROR	01	Repeated CBM position does not agree with requested position	CBM Status
CBM WHEEL TIMEOUT	02	CMM has not confirmed wheel position after a request to rotate the wheel	N/A
COLOR SENSOR RESET	03	Color Sensor has reset. INFO only	N/A
COLOR SENSOR RECONFIGURATION	04	Color Sensor has received configuration data. INFO only.	Config. Data checksum
CONFIGURATION PARAMETER ERROR	05	CMM has received invalid configuration data. Check documentation for legal ranges of the configuration parameters. The line number of the first detected bad configuration parameter as shown on the download frame	Various limits
DYNAMIC STDZ OUT OF TOLERANCE	06	Dynamic standardize is disabled due to excessive scan-to-scan change in reading on backing tile	Last delta Y backing tile (%)
SENSOR OVER TEMPERATURE ERROR	07	CMM temperature exceeds 50 °C (122 °F)	N/A
MMS A: EXCESSIVE NOISE	08	Signal on channel 2 is unstable during dark measurement. Indicates faulty or marginal MMS unit. Check cables and ground connection to MMS	"noise" value (%) < 0.25, < 0.5
MMS A: HIGH DARK READING	09	Channel 2 dark signal exceeds hard-coded f/w limit. Possible cause: dark shutter did not close during standardize sequence.	< 10.0, < 15.0
MMS A: LOW DARK READING	010	Channel 2 dark signal is at or near zero counts for some pixels. If *hard error* subsequent gauge calculations are BAD	> 0.25, > 0.05
MMS B: EXCESSIVE NOISE	011	Channel 1 signal is unstable during dark measurement. Indicates faulty or marginal MMS unit. Check cables and ground connection to MMS	*noise* value (%) < 0.25, < 0.5
MMS B: HIGH DARK READING	012	Channel 1 dark signal exceeds hard-coded f/w limit. Possible cause: dark shutter did not close during standardize sequence	< 10.0, < 15.0
MMS B: LOW DARK READING	013	Channel 1 dark signal is at or near zero counts for some pixels. If *hard error*, subsequent gauge calculations are bad	> 0.25, > 0.05
LAMP 1: EXCESSIVE JITTER	014	Signal on WHT tile from tungsten illumination alone is excessively noisy. Possible causes: defective MMS, poor connection to tungsten lamp	< 0.3, < 0.6
LAMP 1: HIGH LAMP INTENSITY	015	Signal on WHT tile is saturating or near saturation on some pixels. If *hard error*, subsequent gauge calculations are bad. Adjust the supply voltage for the QTH lamp	< 95.0, < 99.5
LAMP 1: LOW LAMP INTENSITY	016	Signal on WHT tile is too low. If *hard error* limit is exceeded, bad device ordinal will be set	> 15.0, > 10.0

Message	Message Number	Description	Check Limit (firmware)
LAMP 2: EXCESSIVE JITTER	019	Signal on WHT tile from combination of tungsten and xenon flashlamp is excessively noisy. Possible causes: bad MMS unit, unstable flashlamp	< 0.5, < 0.8
LAMP 2: HIGH LAMP INTENSITY	020	Signal on WHT tile is saturating or near saturation on some pixels. If *hard error*, subsequent gauge calculations are bad	< 95.0, < 99.5
LAMP 2: LOW LAMP INTENSITY	021	Little or no signal detected from xenon flashlamp. Probable cause: flashlamp failure, defective cable, failure of flashlamp power supply or trigger module	> 2.0, > 1.0
CHECK TILE HIGH FLUORESCENCE	022	False fluorescence detected on non-fluorescent check tile. Probable cause: unstable MMS unit, non-functioning xenon flashlamp.	< 0.5, < 1.0
CHECK TILE BALANCE	023	Check tile color not the same as measured by channels 1 and 2, respectively. Probable cause: incorrect MMS calibration parameters, unstable MMS, dirty tiles, wheel problem	< 0.4, < 1.0
BAD + 5 V REFERENCE VOLTAGE	024	5 V reference ADC self-check fails. Probable cause: defective processor board	N/A
CBM SELF-TEST FAILED	028	CBM self-test has failed. Look for additional errors to narrow cause.	CBM Status
BACKING WHEEL: LINK FAILURE	029	CMM cannot communicate with CBM. Probable cause: CBM not powered up, bad connector or bad wiring between heads	CBM Status
BACKING WHEEL: BEZEL POSITIONING ERROR	030	Bezel has not retracted when commanded. Probable cause: initial error on power-up, wheel has not rotated a complete cycle successfully, failure of bezel detect switch or wiring. Imperfection in drive belt	CBM Status
BACKING WHEEL: 0 DEGREE POSITIONING ERROR	031	Encoder did not detect home position, or detected it at an unexpected step count. Probable cause: broken wiring or connectors to motor or encoder, encoder incorrectly aligned, defective drive belt	CBM Status
BACKING WHEEL: 90 DEGREE POSITIONING ERROR	032	Encoder did not detect tile position at expected motor step. Possible cause: low air pressure	CBM Status

5. Configuration

After the color sensor is installed on the scanner and added into the quality control system (QCS) server software, the next step is to configure parameters used in color calculations both in the color sensor and in the color measurement application in the QCS server software. The color values are needed to be calculated under two main conditions or codes:

- the customer color measurement setup: CODE_COLOR_CUSTOM
- the default Honeywell color measurement setup: CODE_COLOR_CHECK

The default Honeywell color measurement setup code is used for diagnostics, standardization, reference, and the secondary calibration of the color sensor. The customer color measurement setup code is used to achieve a correlation between the on-line and the laboratory (off-line) color measurement.

All the color sensor configuration and calibration data relating to color measurement and control are stored in a portion of the QCS system database and accessed through **Recipe Maintenance** display.

- use the **Color Config/Calib Download** display to make temporary changes to the sensor configuration
- use the **Recipe Maintenance** display under the **Setup** tab to make permanent changes to the sensor configuration

To change the color sensor configuration or calibration parameters, you must have the required password and security privileges.

A standardize/reference operation must first be performed to activate the changed configuration parameters.

If not yet done, the first task is to create the master color verification code in a QCS server recipe-database, COL_CHECK with color code COLOR_CHECK. For more information on how to create code and color code, see Chapter 11.

The next task is to define the customer color measurement setup in a QCS server recipe-database COL_CUSTOM with color code COLOR_CUSTOM.

5.1. Laboratory Color Measurement Setup

The task to define the customer color measurement setup begins by studying the laboratory color measurement instrument and measurement procures used currently at the quality laboratory. The coloring process study in Appendix B of this manual contains groups of questions, of which questions C to G help to determine the quality laboratory color measurement setup used at the mill. Table B-1 is also very useful when talking to the Honeywell TAC organization.

It is valuable to study the methods and practices used to collect, store, and measure the samples from the produced paper. For example:

- Is an average color of samples from several cross direction locations measured?
- Is the moisture content of the on-line measured paper similar to the preconditioned moisture measured in the laboratory, being 6–7%?
- Is the measured stack of sheets really *infinitely thick*–you should not observer any light through the used stack when measured at the laboratory color instrument without any mechanical backing.
- Is the fluorescence-excluded measurement really fluorescence-excluded, or some fluorescence-included measurement?
- Is the separate stack of sheet used as off-line backing replaced every time with new ones from the same reel?

Care must be taken as to what kind of UV cut-off filter is actually used when talking about UV-excluded color measurement. Someone may call a color measurement made with a 395 nm or 400 nm UV cut-off filter a UV-excluded measurement. Unfortunately, this is not a non-fluorescence measurement, as can be seen in Figure 5-1, where true reflectance R(λ), apparent reflectance with 400 nm UV cut-off filter on the light path R'(λ|D65 with 400 nm UV cut-off), and apparent reflectance R'(λ|D65) are shown for a white fluorescent copy paper. As can be seen, a large quantity of emission is still left on after filtering the illumination with the 400 nm UV cut-off filter.

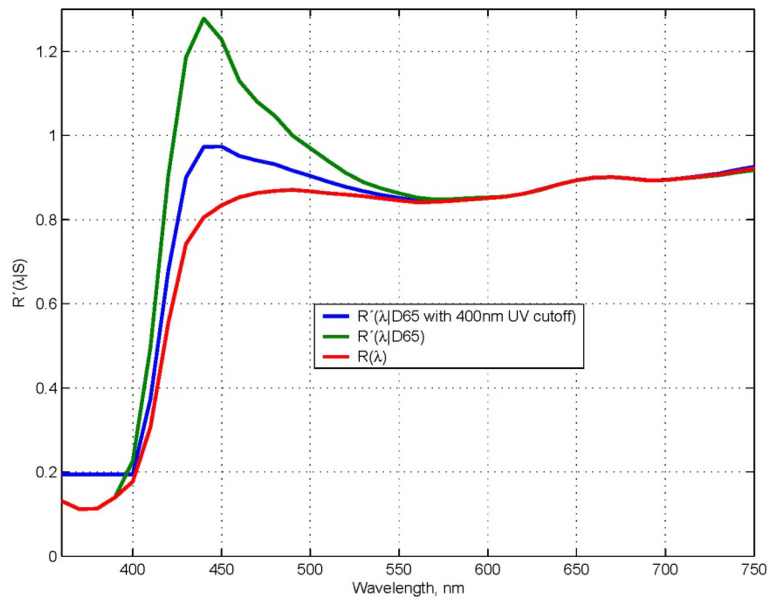


Figure 5-1 Reflectance Graph

Figure 5-1 shows reflectance and apparent reflectance of a white fluorescent copy paper, especially when the 400 nm UV cut-off filter is used to make a UV-excluded measurement.

Calculations of color values that include the fluorescent emission for the chosen illuminant are referred throughout as fluorescence-corrected spectrum, (FC), based on $R'(\lambda|S)$, $R'_\infty(\lambda|S)$ measurements.

Calculations, where the effect of the fluorescent emission component is removed, are referred to as fluorescence-suppressed, (FS), true reflectance, based on $R(\lambda)$, $R_\infty(\lambda)$ measurements.

R_∞ has here the meaning of the color of an infinitely thick stack of papers.

5.2. RAE Color Measurement Setup

The color measurement setup is located in the color recipe database. A color grade/recipe is called a color code, and is loaded with the main recipe (called a code).

The color code is constructed of several tables. This hyperlink structure with pointers from the color code## to other tables makes it possible to form required quantity of different color grades being independent of the machine grades:

- COLORP## Configuration table

- COLORP## MSS Setup table
- COLORP## Calibration table
- COLORP## Color Standard table
- COLORP## Standard Spectra Array

Table 5-1 contains a list of variables with explanations.

Table 5-1 Color Code Numbers

Line	Parameter	Explanation	Default
1	Scanner# L Nominal	Grade standard for L*	96
2	Scanner# a Nominal	Grade standard for a*	1
3	Scanner# b Nominal	Grade standard for b*	-15
4	Scanner# Fluor Index Nominal	Grade standard for FI	14
5	Scanner# Brightness Nominal	Grade standard for brightness	92
6	Scanner# Whiteness Nominal	Grade standard for whiteness	140
7	Scanner# Tint Nominal	Grade standard for Tint	1
8	Scanner# Dominant Wavelength Nominal	Grade standard for DWL	520
9	Scanner# Purity Nominal	Grade standard for purity	5
10	Color alarm limits	Color alarm limits table for this color code	color alarm limits00
11	COLORP## Calibration table	Color calibration parameter table for this color code	COLORP## Calibration
12	COLORP## Color Standard table	Color grade standard table for this color code	COLORP## Color
13	COLORP## Configuration table	Configuration parameter table for this color code	COLORP## Configuration
14	COLORP## MSS Setup table	MMS setup table for this color code	COLORP## MSS Setup
15	COLORP## Standard Spectra Array	Grade standard spectra array table for this color code	COLORP## Standard

Parameters in the COLORP## Calibration table are explained in Chapter 6.

5.2.1. COLORP## Configuration Table

The setup of the color sensor color measurement is typically based on the existing setup of the laboratory color instrument currently in use. The received information of the setup of the laboratory color measurement may be erroneous, and may lead to poor correlation between on-line and off-line color measurements.

Table 5-2 contains the list of configuration parameters located on the COLORP## Configuration table available through the **Recipe Maintenance** display. These parameters affect the results of CIE tristimulus X, Y, Z, and brightness calculations, and they define next level color space calculations.

Based on the collected information from the laboratory measurement, the customer color measurement setup color grade entry COLOR_CUSTOM can be set up. The chosen pair of the CIE illumination and CIE observer must be selected (such as C/2°, D65/10° or D50/2°) to be used in all color value calculations excluding brightness.

The practical correlation to the laboratory instrument is made at spectral level, more precisely at reflectance level, using calibration parameters.

Table 5-2 COLORP## Configuration

Line	Parameter	Explanation	Default
1	Lab F/T=Hunter/CIE	Selects whether Hunter Lab or CIE L* a* b* units are used.	True
2	WHITEN Fn F/T=CG/CIE	Selects whether Ciba/Ganz or CIE whiteness function is used. Typically CIE whiteness.	True
3	WHITEN F/T=DISAB/ENAB	Enables calculation of the selected whiteness value.	True
4	DOM WAVELENGTH ENABLE	Enables calculation of the dominant wavelength (DWL) value.	False
5	Delta(E) F/T=Lab/CMC	Today ΔE^*_{ab} total color error used in the paper industry, thus Lab.	False
6	Dyn offset F/T=No/Yes	Enables the usage of the dynamic offsets to adjust the final color values.	True
7	Dyn slope F/T=No/Yes	Enables the usage of the dynamic slopes to adjust the final color values.	True
8	High Slice Boundary	Not used.	99
9	Low Slice Boundary	Not used.	1
10	Download Request 0/1=No/Yes	Enables download of color code data into the color sensor at a recipe download.	1
11	Observer Function: 0/1=1931/1964	Selects whether 2° observer (1931) or 10° observer (1994) is used. Must match to the laboratory color instrument's setting.	1
12	Primary Illum 0-5= A/C/D65/E/F7/D50	Selects the used CIE illuminant for the color measurement. Typically C or D65.	2
13	Metameric (Secondary) Illum 0-5= A/C/D65/E/F7/D50	Selects the used CIE illuminant used to define specific metamerism of the sample. Typically A, and must always be different from the primary illuminant.	0
14	Brightness Illum 0-5= A/C/D65/E/F7/D50	Used CIE illuminant for the brightness measurement. ISO and TAPPI brightness uses C and D65 brightness uses D65.	1
15	Brightness Func 0-2= GE/TAPPI/ISO	Selects used brightness function.	2
16	Fluorescence calc 0-2= ΔBrt/ΔZ/ΔMx	Selects used fluorescence index calculation function; difference in FC and FS brightness, Z or GE values. Typically ΔBrt.	0

17	Lab profiles select 0/1=FC/FS	Selects whether FC or FS slice color values are sent during the scanning or fixed point measurement.	1
18	Brightness profiles select 0/1=FC/FS	Selects whether FC or FS slice brightness values are sent during the scanning or fixed point measurement.	0
19	Kubelka-Munk 0/1/2= no/scan/scansample	Enables infinite stack estimation calculation for scan or scan and sample measurements.	2
20	DynStdz 0=Disab/scans	Enables the dynamic standardize feature and set its aggressiveness. Not recommended to use.	0
21	Color Sensor Spare 5	N/A	0
22	Color Sensor Spare 6	N/A	0
23	Error Report Time Interval ms	Sending interval time of the color sensor firmware errors in milliseconds. Consult Honeywell TAC to change default.	18000

Color and Coloring of Paper Reference Manual contains more information on color spaces and CIE illuminants and observers.

5.2.2. COLORP## MSS Setup Table

Color is mainly a machine directional quantity, when the dynamic affecting factors are eliminated from the cross directional profile of the web. A non-flat profile in some process variables, including moisture, sheet temperature, or filler can produce a color profile effect. Special spreading rolls can also cause variation in the pass-line of the web. This may cause bad edges for the cross direction color measurement. Since most of the time only the machine directional aspect of the color is of interest, the bad edges can be removed to form a representative color measurement of the coloring process.

Exclude color measurements from the edges of the sheet from the scan average values, EOS measurements. Enter separate values to indicate where data accumulation for scan averaging starts and stops, depending on whether the scan starts at the low end of the sheet and stops at the high end, or starts at the high end and stops at the low end.

To change the areas of the sheet that are excluded from measurement:

1. Place the sensor into maintenance mode.
2. Use the **Recipe Maintenance** display and select color code at the bottom of the display.
3. Select the **COLORP## MSS Setup** table from the list of **COLORP## Calibration and Configuration** tables available through the display.
4. Find the appropriate pair of values for:

Hi End Stop Accum(Off), and *Lo End Start Accum(On)*

Hi End Start Accum(On), and *Lo End Stop Accum(Off)*

5. To test the new values, click **Initialize**, and resume scanning by returning the sensor to production mode through the **Sensor Maintenance** display.

6. Save your new successful settings.

Table 5-3 COLORP## MSS Setup

Line	Parameter	Default
1	Hi End Start Accum(On) mm	200
2	Hi End Stop Accum(Off) mm	300
3	Lo End Start Accum(On) mm	200
4	Lo End Stop Accum(Off) mm	200
5	EOS Wait for Spectra delay	900

5.2.3. COLORP## Color Standard Table

The COLORP## Color Standard table contains the grade standards for fluorescent corrected (FC) color values (L*, a*, and b*) for the secondary illuminant, typically A, and the CIE observer in use (2° or 10°). These are used in the **Metamerism Index** calculation shown in **Color Space Window**.

It also contains the grade standards for fluorescent-corrected (FC) and fluorescent-suppressed (FS) color coordinates, such as L*, a*, and b*, for the primary illuminant and the chosen CIE observer.

Values are obtained from product or recipe specifications provided by the customer, or they can be obtained on-line by means of the system during scanning and sampling.

5.2.4. COLORP## Standard Spectra Array

The COLORP## Standard Spectra Array contains the grade standard FS and FC spectra for a color grade.

The reflectance values (%R) can be obtained on-line by means of the QCS during scanning or sampling.

Elements 1 through 81 of the table correspond to the reflectance values at wavelength 350, 355 through 765, and 750 nm.

5.2.5. Color Alarm Limits

The color alarm limits table contains low and high alarm limits for the color and appearance coordinates. The values for these limits are obtained from product or recipe specifications provided by the customer.

6. Calibration

After configuration of the color sensor, the next step is to adjust the color measurement by:

- colorimetric calibration of the color sensor
- static cross-adjustment for compensating instrumental and stack estimation effects between on-line and off-line (see Chapter 8)
- dynamic cross-adjustment for compensating remaining environmental- and grade-dependent issues (see Chapter 9)

The colorimetric calibration of the color sensor and parameters affecting it are described in this chapter.

6.1. Color Measurement Calibration Parameters

The parameters in Table 6-1 appear in the **Color Config/Calib Download** display in the upper table, and in the **Recipe Maintenance** display.

The table contains parameters for all three adjustment levels of the color measurement. More detailed descriptions of the effects of most parameters are described in Subsection 6.1.1.

ATTENTION

Apparent reflectance $R'(\lambda \,|S)$ has the same meaning as the fluorescence-corrected (FC) spectrum.

Reflectance $R(\lambda)$ has the same meaning as the fluorescent-suppressed (FS) spectrum.

Table 6-1 COLORP## Calibration Parameters

Line	Parameter	Explanation	Default
1	UV Modifier: Primary Illuminant	Adjusts the quantity of fluorescence on the color measurement for samples containing FWAs/OBAs. Used to adjust the on-line apparent reflectance $R'(\lambda \| S_{Primary})$ against the off-line's $R'(\lambda \| S)$, where $S_{Primary}$ is the chosen CIE illuminant.	1.0
2	UV Modifier: Secondary Illuminant	Adjusts the quantity of fluorescence on the color under illuminant metamerism conditions for samples containing FWAs/OBAs, when the chosen CIE illuminant is typically A.	1.0
3	UV Modifier: Brightness Illuminant	Adjusts the quantity of fluorescence on the brightness measurement for samples containing FWAs/OBAs. Used to adjust the on-line apparent reflectance $R'(\lambda \| S_{Brightness})$ for brightness against the off-line's $R'(\lambda \| S)$, where $S_{Brightness}$ is the chosen CIE illuminant (typically C).	1.0
4	Tungsten UV Adjust Factor	Adjusts the quantity of residual fluorescence on the reflectance $R(\lambda)$ for samples containing FWAs/OBAs against the laboratory sensor's $R(\lambda)$.	0.75
5	Xenon UV Adjust Factor	Adjusts the gain of fluorescent excitation strength relative to the fluorescent standard. Note, use UV Modifier: Primary and Brightness Illuminant instead of this.	1.0
6	White Standard Y Value (Y_{STD})	Defines the 100% line for the measured reflectance $R(\lambda)$ based on the white tile measurement at standardization. A certified Y_{STD} value is provided with each white tile. This parameter is also used to adjust the on-line L* value against the off-line L* value.	certified Y_{STD} value < 98
7	Fluor Std: Fluor Strength (FI)	Defines the amount of fluorescence for measured $R'(\lambda \| S)$ based on the fluorescent tile measurement at standardization. A certified Fluor Std: Fluor Strength (FI) value is provided with each fluorescent standard tile under illuminant D65.	A certified Fluor Std: Fluor Strength (FI) c. 17
8	Fluor Std: Base Adjust	Defines the contribution of residual fluorescence on the reflectance $R(\lambda)$ for the fluorescent tile. Defined using a UV cut-off filter in front of quartz tungsten halogen (QTH) lamp.	c. -2
9	MMS Channel 1 (White) Const D0'	Defines wavelength calibration parameter D0' for the channel 1 spectrometer. A certified D0', D1' and D2' parameters are provided with each spectrometer.	A certified D0' value c. -89
10	MMS Channel 1 (White) Const D1'	Defines wavelength calibration parameter D1' for the channel 1 spectrometer.	A certified D1' value c. 0.3
11	MMS Channel 1 (White) Const D2'	Defines wavelength calibration parameter D2' for the channel 1 spectrometer.	A certified D2' value c. 9
12	MMS Channel 2 (Black) Const D0'	Defines wavelength calibration parameter D0' for the channel 2 spectrometer A certified D0', D1' and D2' parameters are provided with each spectrometer.	A certified D0' value c. -89
13	MMS Channel 2 (Black) Const D1'	Defines wavelength calibration parameter D1' for the channel 2 spectrometer.	A certified D1' value c. 0.3
14	MMS Channel 2 (Black) Const 20'	Defines wavelength calibration parameter D2' for the channel 2 spectrometer	A certified D2' value c. 9
15	White Standard: 350 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0

Line	Parameter	Explanation	Default
16	White Standard: 400 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0
17	White Standard: 450 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0
18	White Standard: 500 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0
19	White Standard: 550 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0
20	White Standard: 600 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0
21	White Standard: 650 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0
22	White Standard: 700 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0
23	White Standard: 750 nm	Represents a percent deviation of the actual white tile reflectance from nominal one. Usage requires assistance of Honeywell TAC.	0
24	Brightness Gain Adjust	Adjusts the on-line color based brightness scale to off-line brightness instrument's one. A value 0 disables the Brightness Gain Adjustment, being equal to a again 1.Use only, if a separate brightness meter used in the laboratory.	0
25	Dynamic Stdz Tolerance	Defines the compensation in lamp intensity between standardizations used by the dynamic standardize algorithm executing at scan turnaround. Not recommended to use.	0.2
26	KM: Opacity Corrector	Adjusts the gain used on the proprietary improvement of Kubelka-Munk stack estimation calculation for $R(\lambda)$.	0
27	KM: Backing Corrector	Adjusts theoretical issues on the $R(\lambda)^{white}_{Tile\text{-}B/W}$ in Kubelka-Munk stack estimation.	Typical value 1.05
28	KM: Opacity*Fluor Factor	Adjusts the gain used on the proprietary improvement of Kubelka-Munk stack estimation for fluorescence emission calculation used in $R'(\lambda\|S)$.	0
29	Color Sensor Spare 3	N/A	0
30	Ellipse axis a	Axis a on the 2D a, b display in the **Color Space Window**	2
31	Ellipse axis b	Axis a on the 2D a, b display in the **Color Space Window**	3
32	Ctrl 0/1/2 = prof/FC/FS	Measurement input for the color control, Now profile, EOS FC or EOS FS color measurements. Default is to use EOS FS.	2
33	Dynamic Offset L	Offset to adjust final measured value of L*.	0
34	Dynamic Offset a	Offset to adjust final measured value of a*.	0
35	Dynamic Offset b	Offset to adjust final measured value of b*.	0
36	Dynamic Offset Bright	Offset to adjust final measured value of Brightness.	0
37	Dyn Off Fluor Index	Offset to adjust final measured value of FI.	0
38	Dyn Off Dom Wavel	Offset to adjust final measured value of DWL.	0
39	Dynamic Offset Purity	Offset to adjust final measured value of Purity.	0

Line	Parameter	Explanation	Default
40	Dyn Off Whiteness	Offset to adjust final measured value of CIE Whiteness	0
52	Dynamic Slope L	Slope to adjust final measured value of L*	1.0
53	Dynamic Slope a	Slope to adjust final measured value of a*	1.0
54	Dynamic Slope b	Slope to adjust final measured value of b*	1.0
55	Dynamic Slope Bright	Slope to adjust final measured value of Brightness.	1.0
56	Dyn Slope Fluor Index	Slope to adjust final measured value of FI.	1.0
57	Dyn Slope Dom Wavel	Slope to adjust final measured value of DWL.	1.0
58	Dynamic Slope Purity	Slope to adjust final measured value of Purity.	1.0
59	Dyn Slope Whiteness	Slope to adjust final measured value of Whiteness.	1.0

6.1.1. Colorimetric Calibration Parameters

The colorimetric calibration parameters are used in the color sensor calibration, and values of these parameters are included with the shipment of the sensor. They also provide the reproducibility among Honeywell sensors, while other parameters listed in Table 6-1 have a default value.

6.1.1.1. White Standard Y Value, Y_{STD}

A certified Y_{STD}, CIE tristimulus Y value under D65/10°, is provided with each white standard tile, White Standard Y Value.

This parameter defines the full-scale (100%R) of reflectance R(λ) using the known reflectance stored in the firmware of the color sensor through the known CIE tristimulus Y value. Figure 6-1 and Table 6-2 show an example of the effect of change of Y_{STD} value on a white fluorescent paper sample.

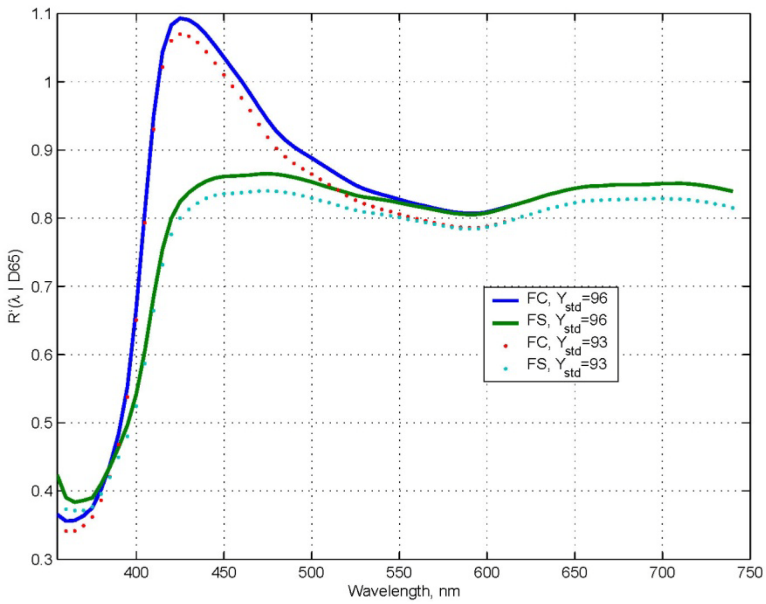


Figure 6-1 Measured Apparent Reflectance Graph 1

Figure 6-1 shows measured apparent reflectance from a white fluorescent sample with Y_{STD} being 96.0 and 93.0. Note resulted level difference on reflectances.

Table 6-2 shows an example of an effect of changing Y_{STD} parameter on fluorescent color measurement under D65/10°.

Table 6-2 YSTD Parameters

Measurement	YSTD	L*	a*	b*	FI	Brt	Wht
FC	96.0	93.9	2.1	-11.8	16.5	101.7	138.1
FC	93.0	92.9	2.1	-11.8	16.5	99.2	136.5
FS	96.0	92.9	-1.5	0.7	16.5	85.2	85.6
FS	93.0	91.9	-1.5	-0.5	16.5	82.7	82.6

6.1.1.2. Fluorescent Standard Fluorescence Strength

A certified fluorescent emission strength, FI, value under D65/10° is provided with each fluorescent tile based on difference of FS and FC brightness, Fluor Std: Fluor Strength(FI).

This parameter should only be changed when the internal fluorescent tile is changed, or when the FI of the fluorescent tile is reliably re-calibrated.

This parameter scales the amount of fluorescence on measured samples based on known fluorescence on the fluorescent tile based on value of Fluor Std: Fluor Strength(FI).

Figure 6-2 and Table 6-3 show an example of the effect of change of fluorescent standard fluorescent strength value on a white fluorescent paper sample. This parameter affects the amount of fluorescence emission E(λ|S), not reflectance R(λ).

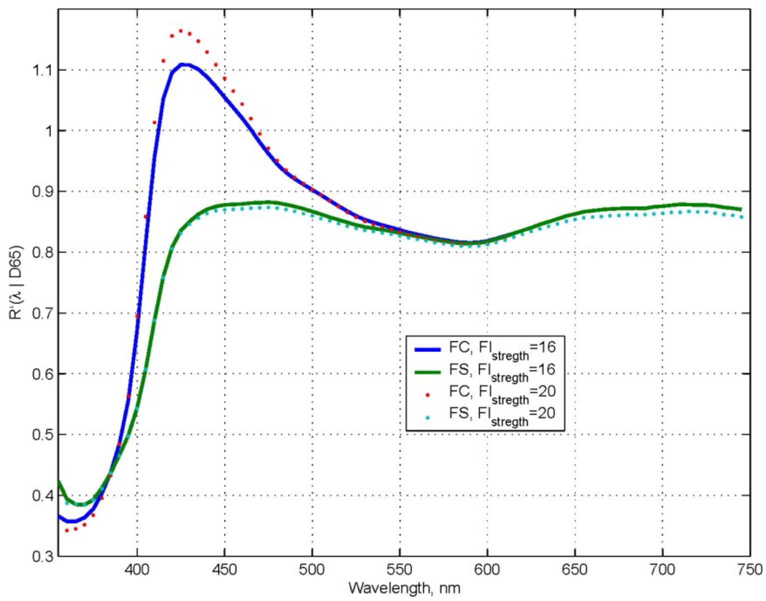


Figure 6-2 Measured Apparent Reflectance Graph 2

Figure 6-2 shows measured apparent reflectance from fluorescent white paper with fluorescent standard fluorescent strength, strength being 16 and 20. Note difference on amount of fluorescent emission.

Table 6-3 shows an example of effect of changing the fluorescent standard fluorescent strength parameter on fluorescent color measurement under D65/10°.

Table 6-3 Changing Fluorescent Standard

Measured	$FI_{strength}$	L*	a*	b*	FI	Brt	Wht
FC	16	94.4	2.1	-12.0	16.8	103.5	140.2
FC	20	94.3	2.9	-14.3	20.5	106.5	150.1
FS	16	93.3	-1.5	-0.9	16.8	86.4	87.4
FS	20	93.3	-1.5	-0.9	20.5	86.4	87.4

6.1.1.3. Fluorescent Standard Base Adjust

The parameter Fluor Std: Base Adjust is determined in primary calibration using an ultraviolet cut-off filter. If mirrors or lenses of the optical path are replaced, it is a good practice to re-check this value. This parameter adjusts the contribution of residual fluorescence on the reflectance R(λ) of the fluorescent tile. The value is relative to the tile reflectivity at 550 nm (green).

Figure 6-3 shows apparent reflectance with FI_{base} being -1.5 and 1.5. Note affects on reflectance value, and thus R'(λ|S) because R'(λ|S)=R(λ) + E(λ|S).

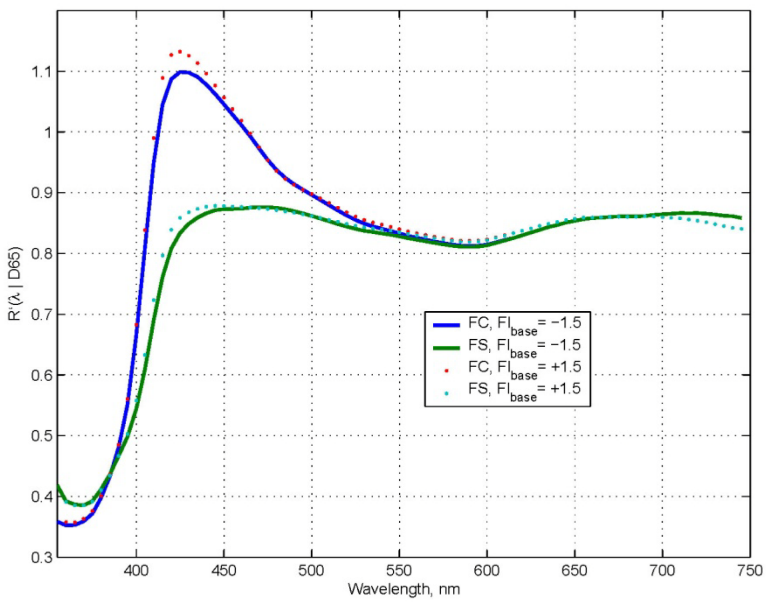


Figure 6-3 Apparent Reflectance Graph 3

Table 6-4 shows an example of effect of changing FI_{base} parameter on fluorescent color measurement under D65/10°.

Table 6-4 Changing FI_{base} Parameter

Measurement	FI_{base}	L*	a*	b*	FI	Brt	Wht
FC	-1.5	94.2	2.0	-11.8	16.3	102.6	138.8
FC	1.5	94.4	2.6	-12.4	16.8	103.8	141.9
FS	-1.5	93.3	-1.5	-0.9	16.3	86.3	87.6
FS	1.5	93.5	-1.0.	-1.3	16.8	86.9	87.7

6.1.1.4. Channel Measurement Sub System Unit Constants

Three constants, D0', D1', and D2', are the quadratic fit coefficients used by the firmware to calculate a wavelength (in nanometers) from an array diode number for the channel Measurement Sub System (MSS) unit. These values are determined by the spectrometer manufacturer and should not be adjusted. Update the values into COLORP Calibration## table if the MSS unit is changed. Every spectrometer is delivered with the certified wavelength calibration constants. Save them for future use.

6.1.1.5. White Standard (350–750 nm)

These nine parameters (Table 6-1 Lines 15-23 White standard XX0nm, 350nm, 400nm.450nm, 500nm) White Standard: XX0 nm represent the percent deviation of the actual white tile reflectance $R(\lambda)_{White\_tile}$ from the nominal across the spectrum. These parameters are typically zero; they should not be changed in the field without assistance from Honeywell TAC.

6.2. Determine Colorimetric Calibration

Set up a separate calibration recipe, name it, for example, COLOR_CHECK, with the original factory calibration values. Use this recipe for calibration verification. Change the parameters in this file only if new standard tiles are installed in the color sensor.

Check the parameters shown in Table 6-5:

Table 6-5 COLORP## Calibration Parameters

Line	Parameter	Value
1	UV Modifier: Primary Illuminant	1.0
2	UV Modifier: Secondary Illuminant	1.0
3	UV Modifier: Brightness Illuminant	1.0
4	Tungsten UV Adjust Factor	0.75
5	Xenon UV Adjust Factor	1.0
15–23	White standard: XX nm	0.0
24	Brightness Gain adjust	0.0
26	KM: Opacity Corrector	0
27	KM: Backing Corrector	1.05
28	KM: Opacity*Fluor Factor	0
33–51	Dynamic offsets	0.0

1. Enter the certified values of the tiles in the color backing module (CBM) and MMS spectrometers used in the color sensor onto the COLORP## Calibration table, see Table 6-6.

Table 6-6 MMS Spectrometer and Tile Serial Numbers and Values

Line	Parameter	Value and Serial Number
6	White standard Y value	Provided with the white tile
7	Fluorescent standard Fluor Std: Fluor Strength(FI)	Provided with the fluor tile
8	Fluorescent standard Fluor Std: Base Adjust	Provided with the color sensor
10–14	MMS spectrometer wavelength calibration coefficients D0', D1', D2’	Provided with spectrometers/color sensor

2. Download the code COLOR_CHECK, and perform a reference to take the parameters in use.
3. Check the standardization/reference values. If needed, troubleshoot any problems.
4. Check the stability of the color sensor using mid-term repeatability of the standardization. If needed, troubleshoot any problems.
5. Ensure that the correct code COLOR_CHECK is still in use.
6. Perform a reference with the stable color sensor.
7. Document the results of the reference calibration:

   Using **HW Request** on the **Color Diagnostic** display, rotate the backing wheel to each of the four positions.

   Perform a sample from each tile using the **Color Spectrum** display.

   Print a hard copy of each tile measurement, showing measured FS and FC Primary illuminant spectra and L*, a*, b* values.

8. Inspect the measured values of the white and fluorescent tile:

   Check that the measured Y of the white tile agrees with the certified Y_{STD} value to ± 0.5.

   Check that the measured FI of the fluorescent tile agrees with the certified FI value to ± 0.5.

Print a hard copy of the COLORP## Calibration table of the used color code.

Write down the code and color code used during these measurements.

9. If the measured values of the white and fluorescent tiles do not agree with the given certified values, clean windows and tiles, and verify that the serial numbers of the tiles are correct.

10. If the measured values of the white and fluorescent tiles agree with the given certified values, the colorimetric calibration of the color sensor is done.

6.2.1. Define Parameter Fluorescence Std: Base Adjust

If repair work is done for the color measurement module (CMM) optical parts, it may be good to redefine parameter Fluorescence Std: Base adjust.

This procedure is done with a properly functioning, stable color sensor:

1. Download the color code COLOR_CHECK and perform a reference to take the parameters in use.

2. Place the UV blocking filter from the Sensor Verification Accessory Kit (p/n 09834700) in front of the QTH lamp by loosening the screws of the lamp holder and sliding the filter into the slot.

3. Wait five minutes for the sensor to equilibrate, then perform a reference.

4. After reference is completed, note the QTH lamp fluorescent emission Tile-F FI L1 (Fluor tile FI activated by tungsten) from the *Standardize Report* on the **Sensor Reporting** display.

5. Add the Tile-F FI L1 value to the Fluor Std: Base Adjust value and enter the result to the Fluor Std: Base Adjust on the **Color Configuration/Calibration Parameter** display.

6. Click **Download Configuration**, and perform a reference.

7. Repeat Step 6 two or three times until the value of the Tile-F FI L1 is close to 0.0 (with the UV blocking filter still in front of the QTH lamp).

8. Remove the UV blocking filter and allow five minutes for the sensor to equilibrate and perform a reference.

9. Save the final Fluorescence Std: Base adjust parameter into the configuration COLORP## Calibration table using the **Recipe Maintenance** display.

Fluor Std: Base Adjust is typically negative if initially = 0. During this test, the sensor may report firmware error message 16: Lamp 1, Low Lamp Intensity. This is due to the filter attenuating the light and it can be ignored.

7. Introduction to Measurements

This chapter provides a basic understanding of the spectral measurements of reflectance R(λ) (often also called a spectrum), and apparent reflectance R'(λ|S). Achievable correlation to the laboratory color measurement is made at a spectral level using the color sensor calibration parameters.

The color and appearance measurements are relative measurements. The measured color is commonly defined based on the known reflectance R(λ) of the white, perfect-reflecting diffuser. This defines the full-scale of reflectance, 100%R(λ), on the photometric scale. By blocking light to a detector, the zero-scale, 0%R(λ), reflectance point is defined.

To achieve reflectance R(λ), specific spectral signals at predefined conditions are collected. These signals Φ(λ|S) are A/D converted outputs of a detector array with a known wavelength scale. The required signals are explained and the calculation principle of the reflectance is:

$$R(\lambda) = R(\lambda)_{Std-White} \frac{\Phi(\lambda \mid S)\delta\lambda - \Phi(\lambda \mid S)_{Std-Black}\,\delta\lambda}{\Phi(\lambda \mid S)_{Std-White}\,\delta\lambda - \Phi(\lambda \mid S)_{Std-Black}\,\delta\lambda}$$

Where $R(\lambda)_{Std-White}$ is the known reflectance of the calibrated white standard, $\Phi(\lambda \mid S)_{Std-White}$ is the spectral reading recorded with the calibrated white standard $R(\lambda)_{Std-White}$ for full-scale, $\Phi(\lambda \mid S)_{Std-Black}$ is the spectral reading recorded with the calibrated black reflectance standard $R(\lambda)_{Std-Black}$ or a light trap for zero-scale, and $\Phi(\lambda \mid S)_{Std-Black}$ is the spectral reading recorded with a sample for wavelength band Δλ of λ.

Reflectance R(λ) is an illuminant and observer independent. For fluorescent samples, apparent reflectance R'(λ|S) for a known illuminant *S* is dependent on the spectral power distribution of the utilized illumination.

Apparent reflectance is a sum of reflectance and fluor fluorescence emission.

$R'(\lambda| S)= R(\lambda) + E(\lambda|S)$

Where $E(\lambda|S)$ is luminescent radiance factor of a fluorescent sample for a known illuminant *S*: the amount of fluorescent emission activated under the illumination *S*.

Based on above equation, for non-fluorescent samples $R'(\lambda|S)=R(\lambda)$.

ATTENTION

Calculations of color values that include the fluorescent emission for chosen illuminant are referred to throughout this manual as a fluorescence-corrected spectrum, (FC), based on $R'(\lambda|S)$ measurements.

Calculations, where effect of the fluorescent emission component is removed, are referred to as a fluorescence-suppressed, (FS), based on $R(\lambda)$ measurements.

By using a pair of chosen CIE illuminant and observer, such as D65/10°or C/2°, the CIE tristimulus X, Y, Z values can be calculated from $R(\lambda)$ and $R'(\lambda|S)$.

The CIE tristimulus values give a good base to calculate almost any other color values, such as CIE L*, a*, b* and CIE whiteness, for the same used illuminant and observer. Required equations and steps are discussed in *Color and Coloring of Paper Reference Manual*.

A quality control system (QCS) server is used to set up and communicate the wanted color measurement set up into the color sensor, for example usage of the CIE standard illuminant D65 and 10° observer. Based on this knowledge, the color sensor's firmware uses correct standard tables and other parameters from its stored tables to be used on the color calculations.

7.1. Standardization

All of the color and appearance calculations for the standardization reporting are done under CIE illuminant D65 and CIE observer 10°.

During standardization or reference, the color measurement module (CMM) processor acquires these spectral readings for each detecting channel and for both illumination conditions S1 and S2 (combined below as SX):

- closes the shutter to collect and store a dark spectral radiant flux $\Phi(\lambda \,|\, SX)_{dark}$

- opens shutter
- collects and stores a white tile spectral radiant flux $\Phi(\lambda \mid SX)_{Tile-White}$
- collects and stores a fluorescent tile spectral radiant flux $\Phi(\lambda \mid SX)_{Tile-Fluor}$
- collects and stores a check tile spectral radiant flux $\Phi(\lambda \mid SX)_{Tile-Check}$
- collects and stores a black/white tile spectral radiant flux $\Phi(\lambda \mid SX)_{Tile-B/W}$

This acquired data is processed to define the photometric scale of reflectance R(λ) for any sample:

$R(\lambda) = Y_{STD} * R(\lambda)^{Tile\text{-}White} (\Phi(\lambda|SX)\delta\lambda - \Phi(\lambda|SX)_{dark}\delta\lambda) / (\Phi(\lambda|SX)_{Tile\text{-}white}\delta\lambda - \Phi(\lambda|SX)_{dark}\delta\lambda)$

Where Y_{STD} is the white tile Y value, reflectance $R(\lambda)_{Tile\text{-}White}$ of the non-fluorescent white tile is stored in the color sensor firmware, $\Phi(\lambda|SX)_{dark}$ contains corrections for the electronic and stray light backgrounds, and Φ(λ|SX) is the spectral reading recorded with a sample.

7.2. Calculated Measurements in the Color Sensor

During on-line measurement on-sheet as well as during standardization total of four apparent reflectances are collected per measurement. They can be identified as:

- R'(λ|S1)white with a lower UV level over the white portion of the B/W tile
- R'(λ|S1)black with a lower UV level over the black portion of the B/W tile
- R'(λ|S2)white with a higher UV level over the white portion of the B/W tile
- R'(λ|S2)black with a higher UV level over the black portion of the B/W tile

where the illumination S1 with lower UV level is produced by lamp 1 and the illumination S2 with higher UV level is produced by lamp 1 and lamp 2

During measurement on-sheet, the CMM processor acquires actual color data in two modes:

- averaging raw spectral data over the measurement interval (normally 100 ms)

  Now color measurement.

- averaging raw spectral data over the whole scan, excluding specified edges

  End of scan (**EOS**) color measurement.

In both modes the apparent reflectances R'(λ|S) of a sample, typically a sheet, is processed at the end of the averaging in the following way as described in the next sections.

7.2.1. Compute Reflectance R(λ) for the Sample (fluorescence-suppressed)

First, a fluorescence emission strength and shape E(λ|S) produced by a sample at two illumination levels is estimated based on apparent reflectances of a sample over the white backing. For an example of a fluorescence emission strength and shape E(λ|S) of white copy paper, see Figure 7-1.

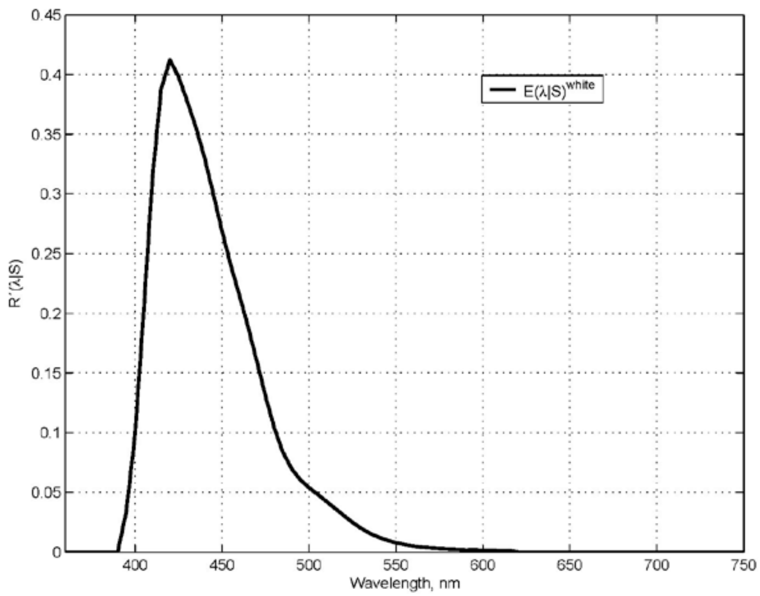


Figure 7-1 Emission Strength: Graph 1

$E(\lambda|S)^{white}=R'(\lambda|S2)^{white}- R'(\lambda|S1)^{white.}$

For a non-fluorescent sample:

$R'(\lambda|S2)^{white} = R'(\lambda|S1)^{white}$ and thus $E(\lambda|S)^{white} = 0$.

Then reflectance R(λ) is computed by subtracting an amount of the fluorescence emission from $R'(\lambda|S1)^{white}$:

$R(\lambda)^{white}=R'(\lambda|S1)^{white}- \alpha * E(\lambda|S)^{white}$

where α adjusts the effective fluorescence excitation strength $E(\lambda|S)^{white}$ to produce reflectance measurement R(λ) based on measurements made on the fluorescent tile at last standardization and determined calibration parameters.

R(λ) can never be ≥1.0 by definition.

7.2.2. Compute the Stack Estimated Reflectance $R_\infty(\lambda)$

To calculate the stack estimated reflectance $R_\infty(\lambda)$, the Kubelka-Munk method is used with proprietary improvements.

The Kubelka-Munk equation is:

$R_\infty(\lambda)$= a - sqrt{a^2 -1}

where a=0.5 * [$R(\lambda)^{white}$ + ($R(\lambda)^{black}$- $R(\lambda)^{white}$ + γ_{KM} *$R(\lambda)_{Tile\text{-}B/W}{}^{white}$)/ ($R(\lambda)^{black}$ * γ_{KM} $R(\lambda)_{Tile\text{-}B/W}{}^{white}$)]

where $R(\lambda)^{white}$ is the reflectance of a sample with white backing, $R(\lambda)^{black}$ is the reflectance of a sample with black backing, γ_{KM} is Kubelka-Munk backing corrector and $R(\lambda)_{Tile\text{-}B/W}{}^{white}$ is the reflectance of the white backing.

Absolute values of reflectance $R(\lambda)< 1$ must be used.

For an example of $R(\lambda)^{white}$ and $R(\lambda)^{black}$ of white copy paper, see Figure 7-2.

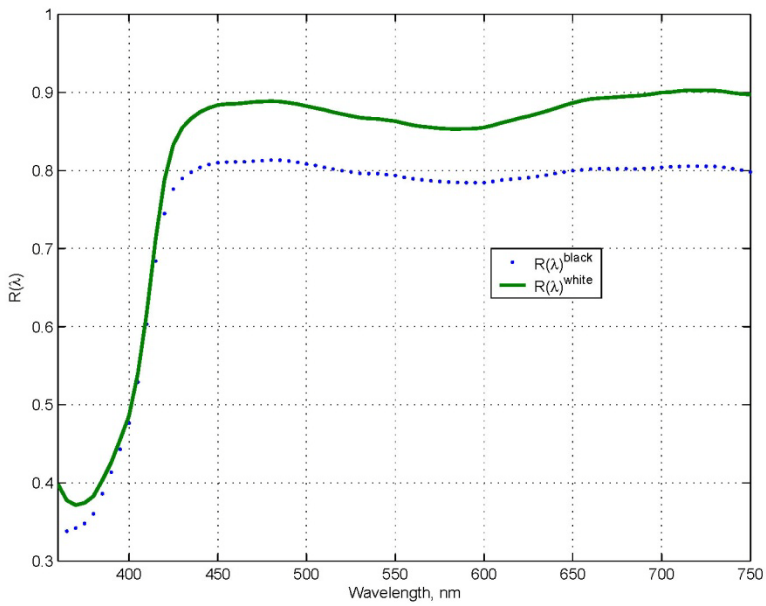


Figure 7-2 Emission Strength: Graph 2

The Kubelka-Munk parameter KM: Backing Corrector (γ_{KM}), is used to adjust assumed theoretical conditions of the model to practical ones. Typically this value is about 1.05.

Note, Kubelka-Munk theory requires that γ_{KM} * $R(\lambda)_{Tile\text{-}B/W}{}^{white} > R(\lambda)^{black}$. This requirement may be a problem in some yellow grades, due to fluorescence causing the spectrum to be cut. In these cases, increase the value of Kubelka-Munk backing corrector γ_{KM} up to 1.3.

For paper grades having very low scattering properties a proprietary improvement has been developed. Usage is controlled by the Kubelka-Munk parameter KM: Opacity Corrector (α_{KM}).

$$\check{R}_\infty(\lambda) = R_\infty(\lambda) + \alpha_{KM} * (1 - R(\lambda)^{black} / R_\infty(\lambda))$$

Where α_{KM} is a Kubelka-Munk opacity corrector, KM: Opacity Corrector, for any remaining opacity-dependent effects. For an example of ($1 - R(\lambda)^{black} / R\infty(\lambda)$) of white copy paper, see Figure 7-3.

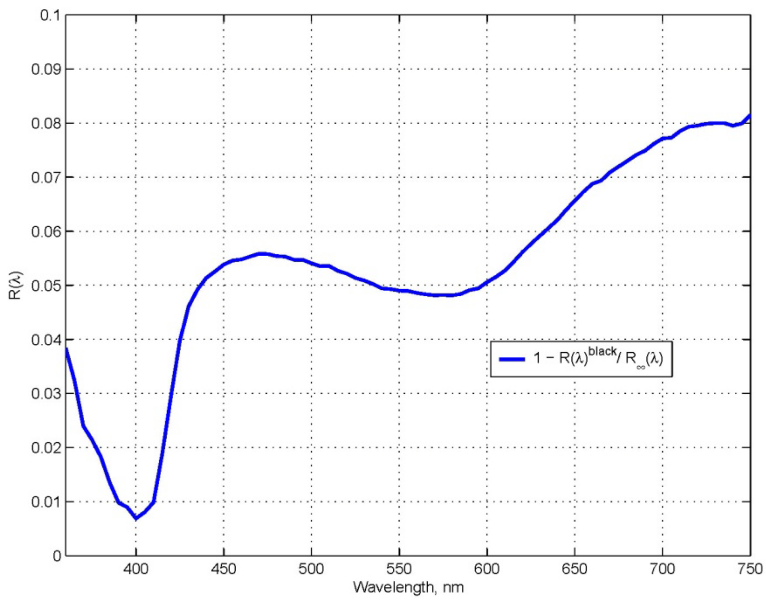


Figure 7-3 Emission Strength: Graph 3

7.2.3. Compute Apparent Reflectance R'(λ |S) for Chosen Standard Illuminant (fluorescence-corrected)

First, a fluorescence excitation strength and shape $E(\lambda| S)^{white}$ is scaled to the chosen CIE illuminant fluorescence excitation strength. For paper grades having very low scattering properties, a proprietary improvement has been developed. The usage of which is controlled by Kubelka-Munk parameter KM: Opacity*Fluor Factor (β_{KM}).

$$\check{E}(\lambda|S)^{white} = \beta * E(\lambda|S)^{white} * [1 + \beta_{KM} * (1 - R(\lambda)^{black} / R_\infty(\lambda))]$$

where β adjusts the effective fluorescence excitation strength $E(\lambda|S)^{white}$ to the chosen CIE illuminant's fluorescence excitation strength. β_{KM} is a Kubelka-Munk opacity fluorescence corrector for the normalized fluorescence emission to adjust possible opacity-related effect.

For an example of $E(\lambda \mid S)^{white} * [1 + \beta KM * (1 - R(\lambda)^{black} / R_{\infty}(\lambda))]$of white copy paper, see Figure 7-4.

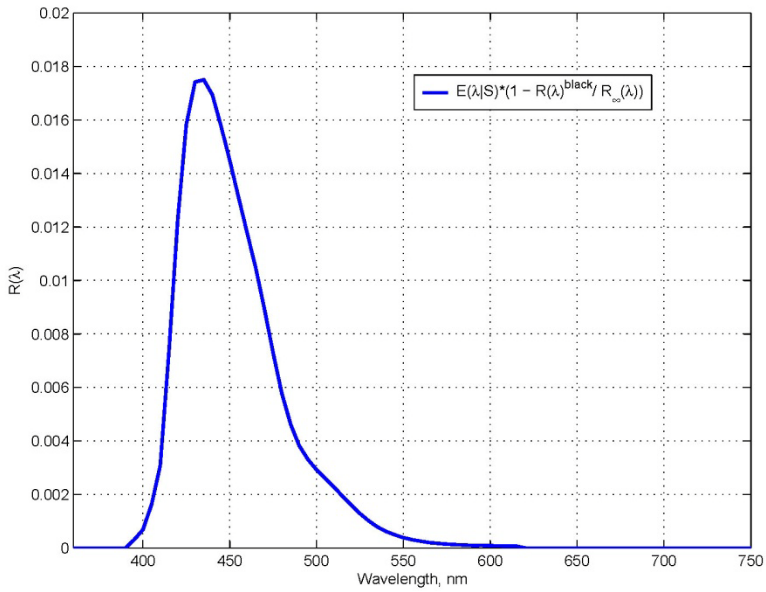


Figure 7-4 Emission Strength: Graph 4

By using the knowledge that apparent reflectance is the sum of reflectance and normalized fluorescence emission, the final result is achieved:

$R'_{\infty}(\lambda|S) = R_{\infty}(\lambda) + \check{E}\,(\lambda|S)^{white}$

For an example of $R_\infty(\lambda)$ and $R'_\infty(\lambda|D65)$ of white copy paper, see Figure 7-5.

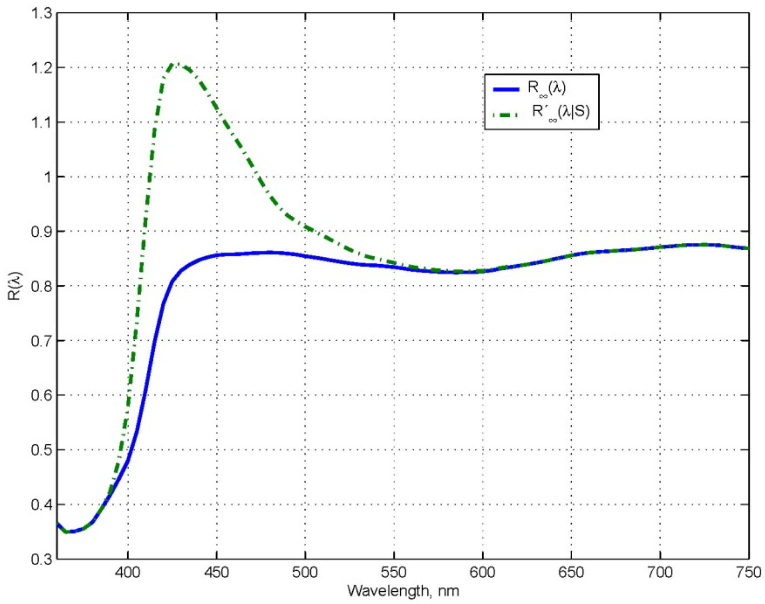


Figure 7-5 Emission Strength: Graph 5

Value of $R_\infty(\lambda)$ does not remove the unity, and for non-fluorescent papers, $E'(\lambda|S)^{white}$ is zero.

7.2.4. Calculate CIE Tristimulus X, Y, Z and Brightness Values

The CIE tristimulus X, Y, Z values are calculated using a chosen CIE standard illuminant and observer in the color sensor firmware for $R_\infty(\lambda)$ and $R'_\infty(\lambda|S)$.

Also, brightness values and fluorescence index are calculated based on $R_\infty(\lambda)$ and $R'_\infty(\lambda|S)$.

Actual calculations are explained in *Color and Coloring of Paper Reference Manual*.

In the end-of-scan (EOS) measurement, the CIE tristimulus values X, Y, Z are also evaluated for a defined secondary illuminant in the color sensor. This secondary illuminant is CIE illuminant *A*. All calculated color data is sent to the QCS server.

7.3. Calculated Measurements in the Quality Control System Server

The QCS server converts the CIE tristimulus X, Y, Z coordinates to CIE L*, a*, b* or Hunter L, a, b values under the same illumination and observer conditions.

It may also calculate other apparent values such as:

- whiteness WHT
- tint T
- dominant wavelength DWL
- excitation purity EP
- luminance Y
- hue $H^*_{a,b}$
- chroma $C^*_{a,b}$

8. Static Cross-adjustment

After the colorimetric calibration of the color measurement sensor, the next step is to adjust the color measurement by cross-adjustment for compensating instrumental effects between on-line and off-line.

The meaning of this static cross-adjustment is to find a static correlation between the on-line and off-line (laboratory) color measurement at the color instrument level using paper samples that are preconditioned to room temperature and moisture. This task begins after ensuring that the temperature of the color measurement module (CMM) varies only within one degree and keeping below 42 °C (107.6 °F).

The static cross-adjustment is done using the customer color measurement setup for the on-line color sensor in a quality control system (QCS) server. If you have not yet created a customer color measurement set-up code in a QCS server recipe-database, do it now, using, for example, COLOR_CUSTOM.

Record any changes that you make to the configuration and calibration parameters, including the time and date of the changes. You can copy the updated COLOR_CHECK to COLOR_CUSTOM containing up-to-date colorimetric calibration parameters.

Before static cross-adjusting the color measurement sensor to a laboratory color measurement, ensure that the color sensor has undergone the colorimetric calibration. This section describes how to make the static cross-adjustment to an off-line color measurement after the colorimetric calibration and its verification are completed on the color measurement sensor.

8.1. Static Cross-adjustment Parameters

The parameters described in this section are used to find a static correlation between the on-line and the off-line color measurement at the color sensor level.

8.1.1. White Standard Y Value, Y_{STD}

A certified Y_{STD}, CIE tristimulus Y value, White Standard Y Value is provided with each white standard tile measured under D65/10°. This parameter is also used to tune in the L* value to achieve better correlation between the on-line and the laboratory color instrument using non-fluorescent samples.

Y_{STD} should always be less than 99, with a recommended value of less than 97. If higher measured L* values are required to match off-line readings, utilize the L* dynamic offset.

8.1.2. Tungsten UV-adjust Factor

Tungsten UV-adjust factor is used in the color measurement sensor firmware in calculation of $R(\lambda)$ and fluorescence-suppressed color values. This factor is used in the equations to emulate calculated true reflectance based on measured spectra under two illumination conditions:

- S1
- S2

Off-line color instruments commonly measure true reflectance using a 420 nm UV cut-off filter preventing fluorescent whitening agents (FWAs) to activate. This is meaningful for white fluorescent samples.

The greater the value of the tungsten UV-adjust factor, the larger amount of fluorescent emission is removed from $R'(\lambda|S1)^{white}$. A value of approximately 0.75 is typical as tungsten UV-adjust factor for white fluorescent papers.

Fluorescence-suppressed spectrum, $R(\lambda)$, must always have values less than 1.0 or 100%R.

Figure 8-1 shows measured reflectance R(λ) from a white fluorescent sample with tungsten UV-adjust factor being 0.75 and 1.0. Parameter does not affect FI value.

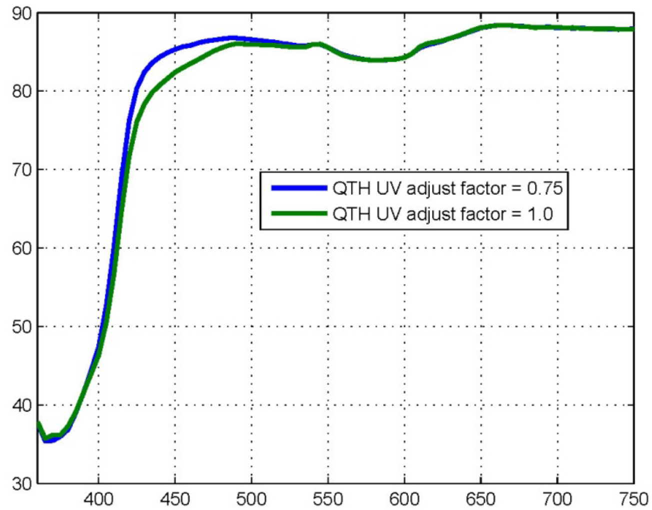


Figure 8-1 Measured Reflectance Graph 1

Table 8-1 shows an example of the effect of changing tungsten UV-adjust factor parameter on fluorescent color measurement under D65/10°.

Table 8-1 UV-adjust Factor Parameters (tungsten)

Measurement	QTH UV-adjust	L*	a*	b*	Brt
FC	0.75	95.0	2.7	-10.8	96.0
FC	1.0	94.9	2.2	-9.3	93.5
FS	0.75	94.1	-1.2	1.3	85.7
FS	1.0	93.9	-1.7	3.2	83.2

Changing this value also influences apparent reflectance, because R'(λ |S) = R(λ) + fluorescence.

The effect of tungsten UV-adjust factor and Fluorescent Std: base adjust are strongly coupled.

8.1.3. UV Modifiers

The UV modifier (UVM) coefficient affects the amount of fluorescent emission in the fluorescent-corrected spectra, apparent reflectance R'(λ|S), by increasing or reducing amount of effective UV irradiation on the FBAs/FWAs/OBAs and thus the emitted fluorescence under the configured illuminant *S*.

Depending on UV irradiation level on the laboratory color measurement instrument and its spectral distribution, the UVM coefficient can be used to adjust the level of fluorescent emission equal between the instruments for white fluorescent paper grades. The UVMs are not utilized when non-fluorescent paper is measured. A value of 1.0 is nominally correct. Increasing the coefficient increases the amplitude of fluorescent emission.

There are UVMs for three apparent reflectances:

- UVM: Primary illuminant (color measurement), effects FC Now X, Y, Z, and EOS R'(λ|SPrimary), X, Y, Z
- UVM: Secondary illuminant, effects FC EOS R'(λ|SSecondary), X, Y, Z
- UVM: Brightness illuminant (brightness measurement), effects FC Now Brt and FI, and EOS R'(λ|SBrightness), Brt and FI

Figure 8-2 shows the measured apparent reflectance R'(λ|S) from a white fluorescent sample with UVM: Primary illuminant being 1.0 and 1.2.

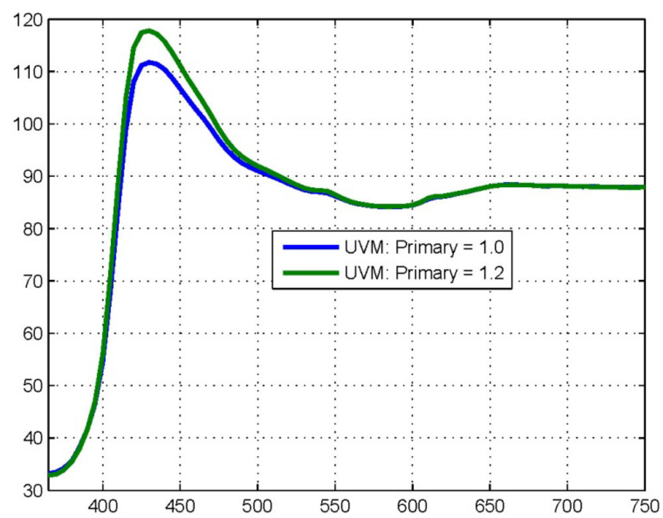


Figure 8-2 Measured Reflectance Graph 2

Changing this value does not influence reflectance R(λ), because R'(λ |S) = R(λ) + fluorescence.

Table 8-2 shows an example of an effect of changing UVM: Primary illuminant parameter on fluorescent color measurement under D65/10°.

Table 8-2 UV-adjust Parameters (primary illuminant)

Measurement	UVM: Primary	L*	a*	b*	Brt
FC	1.0	95.0	2.7	-10.8	96.0
FC	1.2	95.2	3.5	-13.1	96.5
FS	1.0	94.1	-1.2	1.3	85.7
FS	1.2	94.1	-1.2	1.3	85.7

8.1.4. Xenon UV-adjust Factor

Use the UVMs instead of the xenon UV-adjust factor because of the possible need for an independent brightness measurement adjustment.

This coefficient is meant to be used to adjust difference in the fluorescent excitation efficiency of the actual fluorescent whitening agent and the fluorescent standard caused by the higher UV level illumination due to possible differences in fluor excitation spectra. This is used in the firmware in calculation of R'(λ|S) for white fluorescent samples.

This parameter should remain at 1.0, meaning equal fluorescent excitation efficiency between the fluors. It should not be changed in the field without assistance from Honeywell TAC organization.

ATTENTION

The effect of the xenon UV-adjust factor and Fluorescent Std: Fluor Strength are strongly coupled.

8.1.5. Brightness Gain Adjust

If a separate brightness meter is used in the laboratory, this parameter can be used to adjust the color based scale for (FS) brightness calculation to match the brightness scale used in the brightness meter. If the laboratory brightness meter reads higher values than the color sensor on the non-fluorescent paper samples, increase the gain factor.

A value of zero disables **Brightness Gain Adjustment** and is equivalent to a gain of 1.0.

8.1.6. Other Parameters

8.1.6.1. KM: Enable

COLORP## Configuration table contains the Kubelka-Munk parameter, which enables the stack color estimation calculation for scan, sample, or scan and sample.

When measuring the tiles of 4215 or *infinite thick* stack of paper, it is recommended to use the parameter value of zero.

8.1.6.2. Dynamic Standardize Tolerance

Normally, dynamic standardization function is not needed or used.

This parameter may be used by the dynamic standardize algorithm that executes at scan-turnaround to compensate for changes in lamp intensity between standardizes. This feature can be utilized only if the black/white backing tile stays perfectly clean. This parameter is not meant to be used to compensate for a standardize interval that is too long. The recommended standardize interval should not exceed 60 minutes.

If the absolute percent difference between the current offsheet and the last standardize tristimulus Y value read on the backing tile is less than this amount, a correction is calculated for the standardize arrays based on the measurement change. A typical value is 0.2.

8.2. Required Samples and Measurements

This section describes principles for gathering required samples and measurements for making static cross-adjustment between the on-line and off-line color sensor.

8.2.1. Samples

Before you start a procedure to form a static correlation between the color sensor and the laboratory color instrument, gather together the following information and sample sets:

- answers about the laboratory color instrument of coloring process (see questions C through G in Appendix B)

- one to three sets of approximately 80–100 g/m^2 non-fluorescent white fine paper sheets with high opacity (copy paper), CIE Whiteness D65/10° below 100, ISO Brightness below 80
- one to three sets of approximately 80–100 g/m^2 low fluorescent (FI < 5) white fine paper sheets with high opacity (copy paper), CIE Whiteness D65/10° between 100 to 140, ISO Brightness between 80–100
- one to three sets of approximately 80–100 g/m^2 high fluorescent (FI > 10) white fine paper sheets with high opacity (copy paper), CIE Whiteness D65/10° above 155, ISO Brightness above 105
- one set of approximately 80–100 g/m^2 non-fluorescent black fine paper sheets with high opacity (copy paper)
- 420 nm UV cut-off filter from the Sensor Verification Accessory Kit (p/n 09834700)
- one to two sets of approximately 60–100 g/m^2 fluorescent white paper sheets produced by the mill

Commercial copy or inkjet fine papers can be used here for the paper set if not produced by the mill. The set contains at least 10 sheets of *A4* or *Letter* size paper.

Protect the measurement area of the sample from contamination. The best practice is to use the same color cover sheet on top, while storing these sets of samples in a black plastic bag.

Even if the product does not normally include fluorescent whitening agents (FWAs), it is often possible for mill broke and secondary fibers to contain FWAs of unknown amounts. It is important to have the off-line and the on-line sensor respond to the fluorescence in a similar way.

8.2.2. Off-line Measurements

Currently, more and more color measurements are made using automated testing systems in the paper mill quality laboratory. These automated quality testing systems with a color instrument may not have the facility or ability to measure an infinitely thick stack of paper samples.

The allowed size and shape of the sample may also be very limited. These restrictions create great challenges to get the off-line color measurement instrument and the on-line color measurement sensor to correlate.

For each sample set, a fluorescence-included and -excluded color measurement is made. The sample set is formed by placing two sheets of the sample set to be measured on top of a single black paper sheet. The black sheet functions as a backing sheet during the measurement, for example, two non-fluorescent white paper sheets on the top of the black sheet.

The following measurements are assumed to be measured using the off-line color instrument:

- find out the CIE illuminant and observer used for color measurement
- measure the sample of the non-fluorescent white paper sets
- measure the sample of the low fluorescent white paper sets
- measure the sample of the high fluorescent white paper sets
- measure the sample of the sets of approximately 60–100 g/m^2 fluorescent white paper sheets produced by the mill
- measure three sheets of the black paper
- for all sample sets, record:

  fluorescence index, FI

  fluorescence included (FC) L*, a*, b*, Brightness. If reported X, Y, Z

  fluorescence excluded (FS) L*, a*, b*, Brightness. If reported X, Y, Z

If only cross direction strips of paper can be measured with the automated quality testing system including the color instrument at the quality laboratory, then replace the sheets with cross direction strips of similar type of papers as defined by the measurements listed previously in this section. Most likely the measurement results will be estimated infinitely thick stack of color measurements based on R(λ) and R'(λ|S), not measured infinitely-thick stack color. Methods used may be a black and white backing or white backing with transmittance utilizing Kubelka-Munk, or a stack of sheets to be formed from each reel.

8.2.3. On-line Measurements

Before performing any on-line measurement with the 4215 color measurement sensor for the sample:

- ensure that the colorimetric calibration is done
- clean the surfaces of the scanner heads, removing oil, dust, and other residuals to protect from contamination of the paper samples
- check that air is supplied into the vortex and that it sucks the paper close to the black/white backing tile
- ensure that the tiles in the color backing module (CBM) are clean
- check the stability of the color sensor
- choose or create a customer color measurement set-up color grade for static correlation
- check the correct CIE illuminant and observer are configured and used in the selected color grade
- ensure that KM: Enable has a value of zero
- ensure that tungsten UV-adjust factor has a value 0.75
- load the customer code/color code
- perform a reference with the stable color sensor

Because it is not possible to measure an infinitely thick stack paper sample on the color measurement sensor installed into the scanner, the most functional and practical practice is introduced.

The sample set is formed by placing two sheets of the sample set to be measured on the top of a single black paper sheet. The black sheet functions as the backing sheet during the measurement, for example, two non-fluorescence white paper sheets on the top of the black sheet. A sample holder for moisture may be used if you ensure that the sample sheets having black sheet is in contact with the black/white backing tile. The sample may be moved around by hand 1–2 cm (0.39–0.79 in) during the measurement.

Make two series of measurements. The first series is done after placing the 420 nm UV cut-off filter from the Sensor Verification Accessory Kit (p/n 09834700) on the front of the quartz tungsten halogen (QTH) filter to determine the White Standard Y Value relative to the off-line instrument.

1. Loosen the screws holding the QTH lamp in place to more easily slide the UV cut-off filter in place, then gently tighten them.

2. Wait 10 minutes, then proceed (remember to record the FS color values with measurement utilized with the UV cut-off filter).

3. Check KM: Enable has a value of zero.

4. Perform a reference.

5. Measure the sample of the non-fluorescent white paper sets.

6. Measure the sample of the low fluorescent white paper sets.

7. Measure the sample of the high fluorescent white paper sets.

8. Measure the sample of the sets of about 60–100 g/m^2 fluorescence white paper sheets produced by the mill.

9. Measure three sheets of the black paper.

10. For all sample sets, record:

    fluorescence index FI

    fluorescence-excluded (FS with 420 nm UV filter) L*, a*, b*, Brightness, and X, Y, Z

    for measurements without the 420 nm UV cut-off filter: fluorescence-included (FC) L*, a*, b*, Brightness, and X, Y, Z

11. Determine the correct White Standard Y value based on the first series of measurements (FS) using the steps in Subsection 8.3.1.

12. Determine the correct tungsten UV-adjust factor using the steps in Subsection 8.3.3. After the correct White Standard Y value and tungsten UV-adjust factor have been determined, make the second series of measurements (FC and FS).

    Remove the 420 nm UV cut-off filter, wait 10 minutes, then perform a reference.

Measure the sample sets to determine UVM: Primary illuminant and UVM: Brightness illuminant.

Record the FC and FS color and brightness values.

8.3. Determining Static Parameters

The static cross-adjustment between the on-line and laboratory color measurement starts with matching L* value of preferably non-fluorescent white paper by adjusting Y_{STD}.

The tungsten UV-adjust factor is then determined (and last UVM).

8.3.1. Full-scale, Y_{STD}

The first step in the static cross-adjusting to a laboratory color sensor is to adjust the *full-scales* of reflectance of the two instruments using the calibration parameter White Standard Y Value, Y_{STD}. Ensure that you record the original certified Y_{STD} value of the white tile with the tile serial number.

The samples of two white sheets with one black sheet as backing are measured both with off-line and on-line color sensors under UV-excluded conditions. For the on-line sensor, use a 420 nm UV cut-off filter and record the fluorescence-suppressed values. Also measure the sample of three black sheets.

These measurements partially represent an infinitely thick stack of samples having a common black backing. Both off-line and on-line measurements should be comparable using this method.

Use fluorescence-excluded L* and/or Y off-line measurements. Note, the L* values must be less than 100.

If needed, the CIE L* value can be converted to the tristimulus Y value as:

$$Y = 100 * ((L^* + 16)/116)^3$$

If the measured Y values within all white samples (fluorescence and non-fluorescence) from the on-line sensor do not agree with the corresponding values measured on the laboratory instrument to within ± 0.5, adjust Y_{STD} using the following equation:

$$Y_{STD\_new} = Y_{STD} * \Sigma\, Y_{off\text{-}line} / \Sigma\, Y_{on\text{-}line}$$

The Y_{STD} value should never exceed 100; in practice it should be < 97. If a higher Y value is needed, use dynamic offset for final measurement quantity L*.

Most sphere-based color instruments in the paper industry use specular excluded (SPE) measurements. These instruments correlate quite well with the on-line color measurement geometry (45/0), which also excludes the specular component.

To verify the effect of change in Y_{STD}_new:

1. Enter the updated YSTD_new value into the White Standard Y value on the **Color Configuration/Calibration Parameter** display.
2. Click **Download Configuration**.
3. Inset 420 nm UV cut-off filter in front of the QTH lamp.
4. Perform a reference.
5. Measure the sample sets again using 420 nm UV cut-off filter on front of the QTH lamp.
6. Compare the fluorescence-excluded results.
7. Repeat these steps until the on-line and off-line Y values agree within ± 0.8.
8. Enter the updated YSTD_new value into the COLOR_CUSTOM color code setup.

The color measurement sensor is now calibrated to the same full (100%) reflectance scale as the laboratory sensor.

If there are large variations in L* and Y between the on-line and off-line measurement, study and improve sampling holding during the color measurement.

8.3.2. Zero-scale

For deep colored and black grades, it is useful to also check how well the zero-scale of the reflectance matches. In 2011, ISO standard recommended to use a light trap to calibrate the zero-scale between off-line color instruments.

There is no adjustment for this, but the knowledge is valuable for some grades to understand the need of dynamic offsets. The L* value of the black non-fluorescent sample should agree within ± 0.5.

1. Make a note of the agreement of the zero-scale based on L* or Y value.

2. Take the measured black sheet and two below it from the black set to form a three-sheet stack.

3. The three-sheet stack sample may be held and moved by hand on top of the black/white backing, or a moisture sample holder may be used.

4. Run a sample of a three-sheet stack while moving it a little using the **Color Spectrum** display.

5. Remove the three-sheet stack sample and replace it in a protective bag.

6. Record the following values:

   fluorescence excluded (FS) L*, and Y: FS and FC values should be the same

   compare recorded L* values

8.3.3. Tungsten UV-adjust Factor

This parameter is used to tune α, tungsten UV-adjust factor. This parameter affects only the color measurement of the fluorescent white papers.

If this parameter is too small, there will be some fluorescence remaining in the fluorescence-suppressed values for white fluorescent papers. the FS L* will be too large, and FS b* and FI will be too small, and vice versa. Most important is that $R(\lambda)$, FS spectrum, must always be less than 100%R or 1.0.

Use the on-line measured sample sets of fluorescent white samples, both FS (fluorescence-suppressed) measurements done with 420 nm UV cut-off filter on front of the QTH lamp and without the UV filter.

- the configured brightness function must be GE, Brightness Func = 0
- the configured fluorescence calculation must be ΔBrt, Fluorescence calc = 0

If the sum of fluorescence-suppressed (FS) brightness values measured using the GE brightness function of the sample sets is greater than 0.2 without the UV filter than with the UV filter inserted, increase tungsten UV-adjust factor in increments of 0.2, and vice versa. Use the **Color Configuration/Calibration Parameter** display for testing.

To verify the changes:

1. Enter the updated tungsten UV-adjust factor on the **Color Configuration/Calibration Parameter** display.
2. Click **Download Configuration** and perform a reference.
3. Perform a sample measurement as sample of low and high white fluorescent and a black sheet without the 420 nm UV cut-off filter.
4. If needed, adjust tungsten UV-adjust factor unless GE brightness values matches within ± 0.2 with and without the UV filter.
5. Update the final tungsten UV-adjust factor into the customer color measurement set-up COLORP## Calibration table on the **Recipe Maintenance** display into the color grade COLOR_CUSTOM.
6. Update the customer color measurement set-up to use defined brightness function, such as ISO or TAPPI.

Tungsten UV-adjust factor also has an effect on the fluorescence-excluded (FS) L* value and the fluorescence-included (FC) L* value, because R'(λ|S)=R(λ) + fluorescence.

8.3.4. UV Modifier: Primary Illuminant

If the color sensor spectral power distribution and/or intensity of the UV illumination is different than the laboratory color instrument, it will generally measure different fluorescence-corrected (FC) CIE b* values based on apparent reflectance R'(λ|S) (higher apparent reflectance in the blue region of the spectrum) than the laboratory sensor on sheets containing fluorescent whitening agents (FWAs /FBAs /OBAs).

The UVM: Primary illuminant can be used to adjust the amount of UV light utilized in the apparent reflectance calculation for color.

This adjustment can be done using a fluorescence-included (FC) b* value of the sample set of white fluorescent paper samples.

1. Ensure that the b* values measured with 420 nm UV cut-off filter agree within ± 0.5 between on-line and off-line. Here it is assumed that the off-line color instrument uses 420 nm UV cut-off filter to produce UV-excluded color measurement results.
2. If the measured fluorescence-included (FC) b* value of the fluorescent white samples measured with the on-line sensor does not agree with

the corresponding value measured on the laboratory instrument to within ± 0.5, adjust the UVM: Primary illuminant, UVM: Primary, using the following equation:

$$\text{UVM:Primary}_{new} = \text{UVM:Primary} * (\Sigma\, b^*_{on\text{-}line} / \Sigma\, b^*_{off\text{-}line})$$

3. To verify the modified UVM: Primary:

   Enter the updated UVM: Primary illuminant value into the COLOR_CUSTOM color grade setup, and download it.

   Perform a reference.

   Measure again the b* of the sample sets of fluorescent white sample using the COLOR_CUSTOM color grade setup. And adjust the UVM: Primary illuminant until the two b* values agree within ± 0.2.

UVM: Primary illuminant also has an effect on the fluorescence-included (FC) L* value, but not on the fluorescence-excluded (FS) L* value.

8.3.5. UV Modifier: Brightness Illuminant

If the color sensor spectral power distribution and/or intensity of the UV illumination is different than the laboratory color sensor, it will generally measure different fluorescence-corrected (FC) brightness values based on apparent reflectance R'(λ|S) (higher apparent reflectance in the blue region of the spectrum) than the laboratory sensor on sheets containing fluorescent whitening agents (FWAs or FBAs or OBAs). UVM: Brightness illuminant can be used to adjust the amount of UV light utilized in the apparent reflectance calculation for brightness.

ATTENTION

For ISO and TAPPI brightness the CIE C illuminant should be used as the default brightness illuminant in the configuration of the color sensor. For the D65 brightness should use the D65 brightness illuminant.

This adjustment can be done in two ways, using fluorescence-included (FC) brightness values, or using the fluorescence index (difference of the fluorescence-included (FC) and excluded (FS) brightness values). The problem with the second option is that commonly a 420 nm UV cut-off filter is used in the laboratory color instrument to provide a fluorescent-excluded color measurement. This method produces incorrect results, because the missing R (380–415 nm) is assumed to have the same value as R (420 nm), which is not the case for any white papers, especially papers containing fluorescent whitening agents. However, because the main interest here is the value of the fluorescent index, the method may be used.

If the measured fluorescence index (FI) of the fluorescent white paper samples with fluorescent index at levels of 5 and 20, from the on-line sensor, does not agree with the corresponding value measured on the laboratory sensor to within ± 0.5:

1. Adjust the UVM: Brightness illuminant, UVM: Brightness, using the following equation:

   $\text{UVM:Brightness}_{new} = \text{UVM:Brightness} * (\Sigma\, \text{FI}_{on\text{-}line} / \Sigma\, \text{FI}_{off\text{-}line})$

2. Enter the updated UV Modifier: Brightness illuminant value into the COLOR_CUSTOM color grade setup.
3. Perform a reference.
4. Measure again the fluorescent index (FI) of the used fluorescent white sample using the COLOR_CUSTOM color grade setup.
5. Repeat Steps 1–4 until the two fluorescent indices (FI) values agree within ± 0.5.

UVM: Brightness illuminant does not affect the fluorescence-suppressed brightness value.

8.4. Cross-adjusting to a Laboratory Brightness Instrument

Your paper mill may use separate laboratory instruments for measuring color and brightness.

8.4.1. Determining Brightness Gain Adjust

If a different instrument is used for brightness than for color measurements in the mill quality laboratory, the brightness instrument may have a different scale than a spectrophotometer measuring brightness. This is because the brightness instrument often uses agreed band-pass filters instead of a spectrometer, which low-pass filters the measured reflectance.

To define a separate brightness scale for non-fluorescent white samples for the color sensor:

1. Set Brightness Gain Adjust to 1 on the **Color Config/Calib Download** display and download.

2. Perform a reference.

3. Measure and record brightness readings of a set of non-fluorescent white samples with varying brightness and with high opacity on the laboratory brightness instrument and the color sensor.

4. Compute the Brightness Gain Adjust, BGA (BGA = Σ $Brt_{off\text{-}line}$ / Σ $Brt_{on\text{-}line)}$ and enter it into the sensor configuration.

The color sensor brightness measurement is now correlated to the same brightness scale as the laboratory brightness instrument.

8.4.2. Determining UV Modifier: Brightness Illuminant

If the produced product contains fluorescent whitening agents either dosed or through recycled fibers, the parameter UVM: Brightness illuminant may need to be adjusted. See Subsection 8.3.5.

8.5. Factors Affecting Static Correlation

Paper mills generally use a laboratory color instrument in their quality laboratory as the standard for their color measurements. The control of the coloring process is simple, if the on-line and the laboratory color sensor agree as closely as possible for all grades, there would not be a need to map the laboratory color errors to the actual coloring process errors.

This section describes factors that affect the correlation between the laboratory and the on-line color sensors. It explains why the correlation is so difficult to achieve. More detailed analysis is described in *Color and Coloring of Paper Reference Manual*.

8.5.1. Measurement Geometry

Most laboratory color instruments use a d/0 geometry, where the sample is illuminated diffusely by an integrating sphere. The color sensor uses a 45/0 geometry, where the sample is illuminated by circumferential beams. The geometry of this model has an advantage in that it requires no direct contact between delicate optical components and the sheet, and is generally used for on-line measurement.

Color measurement results from instruments equipped with integrating spheres will differ from the results using instruments with directional 45/0 geometry, and these differences will be sample-dependent. Sphere instruments with d/0 condition produce erroneous results for fluorescent papers, as the light in the sphere is contaminated and colored by the radiation emitted from the sample.

8.5.2. Colorimetric Scale

Color measurement is a relative measurement and all color sensors reference their readings to a known white standard. An ideal white standard would diffuse light perfectly, with 100% diffuse reflectance at all visible wavelengths.

A real white standard is never perfect, so the sensor has to be calibrated to recognize the actual reflectance of the white standard. In the color sensor, this is done by storing the actual reflectance of the white standard into the firmware of the color sensor and specifying its Y_{STD} value: the CIE tristimulus Y value for the internal white standard tile in the backing wheel (for perfect white standard, Y_{STD} = 100). When the on-line and off-line color sensors are required to correlate, the full-scale reflectance must be readjusted using Y_{STD}, so that both sensors give the same measurement when reading the same non-fluorescent white sample.

If the white standard contaminates, it will affect the color measurement.

8.5.3. Spectral Band-pass of the Spectrometer

A spectral band-pass of the spectrometer (grating) is not an issue with white grade with flat reflectance. However, this can start to play a major role when measuring pastel and deeply colored samples, in which reflectance has deep valleys.

If the spectral band-pass of the spectrometer is wide (more than 10 nm), the slit-scattering function low-pass filters the measured reflectance so that the peaks are too broad and the valleys are too shallow. This gives different color results than the instrument with a spectral band-pass of 3–5 nm.

8.5.4. Quality of Ultraviolet Illumination

Non-fluorescent samples are not dependent on the actual spectral power distribution of the provided illumination on the sample. However, it should be noted, that the apparent reflectance $R'(\lambda|S)$ and calculated color values from the white and colored fluorescent samples are strongly dependent on the actual spectral power distribution of the provided illumination on the sample on the fluor excitation band.

In 2011, most laboratory color instruments used a 390 nm UV cut-off filter, which is wedged into the illumination beam until the same fluorescent index is read as given with the IR3 level fluorescent standard. Another problem is that all suppliers have not followed the definition of the D65 illuminant when implementing their light source.

Different grades, containing the same fluorescent whitening agent, and even at the same dosage levels, may not correlate similarly between the color sensors.

Another problem is detecting day-light fluors, such as yellow, orange, green, and red. Their existence may be difficult to notice, and their apparent reflectance cannot be measured at all with common spectrophotometers, and thus measured apparent reflectance $R'(\lambda|S)$ is a guess. Day-light fluors may excite at ultraviolet and visible bands making them difficult to measure accurately.

9. Dynamic Cross-adjustment

After the static cross-adjustment of the color sensor, the next step is to adjust the color measurement by dynamic adjustment, compensating for grade dependent and environmental issues.

The dynamic cross-adjustment finds the required adjustments to get the infinitely thick stack estimate to correlate with the actually measured infinitely thick stack of samples, $R_\infty(\lambda)$, or with estimated infinite pad color of samples, $\check{R}_\infty(\lambda)$.

You may want to achieve an as-good-as-possible cross-adjustment of the on-line color sensor to a color (and a brightness) instrument in the mill quality laboratory. However, the on-line sensor and the laboratory color instrument actually measure the color from different products, one being a hot, single-sheet web moving at high speed, and the other often being a infinitely thick non-moving stack of sheets pre-conditioned to the moisture and temperature of the room of the quality laboratory. There are limitations for the goodness of achievable dynamic correlation.

The dynamic cross-adjustment is done using the customer color measurement set-up for the on-line color sensor in a quality control system (QCS) server. It is important to record any changes that you make to the configuration and calibration parameters, including the time and date of the changes.

Before dynamically cross-adjusting the color sensor to a laboratory color measurement, ensure that the color sensor has undergone the colorimetric calibration and static cross-adjusting to the laboratory color measurement.

The task of dynamic cross-adjustment begins with step by step methods, after ensuring that the moving web is stable on top of the black/white backing tile and the temperature of the color measurement module (CMM) varies only within a degree while keeping below 42°C (107.6°F).

The second level is to find required adjustments to get the infinitely thick stack estimate to correlate with the actually measured infinitely thick stack of samples.

Due to the thermocromic dyes, fluorescent activity depending on the temperature, day-light fluors, moisture, and web stabilizing issues, it may not be possible to find a good correlation between the on-line and the off-line color measurements.

9.1. Dynamic Cross-adjustment Parameters

It is not possible to reproduce exactly the measurement conditions and methods used in the laboratory with an on-line scanning sensor. Certain environmental factors, the nature of the scattering in the paper, and practical differences limit the degree of agreement between the mill quality laboratory and on-line color measurement.

9.1.1. Kebelka-Munk Parameter: Enable

COLORP## Configuration table (see Table 5–2) shows the Kubelka-Munk parameter *KM: Enable*, which enables the stack color estimation calculation for either scan measurement or scan and sample measurements. KM: Enable is the master switch, which defines whether or not the following parameters are taken in use:

- KM: Backing Corrector
- KM: Opacity Corrector
- KM: Opacity*Fluor Factor

When measuring the tiles of Q4215-60 or infinitely thick stack of paper, KM: Enable is disabled.

9.1.2. Kebelka-Munk Parameter: Backing Corrector

The Kubelka-Munk parameter, *KM: Backing Corrector* (γ_{KM}), is used to adjust assumed theoretical issues on the $R(\lambda)^{white}{}_{Tile\_B/W}$ in Kubelka-Munk stack estimation to practical ones.

Typically, γ_{KM} has a value of approximately 1.05, ranging from 1.03 to 1.1. Increasing the value decreases the transparency compensation, particularly in regions of the spectrum where the reflectance is high (usually at the red end of the visible spectrum).

The $R_\infty(\lambda)$ (fluorescence-suppressed spectrum) must have values below 100%R or 1.0.

Figure 9-1 shows an example of effect of γ_{KM} on reflectance $\check{R}_{\infty}(\lambda)_{off\text{-}line}$, when γ_{KM} =1.04 and γ_{KM} =1.09 compared to the measured stack reflectance $R_{\infty}(\lambda)$.

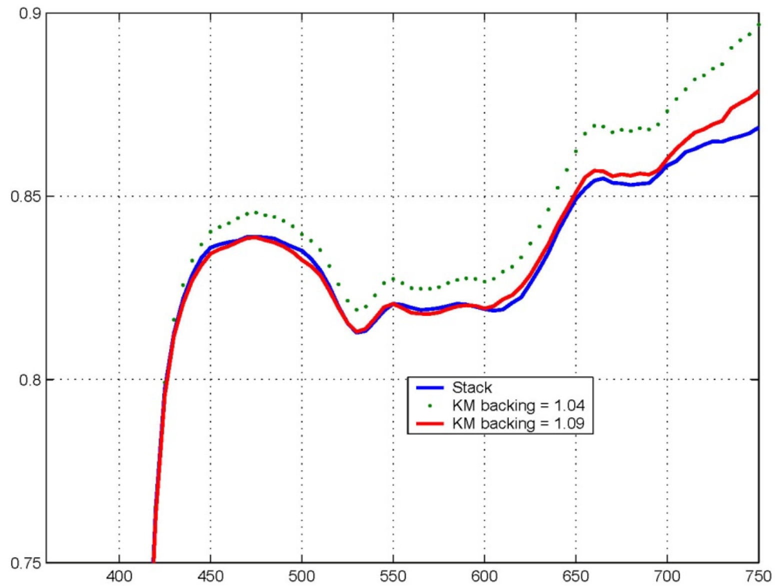


Figure 9-1 Graph 1: Kubelka-Munk Backing Corrector

9.1.3. Kebelka-Munk Parameter: Opacity Corrector

The Kubelka-Munk parameter, KM: Opacity Corrector (α_{KM}), adjusts gain used on the proprietary improvement of Kubelka-Munk stack estimation calculation for $R_{\infty}(\lambda)$.

Figure 9-2 shows an example of effect of α_{KM} on reflectance $\check{R}_{\infty}(\lambda)_{off\text{-}line}$, when α_{KM} = 0.3 and α_{KM} = -0.3 compared to the measured stack reflectance $R_{\infty}(\lambda)$. The default value is zero.

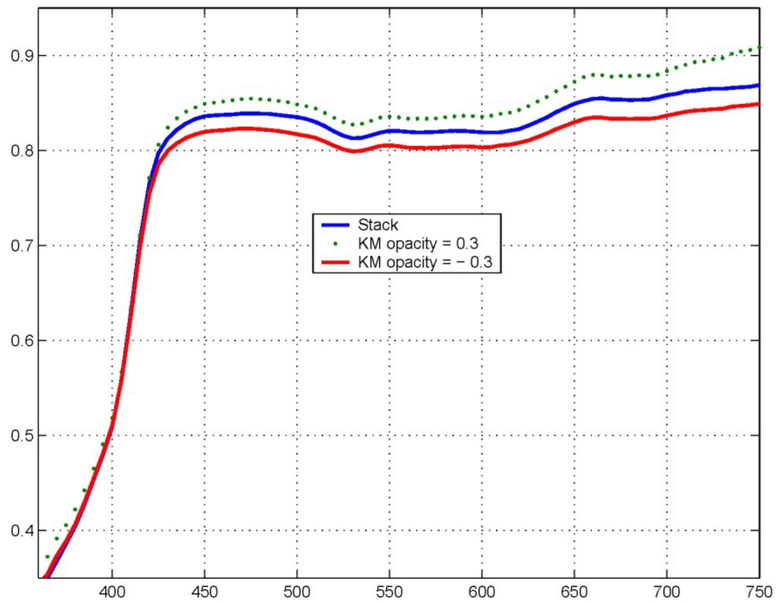


Figure 9-2 Graph 2: Kubelka-Munk Opacity Corrector

9.1.4. Kebelka-Munk Parameter: Opacity*Fluor Factor

The Kubelka-Munk parameter, KM: Opacity*Fluor Factor (β_{KM}), is used to adjust the gain used on the proprietary improvement of Kubelka-Munk stack estimation fluorescence emission calculation used in R'(λ|S). Increasing the value increases the fluorescence emission, in regions of the spectrum where fluorescent emission exists.

Figure 9-3 shows an example of the effect of β_{KM} on apparent reflectance $R'_{\infty}(\lambda |S)_{off\text{-}line}$, when $\beta_{KM} = 0.0$ and $\beta_{KM} = 2.0$ compared to the measured stack apparent reflectance $R'_{\infty}(\lambda |D65)$. The default value is zero.

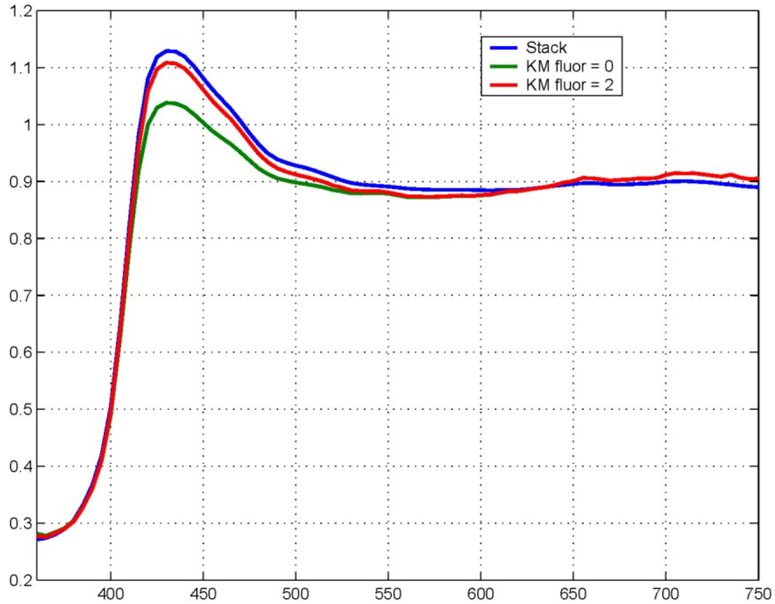


Figure 9-3 Graph 3: Kubelka-Munk Opacity Fluorescence Corrector

9.1.5. Offsets

Dynamic offsets are used to adjust the final sensor values for any dynamic effects that cannot be accommodated in the static and general dynamic cross-calibration, for example, on-line effects. The dynamic effects are often grade dependent. Dynamic offsets are available for the following parameters:

- L*, a*, b*
- brightness
- whiteness
- tint
- dominant wavelength
- purity
- luminance (Y)
- hue (h_{ab})

- chroma (C^*_{ab})

These offset parameters can be found in the *Dynamic Offsets* section of the database file for the color sensor. A run-time version of these parameters is also found in the *Color Config/Calib Download* frame.

9.1.6. Slopes

Slopes are used to adjust the final sensor values for any non-linear static effects that cannot be accommodated in the static or general dynamic cross-calibration. These dynamic effects may be grade-dependent. Dynamic slopes are available for the following parameters:

- L*, a*, b*
- brightness
- whiteness
- tint
- dominant wavelength
- purity
- luminance (Y)
- hue (h_{ab})
- chroma (C^*_{ab})

These slope parameters can be found in the *Dynamic Slopes* section of the database file for the color sensor.

9.2. Pre-sorting Production Grades

If the range of manufactured products is large in means of opacity, fluorescence index, and/or caliber, it is a good practice to presort different paper grades within the color grades. It may be that within the same color grade, different cross-adjustment parameters are needed for different paper grades. Figure 9-4 shows an example of presorting criteria to group paper grades for a color grade based on opacity and fluorescence index.

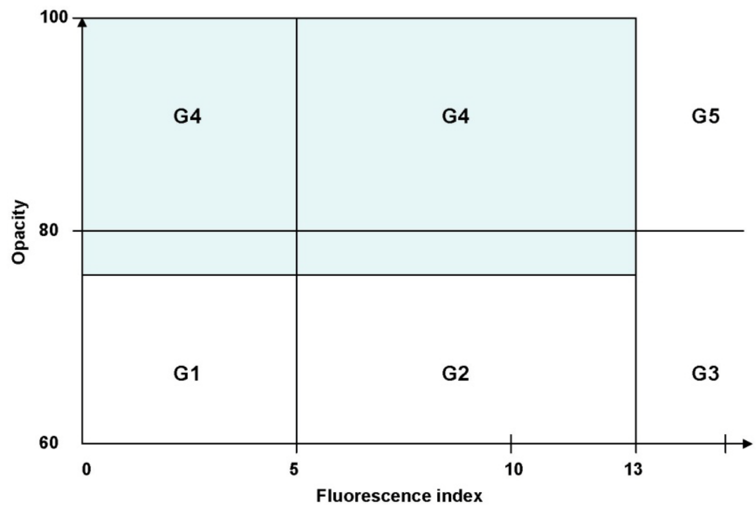


Figure 9-4 Graph 4: Pre-sorting

It is better to use opacity rather than basis weight as the presorting criteria, because opacity correlates better with product scattering properties affecting the paper color.

If the on-line moisture of produced paper is below 5, it may be necessary to create a low moisture color group for high fluorescence papers.

The dynamic cross-adjustment is studied using selected samples from each presorted group. If needed, the presorted groups can be combined or further divide, as needed, later.

9.3. Required Samples and Measurements

9.3.1. Samples

Before you start a procedure to form a dynamic correlation between the color sensor and the laboratory color instrument, gather together the following information and sample sets, as your mill is manufacturing them:

- from one to three sets of non-fluorescence white papers with low and high opacity based on presorted grades
- from one to three sets of low fluorescence (FI < 5) white papers with low and high opacity based on presorted grades

- from one to three sets of high fluorescence (FI > 10) white papers with low and high opacity based on presorted grades
- 420 nm UV cut-off filter

Commercial copy or inkjet fine papers can be used for a paper set, if not produced by the mill and/or the mill production scope is narrow. The set contains at least 20 sheets of *A4* or *Letter* sized paper, or cross direction stripes.

Protect the measurement area of the sample from contamination. The best practice is to use the same color coversheet on top, while storing these sets of samples in a black plastic bag.

Even if the product does not normally include fluorescent whitening agents (FWAs), it is often possible for mill broke and secondary fibers to contain FWAs in unknown amounts. It will generally be important to have the off-line and the on-line sensor respond to the fluorescence in a similar way.

9.3.2. Off-line Measurements

If the off-line color instrument allows the thick stack of paper samples to be measured, the sample is formed by placing at least 20 sheets of the same paper to form a thick, opaque stack. This method produces intrinsic color measurements $R_\infty(\lambda)$ and $R_\infty(\lambda|S)$.

If only the cross direction strips of paper can be measured, then a cross direction strip using a single thickness of the paper is measured. This method produces estimates of intrinsic color measurements $\check{R}_\infty(\lambda)$ and $\check{R}_\infty(\lambda|S)$.

For each sample set, a fluorescence-included and -excluded color measurement is made:

1. Measure the low and high opacity non-fluorescence white paper sets.
2. Measure the low fluorescence white paper sets.
3. Measure the high fluorescence white paper sets.
4. For all sample sets, record:

   Fluorescence index FI.

   Fluorescence-included (FC) L*, a*, b*, Brightness. If reported (FC) R'(450nm|S), R'(650nm|S), and X, Y, Z.

Fluorescence-included (FS) L*, a*, b*, Brightness. If reported (FS) R(450nm), R(650nm), and X, Y, Z.

9.3.3. On-line Measurements

Before performing any on-line measurement for any sample:

- Ensure that the static cross-adjustment is done.
- Clean the surfaces of the scanner heads of oil, dust, and other residue to protect from contamination of the paper samples.
- Check that the air is being supplied into the vortex, and that it sucks the paper close to the black/white backing tile.
- Ensure that the tiles in the color backing module (CBM) are clean.
- Check the stability of the color sensor.
- Choose a customer code/color code for dynamic correlation.
- Check that the correct CIE illuminant and observer are in use in the selected color grade.
- Ensure that KM: Enable has value 2.
- Ensure that KM: Backing Corrector has a value 1.04.
- Ensure that KM: Opacity Corrector has an initial value of zero.
- Ensure that KM: Opacity*Fluor Factor has a value of zero.
- Make at least two series of measurements:

  The first series of measurements is done with the 420 nm UV cut-off filter in the front of the quartz tungsten halogen (QTH) lamp to determine KM: Backing Corrector.

  The second series of measurements is done to determine KM: Opacity*Fluor Factor, if needed. This series of measurement is made without the 420 nm UV cut-off filter.

  A third series of measurement may need to be done, if it looks like KM: Opacity Corrector is needed. This series of measurements is also made with the 420 nm UV cut-off filter.

1. Perform a reference.
2. Measure the sample of the non-fluorescence white paper sets.
3. Measure the sample of the low fluorescence white paper sets.
4. Measure the sample of the high fluorescence white paper sets.
5. For all sample sets record:

   Fluorescence index FI.

   Fluorescence included (FC) L*, a*, b*, Brightness. If reported (FC) R'(450nm|S), R'(650nm|S), and X, Y, Z.

   Fluorescence included (FS) L*, a*, b*, Brightness. If reported (FS) R(450nm), R(650nm), and X, Y, Z.

9.4. Determining Dynamic Parameters

The second level of the correlation is to find the required adjustments to get the infinitely thick stack estimate to correlate with the actually measured infinitely thick stack of samples with the laboratory color sensor, using a selection of paper samples representing different paper grades in means of different level of scattering (level of ash/filler, ratio of cellulose/mechanical fibers, and basis weight) and fluorescence, when the samples have been preconditioned to the temperature and the moisture of the laboratory room.

Scattering of light in the paper is dependent on the wavelength. The maximum scattering is achieved when the wavelength of the light is about half the size of the spaces, where the scattering can take place. The paper is more translucent at longer wavelength (at 700 nm, and more than 400 nm), because less scattering takes place within a sheet of paper. Scattering of light depends also on the moisture content of the paper. A white cotton shirt is quite opaque when dry, but very see-through when wet. The effect of moisture on the fluor emission is a more complicated process. Often the dryer the sheet, the less fluor emission.

There is always the matter of what the conditions of the paper are, when trying to achieve correlation.

9.4.1. Kubelka-Munk-based Backing Correction

The following steps provide instructions for determining the appropriate amount of Kubelka-Munk-based backing correction for the used stack estimation algorithm in the color sensor.

The fluorescence-excluded L* off-line color measurements based on $R_\infty(\lambda)$ and $\check{R}_\infty(\lambda)$ are needed.

The fluorescence-excluded on-line measurements are performed utilizing the 420 nm UV cut-off filter while measuring a single sheet of paper under the following parameters:

1. Loosen the screws holding the QTH lamp in place.
2. Slide the UV cut-off filter into place.
3. Gently tighten the screws.
4. Enter maintenance mode.
5. Load customer code COLOR_CUSTOM.
6. Ensure that following parameters have correct values using the **Color Config/Calib Download** display:

   KM: Enable has a value of 2.

   KM: Backing Corrector has a value of 1.04.

   KM: Opacity Corrector has an initial value of zero.

   KM: Opacity*Fluor Factor has an initial value of zero.
7. Wait 5 to 10 minutes and perform a reference.
8. Measure sample sets as a single sheet of paper:

   Record the FS color values.

If the sum of the on-line opacity-corrected L* (or Y) is greater than the off-line measured L*, the backing corrector value should be raised, and vice versa, as shown in this equation: $\gamma_{KM\_new} = \gamma_{KM} * (\Sigma\, L^*_{\text{off-line}}) / (\Sigma\, L^*_{\text{on-line}})$

Where $L^*_{\text{off-line}}$ is the measured or estimated color of the infinitely thick pad of samples with the laboratory color instrument, and $L^*_{\text{on-line}}$ is the estimated color of the infinitely thick pad of samples measured from a single sheet of paper over the black/white backing tile with KM: Enable to 2 (=scan&sample).

If needed, adjust KM: Backing Corrector using the **Color Configuration/Calibration Download** display. Download the configuration and perform a reference and measure $\check{R}_{\infty}(\lambda)$ of each sample until you are satisfied the opacity-corrected color value L*. Remember to enter the updated KM: Backing Corrector value into the COLOR_CUSTOM on the COLORP## Calibration table.

KM: Backing Corrector has a value typically between 1.03 and 1.07. For low scattering grades, you may also need to use other Kubelka-Munk correctors.

The Kubelka-Munk method to use black and white backing is very sensitive to the distance between the sheet and the backing tile. The web will be in contact with the backing tile when scanning. Ensure that there is an air flow to the CBM vortex while making the measurements.

Depending on the variety of the produced paper grades and their properties, it may be that more than one COLOR_CUSTOM color grade is required to achieve satisfactory correlation to the infinitely thick stack estimate. If needed, sort the samples/production grades into the suitable groups based on KM: Backing Corrector and enter the final KM: Backing Corrector to the appropriate COLOR_CUSTOM color grades.

Some yellow dyes are fluorescent. In 2011, typical spectrophotometers (and any of the on-line color sensors) used in the paper mill quality laboratories cannot reliably measure the quantity of the fluorescence produced by the day-light fluors. They all are optimized to measure FWAs.

The Kubelka-Munk method requires the usage of $R_{\infty}(\lambda)$, not $R'_{\infty}(\lambda|S)$. A small quantity of yellow fluorescence may be compensated for by increasing KM: Backing Corrector to approximately 1.1, but note that this parameter depends on the quantity of yellow emission, which may vary.

9.4.2. Kubelka-Munk-based Opacity Correction

KM: Opacity Corrector can be used to scale the amount of opacity corrector at wavelengths of high reflectance value. The effect of this parameter is added to KM: Backing Corrector one. In practice, it is not recommended to use this parameter, unless in special cases where this would be needed.

This adjustment could be done by using a fluorescence-excluded a* and L* values of the sample set of white fluorescent paper samples. The on-line samples must be measured using 420 nm UV cut-off filter and fluorescence-suppressed a* and L* values are of interest.

If the measured fluorescence excluded a* and L* values of the fluorescent white samples measured with the on-line sensor do not agree with the corresponding value measured on the laboratory sensor to within ± 0.5, then adjust KM: Opacity*Fluor Factor initially setting it to have value 0.1, then use this equation for future adjustment: $KM{:}Opacity_{new} = KM{:}Opacity * (\Sigma\, a^*_{\text{on-line}}) / (\Sigma\, a^*_{\text{off-line}})$

9.4.3. Kubelka-Munk-based Opacity Fluorescent Correction

The fluorescence correction based on the measured scattering scaled with the parameter KM: Opacity*Fluor Factor can be used to adjust the amount of fluorescence created in single sheet versus stack conditions used in the apparent reflectance calculation for color. This may be needed if the actual moisture conditions between the on-line and off-line color measurements are different from grade-to-grade and/or paper the sheet's scattering power is very low.

This adjustment can be done using a fluorescence-included (FC) b* values of the sample set of white fluorescent paper samples. Ensure first that the b* values measured with the 420 nm UV cut-off filter agree within ± 0.3.

If the measured fluorescence-included (FC) b* value of the fluorescent white samples measured with the on-line sensor does not agree with the corresponding value measured on the laboratory sensor to within ± 0.3, adjust KM: Opacity*Fluor Factor, initially setting it to have a value of 0.2, then use this equation for future adjustment: $KM{:}Opacity{*}fluor_{new} = KM{:}Opacity{*}fluor\ (\Sigma\, b^*_{\text{on-line}}) / (\Sigma\, b^*_{\text{off-line}})$

To verify the modified KM:Opacity*fluor:

1. Enter the updated KM: Opacity*Fluor Factor using the **Color Configuration/Calibration Download** display.
2. Click **Download Configuration**.
3. Perform a reference.
4. Measure again the b* of the sample sets of fluorescent white samples.
5. Adjust KM: Opacity*Fluor Factor until the two b* values agree within ± 0.3.

Remember to enter the updated KM: Opacity*Fluor Factor value into the COLOR_CUSTOM on the COLORP## Calibration table.

KM: Opacity*Fluor Factor has an effect on the fluorescence-included (FC) L* value, but not on the fluorescence-excluded (FS) L* value.

9.4.4. Offset

When tuning the color sensor to agree with local laboratory measurements, perform a static agreement by using samples equilibrated to room temperature and moisture, then use the dynamic offsets to tune in the on-line measurements.

To determine the dynamic offsets:

1. Wait for an opportunity when the paper machine is operating in a steady-state, stable mode, and when all of the important process variables, including the color values, are not changing.
2. At reel turn-up, obtain a printout of the last scan average color values and tear a cross direction strip from the reel.
3. Take the scanner off-sheet and measure the cross direction tear strip with the color sensor or the customer lab color sensor at a minimum of three cross direction positions, rejecting edges.
4. Average the torn strip measurements and compute the difference between the average static sample and the on-line values.

If possible, repeat this procedure for several reels over a period of time to ensure that the measured difference is indeed a true dynamic offset and not the result of process variation or measurement error.

Use this difference (for each color variable of interest) for the dynamic offset parameters of the database, accessible through the COLORP## Calibration table of the **Recipe Maintenance** display.

The dynamic offsets are added to the uncorrected color values. Use a positive offset if the lab sensor measures higher than the color sensor. Repeat this process for each recipe group where you want a separate dynamic offset.

9.5. Factors Affecting Dynamic Correlation

This section describes environmental factors that affect the correlation between the laboratory and the on-line color sensors, and the reasons why it is challenging to achieve a good dynamic correlation.

The on-line color sensor is measuring a completely different product during the paper manufacturing process than is done at the mill quality laboratory, starting from issues of a single sheet versus an infinitely thick pad of sheets. Remember that the essential requirements for the on-line color sensor are to provide repeatable and reproducible color measurements.

9.5.1. Temperature Effects

Many dyes used in paper manufacturing exhibit significant temperature sensitivity, especially yellow and red dyes. Their power to absorb light of a given wavelength is a function of the temperature of their environment. The color measured in one environment, such as on-line during production, does not necessarily agree with the color measured in another, such as in the quality laboratory after the paper is equilibrated to room temperature. The yellow tile used in the CBM is also thermochromic.

Fluorescence emission strength depends also on temperature. Higher temperature reduces the efficiency of the fluorescent emission, and thus reduces, for example, fluorescent index.

9.5.2. Moisture Effects

Dye effectiveness is often a function of moisture, as is the scattering of the base sheet itself. Because the behavior of color with moisture is a complex function of many parameters, it is not realistic to compensate for this effect as part of the measurement algorithm. Therefore, moisture level differences of more than 1–2% from nominal should be regarded as a warning that dynamic errors may be present. If on-line moisture is below 4.8%, the correlation to the off-line measurement, especially in brightness, may be very difficult.

Moisture also affects the strength of fluorescence emission. For high white paper, the wetter sheet causes fluorescent index first to increase and then to decrease.

Figure 9-5 shows an example how on-line measured brightness of white fluorescent papers may dependent on actual on-line moisture content, in the case where brightness measured at a laboratory is the same for all pre-conditioned paper samples, having a higher and the same moisture content.

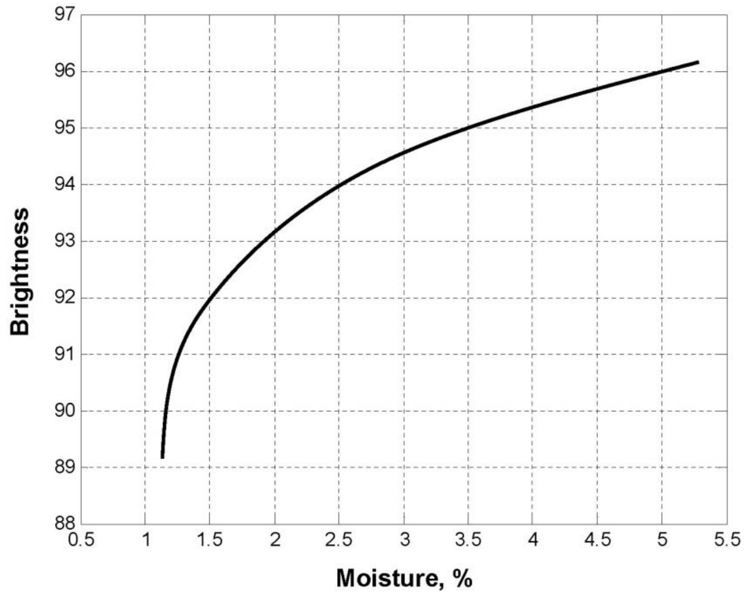


Figure 9-5 Graph 5: Moisture Dependency

9.5.3. Profile Effects

There are several ways that false profiles can affect color, and several ways to determine false profiles.

A false profile shape (other than actual color of product and process issues) can originate from such causes as a bad scanner Z-profile, temperature profiles (gap, environment), bad scanner mechanics and/or head carrier. Most important is to study and define the mechanical condition of your scanner before taking any further action. If you are aware of any unfinished maintenance or repair issues, then first close down any unfinished tasks to avoid endless looping when trying to improve color measured profiles in all other ways than mechanical scanner maintenance.

Before starting to apply any extra devices to the head, it is important to work purposefully and consistently. You must do only one step at a time, collect enough data on how your change affected the measurement process (also with different grades), and try to cover all basic combinations. Rolls and/or sheetguides will affect strongly to Brightness or L* profile. You may also use raw X, Y, Z profiles for analysis, but the effect may not be so obvious.

If you use a static sample (fixture in the gap), you can see if there is any direct effect from the physical condition of the scanner.

Sometimes it is also possible to swap the sensor to another location in the head, or even begin to measure different sides of paper. With these top- or bottom-side issues, interview the customer to determine what they want or need to measure and if there is more than one way of doing so.

When doing tests and adjustments, note the differences in the environmental state (temperature, humidity, and so on) in on-line production mode and off-line outage mode. Some basic procedures can be adjusted off-line, but most procedures need to done when there is active production going on the machine.

Finally, define and report any profile shapes existing and what you cannot control in any way, for example, environmental temperature profiles along the scanner. In some older scanners, the hardware may not be as good as it is in the new ones. If there is a really bad situation, then you may end up with profile correction calculations, but normally it will be enough to find static profile aberrance and mark those.

You should notice a difference between the following cases:

- brightness profile is not flat, but it is stable
- brightness profile shape changes from scan to scan depending on scan direction
- brightness profile will change depending on reel length–in other words, change on web tension or other process effects may show up

There are several tools in newer systems to collect and analyze data. Remember to start with very simple statistical parameters and a lot of data, first excluding all basic sources of error, such as the sensor/scanner hardware.

Color is normally fairly uniform across the produced web if the cross directional moisture profile is flat. However, the following factors can produce real and false color profile effects:

- A non flat color and/or appearance profile correlating with some process variables, including moisture, sheet temperature, or sheet opacity, can produce a profile effect.

  In these cases, the color profile is regarded as dynamic. The profile is likely to not be observed in the laboratory color measurement after the sheet temperature or moisture has equilibrated and/or where the sheet is measured in an infinite opacity pad arrangement.

- Profiles can sometimes occur where colorants, sizing, coatings, or FWAs are applied with a technique that can exhibit cross direction dependency, such as at the size-press.

  These static profiles can typically be confirmed with laboratory color measurements by measuring several reel cross direction paper strips with the customer laboratory color sensor to get the color profile.

- False profiles can occur if the sheet does not stay flat against the backing as the color sensor crosses the web, or as a result of a non-uniform gap or severe scanner misalignment.

  A banana roll before the scanner is a very common source for false color profiles with different smiles.

If you observe a bad color profile, it is important to understand the cause of it so that problems can be eliminated, control can be optimized, and dynamic correlation with the lab can be maximized. Unless the color measurement is used for any cross direction control, for example controlling the slice lip to produce white top liner, the color measurement is actually a machine direction quantity. In most cases, the bad edges of the profiles can and should be honestly eliminated from the color measurement.

9.5.4. Web Tension Effects

If the web tension varies in a controlled or non-controlled manner, it may cause the sheet to not stay flat against the backing. This causes color measurement to vary as a function of the web tension. This may require the use of external sheet stabilization bars and/or rolls if the scanner alignment does not solve the problem.

9.5.5. Sampling Effects

When doing the sampling, remember that a color sensor measures either the top- or bottom-side color of the paper.

Always mark samples and take care that the mill quality laboratory also measures the same side. Most mills have some automated lab result system and there is also a possibility of getting numbers from a wrong measurement (tag) either from the wrong side or even using the wrong settings. Set-up checking must be done as a task at project/installation time, but it is a good idea for you to also check these issues later.

The best practice is to clearly mark both top and bottom-side when taking samples out of the reel and actually follow along with a few samples and observe how the sampling and color measurement is done in the quality laboratory.

You can also request the color measurement numbers (with color measurement) from a lab technician and compare these numbers to the mill system numbers.

If the coloring process is not stable, it is very difficult to measure the same process point of the sheet. This can affect the dynamic correlation between the on-line and the off-line sensors. Commonly the coloring process varies in:

- changes in filler composition, especially TiO_2 effects on FWA excitation and emission capability
- changes in the amount of fluorescence and/or dyes in broke
- changes in the amount of fluorescence and/or dyes in re-cycled furnish
- any chemical changes in the wet end affecting dyes bonding with the fibers
- problems in dyes and/or FWA dosage, in means of concentration variation or oscillating dosage

10. Preventive Maintenance

The frequency of preventive maintenance procedures may need to be adjusted depending on your operating environment.

Table 10-1 Preventive Maintenance Internal Checklist

Procedure	Daily	Weekly	Months		Years			Task Details
			1	3	1	2	5	
Color Measurement Module								
Clean Optics		X						See Subsection 11.1.1
Replace the Quartz Tungsten Halogen Lamp				X				See Subsection 11.1.2
Replace the Quartz Tungsten Halogen Lamp Socket						X		See Subsection 11.1.5
Replace the Xenon Lamp						X		See Subsection 11.1.6
Color Backing Module								
Clean Tiles		X						See Subsection 11.2.1
Replace the Color Backing Module Timing Belt and Bezel Switch						X		See Subsection 11.2.3
Inspect the Color Backing Module for Wear				4 m				See Subsection 11.2.4
Inspect Supplied Air Pressure to the Color Backing M					X			See Subsection 11.2.5
Replace the Fluor and the Backing Tile							X	See Subsection 11.2.6

Procedure	Daily	Weekly	Months		Years			Task Details
			1	3	1	2	5	
Replace the White Tile							8 y	See Subsection 11.2.7
Replace the Color Backing Module Processor								See Subsection 11.2.8
Quality Control System Server								
Inspect Standardization Report		X						See Subsection 11.3.1
Inspect Configuration Parameters					X			See Subsection 11.3.2
Inspect Spectral Measurements				X				See Subsection 11.3.5
Functionality								
Inspect Repeatability					X			See Subsection 11.4.1

11. Tasks

This chapter contains procedures for maintaining optimal color measurement performance. Tasks are organized based on mechanical and functional viewpoints.

11.1. Color Measurement Module

11.1.1. Clean Optics

Dirt and dust accumulation on the window and viewing lenses of the color measurement mode (CMM) results in loss of the signal and eventual deterioration of the sensor performance. Although small losses of optical throughput will standardize out, it is important to keep the viewing lenses clean so that their field of view remains well collimated.

Activity Number:	Q4215-60-ACT-001	**Applicable Models:**	Q4215-60
Type of procedure:	Maintain	**Expertise Level:**	Operator
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 week
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time

Required Tools:	blower with clean air from oil and other contaminants clean microfiber cloth cotton-tipped swab clean water isopropyl alcohol

To clean the window and viewing optics:

1. Power-off the scanner (see your scanner system manual).
2. Separate the heads.
3. Remove the air barrel.
4. Clean the window.
5. Use a blower to remove surface dust.
6. Use a dry, clean, microfiber cloth. If required, dampen the cloth with water, or isopropyl alcohol.
7. Use a cotton-tipped swab soaked with water, or if required, isopropyl alcohol, to clean the edges.
8. Clean the viewing lenses.
9. Use a blower to remove surface dust.
10. Use a cotton-tipped swab soaked with water, or if needed, isopropyl alcohol.
11. Insert the air barrel.
12. Close the heads.
13. Power-on the scanner.
14. Clear **Emergency Stop** error by pressing the **Local Offsheet** button on the scanner.
15. Request two standardizations and check the standardization values.

11.1.2. Replace the Quartz Tungsten Halogen Lamp

Waiting for the quartz tungsten halogen (QTH) lamp to fail results in call-ins and unscheduled color sensor downtime. A QTH lamp may exhibit poor stability and rapidly changing spectral output for some time before final failure.

Honeywell recommends changing the QTH lamp at regular intervals, preferably during scheduled maintenance periods. The recommended maintenance interval is a maximum of three months.

Activity Number:	Q4215-60-ACT-002	**Applicable Models:**	Q4215-60
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	High temperature
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	1 week
Overdue Grace Period:		**Frequency (time period):**	3 months
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:	Pre-age QTH lamp	**Post Procedures:**	Adjust QTH lamp supply voltage
	Part Number	Quantity	Lead Time
Required Parts:	p/n 39000238 QTH lamp		
	Part Number	Quantity	Lead Time
Required Tools:	Insulated gloves Canned air, Air duster PRF 4-44		

To change the QTH lamp:

1. Power-off the scanner (see your scanner system manual).
2. Remove the color measurement sensor from the scanner and place it on a clean working desk.
3. Remove the QTH lamp by sliding it upwards, and out of the lamp holder bracket.

CAUTION

The QTH lamp can be very hot.

4. Inspect the cleanliness of the gold colored dichroic color balancing filter. If dusty, blow excess dust off with clean bottled air, and if required, wipe it gently with the microfiber cleaning tissue.
5. Unplug the old lamp, and plug the new lamp into the holder bracket.
6. Slide the lamp back into the lamp holder bracket, preferably with the same alignment as the old lamp.
7. Reinsert the color measurement sensor into the scanner.
8. Power-on the scanner and the Measurement Sub System (MSS/PMP).
9. Check that the lamp is on normally.
10. Perform a reference.
11. Observe the values of the channel 1 and 2 maximum.
12. It will take at least 10 minutes for the lamp to stabilize providing stabile color reading even with a pre-aged lamp. Stabilizing time may be up to 30 minutes.
13. If the channel maximum is not within the range given in Table 3-1, adjust the lamp supply power using a resistor R3 on the lamp power supply printed circuit board (PCB). The supply voltage should be between 9.5 to 12 V DC, when measured between the contact points TP4 and TP3.
14. Perform a reference again to check the channel maximum signal level.

11.1.3. Pre-age the Quartz Tungsten Halogen Lamp

The QTH lamp will stabilize more quickly if it is pre-aged before installing it on the color sensor.

Activity Number:	Q4215-60-ACT-003	**Applicable Models:**	Q4215-60
Type of procedure:	A good practice	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	High temperature
Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	

Duration (time period):	24hours	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 39000238 QTH lamp p/n 08773400 QTH cable assembly, includes ceramic socket		
	Part Number	Quantity	Lead Time
Required Tools:	DC voltage source with output of 10-11VDC. A track to mount the QTH lamp(s).		

To pre-age the QTH lamp:

1. Install the lamp firmly on a track so that heating lamp does not cause a fire.
2. Install the cables.
3. Provide 10.5 V DC to the lamp for 24 hours continuously, or in shorter periods.
4. Turn off the voltage and store the lamp in the original box now marked *Aged*.

11.1.4. Adjust the Quartz Tungsten Halogen Lamp Supply Voltage

The QTH lamp supply voltage can be adjusted between 9.5 and 12 V DC by adjusting the resistor R3 on 05422600 PCBA, QTH lamp power supply. Adjustment is done based on the channel 1 and 2 maximum readings of the color sensor standardization report.

Activity Number:	Q4215-60-ACT-004	**Applicable Models:**	Q4215-60
Type of procedure:	A good practice	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	High temperature
Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	20 min	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	

	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	A flat head screw driver with a small tip.		

To adjust the QTH lamp supply voltage:

1. Perform a standardization.
2. Note the channel 1 and channel 2 maximum readings.
3. If the channel maximum readings is below 50 or above 85 adjust the QTH lamp supply voltage to between 50 and 85.
4. Open the measurement head.
5. Locate the color measurement module (CMM) of the color sensor, and locate the PCBA 05422500 QTH Lamp power supply.
6. Measure the voltage between test points TP3 and TP4.
7. Adjust the small screw at the end of the resistor R3 (see Figure 11-1). The desired voltage is 9.5–12 V. Higher voltage provides higher channel maximum readings.

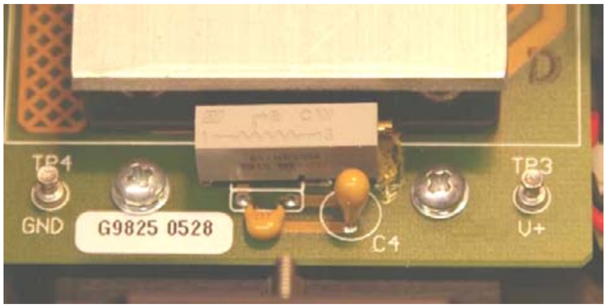


Figure 11-1 QTH Power PCB

8. Perform a standardization.
9. Note the channel 1 and channel 2 maximum readings.
10. If required, re-adjust the supply power to the QTH lamp.
11. Close the measurement head.

11.1.5. Replace the Quartz Tungsten Halogen Lamp Socket

The ceramic lamp socket for the QTH lamp should be changed every two years. While replacing the lamp socket, make an effort to make a good electrical connection.

Activity Number:	Q4215-60-ACT-005	**Applicable Models:**	Q4215-60
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	High temperature
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	1 month
Overdue Grace Period:		**Frequency (time period):**	2 years
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 08773400 QTH cable assembly including ceramic socket		
	Part Number	Quantity	Lead Time
Required Tools:	Insulating gloves A flat head screw driver with a small tip.		

To replace QTH lamp socket:

1. Power-off the scanner.

CAUTION

The QTH lamp can be very hot.

2. Let the lamp cool down.
3. Remove the lamp and the socket by sliding it upwards, and out of the lamp holder bracket.
4. Replace p/n 08773400 QTH Cable Assembly including ceramic socket. You can also change the QTH lamp.
5. Plug the QTH lamp cable into the PCBA QTH power supply.
6. Power-on the scanner.

7. Check that the QTH lamp is on properly.
8. Request STDZ and inspect standardization values.

11.1.6. Replace the Xenon Lamp

Change the xenon lamps at regular intervals, preferably during scheduled maintenance periods. Schedule the xenon lamp replacement for the same time as the QTH lamp.

Activity Number:	Q4215-60-ACT-006	**Applicable Models:**	Q4215-60
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	1 week
Overdue Grace Period:		**Frequency (time period):**	2 years
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 39000239 Xenon flash lamp		
	Part Number	Quantity	Lead Time
Required Tools:	A Philips screw driver.		

To replace the xenon lamp:

1. Power-off the scanner.
2. If there is not enough room to work with the CMM while being in the scanner, disconnect the power and the signal cables and the air hose from the CMM. Remove the CMM from the scanner head and take it to a clean workbench.
3. Loosen the four screws holding the xenon lamp trigger module in place in the CMM.
4. Carefully lift the xenon trigger module straight up–the xenon holder assembly (lens assembly for xenon) lifts with the xenon lamp.
5. Check that long nylon standoffs are still properly mounted.

6. Remove the two small screws on either side of the xenon lens holder and pull it out.

7. Remove the xenon lamp from the connector of the trigger module.

8. Without touching its window, insert the new xenon lamp into the connector of the xenon trigger module.

9. Reinstall the lamp assembly by following Steps 1–8 in reverse order.

10. Power-on the scanner.

11. Perform reference/standardization again to check the signal levels.

12. It should take about 20 minutes for the xenon to stabilize in current ambient conditions.

13. After 20 minutes, make two or three standardizations at short intervals and observer the stability.

11.1.7. Replace the Xenon Lamp Trigger and Power Supply

In a case of xenon lamp trigger or power supply failure, you need to replace both the xenon lamp trigger and power supply units together.

Activity Number:	Q4215-60-ACT-007	**Applicable Models:**	Q4215-60
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):**	At failure
Duration (time period):	3 hours	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 39000240 Xenon lamp trigger p/n 39000241 Xenon power supply		
	Part Number	Quantity	Lead Time
Required Tools:	Screwdriver set, both flat and Philips with small and medium tips. Hex wrench set (inch)		

To replace the xenon lamp trigger and power supply, refer to *Technical Bulletin 6510493016*.

11.1.8. Replace the Dark Solenoid

To be done if the dark solenoid fails.

Activity Number:	Q4215-60-ACT-008	**Applicable Models:**	Q4215-60
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):**	At failure
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 22000146 Solenoid to close light path for dark readings		
	Part Number	Quantity	Lead Time
Required Tools:	Screwdriver set, both flat and Philips with small and medium tips. Hex wrench set (inch)		

To replace the dark solenoid:

1. Power-off the scanner.
2. Open the head.
3. If there is not enough room to work with the CMM while being in the scanner, disconnect the power and the signal cables and the air hose from the CMM. Remove the CMM from the scanner head and take it to a clean workbench.
4. Unplug the cable from TB1 on the color processor board.
5. Loosen the nuts attaching the dark solenoid and the shutter.

6. Slide the dark solenoid out. If you cannot slide the solenoid out (as may be case with older 4215 color sensors), refer to *Technical Bulletin 6510493016*.

7. Install the shutter on the new dark solenoid.

8. Slide the new dark solenoid and the shutter into their places.

9. Tighten the nuts.

10. Plug the cable to TB1 on the color processor board.

11. Close the head.

12. Install into scanner and power-on.

13. Test functionality using display **Color à Color Space Window à Color Diagnostic**. Select **Request Close dark solenoid** and click **HW** request.

14. Verify that the dark solenoid closes. Do not exceed 40 seconds dark solenoid-on. For example, take a sample of the backing tile while the dark solenoid is off and on.

11.1.9. Replace the Matched Pair of Spectrometers

To be done in the instance of overheating.

Activity Number:	Q4215-60-ACT-009	**Applicable Models:**	Q4215-60
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):**	At failure
Duration (time period):	5 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	Inspect standardization report Inspect bad standardization Inspect repeatability
	Part Number	Quantity	Lead Time

Required Parts:	p/n 09887300 A matched pair of CMM spectrometers p/n 42000879 Temperature record label		
	Part Number	Quantity	Lead Time
Required Tools:	Screwdriver set, both flat and Philips with small and medium tips. Hex wrench set (inch)		

This procedure requires a good knowledge and working experience of the color sensor. If you are unsure, contact TAC.

To replace the matched pair of spectrometers:

1. Power-off the scanner.
2. Open the heads.
3. Remove the CMM of the color sensor from the scanner. Take it to a clean work bench.
4. Ensure that you keep track of all connectors coming to the processor board, spectrometers, dark flag solenoid, and xenon power supply.
5. Remove the cables.
6. Remove the color processor board.
7. Remove the PCBA bracket.
8. Note the position of the shutter in its hole and loosen the hex screw holding the shutter to the shaft of the solenoid.
9. Remove the three screws holding the power supply bracket surrounding the body of the sensor and carefully lift up the piece so that the shutter can be removed from the shaft of the solenoid.
10. Remove the screws holding the spectrometers and carefully lower the spectrometers on to the table.
11. Remove the four screws on the circular plate so that you can lift the rest of the sensor body up and can see the conical mirror and have access to the ends of the spectrometer fibers.
12. Carefully, without touching the conical mirror, unscrew the spectrometer fibers free from their mount.
13. To reinstall, follow Steps 3–12 in reverse order.

14. Close the head.
15. Request standardization and inspect results.
16. It is recommended that the difference of maximum channel readings not be larger than ten.
17. Inspect repeatability.

11.1.10. Replace Color Measurement Module Window and Lenses

To be done in the instance of excess dust accumulation inside optics.

Activity Number:	Q4215-60-ACT-010	**Applicable Models:**	Q4215-60
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	At failure
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	4 hours	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	Inspect standardization report
	Part Number	Quantity	Lead Time
Required Parts:	p/n 09881300 CMM window and lenses		
	Part Number	Quantity	Lead Time
Required Tools:	Screwdriver set, both flat and Philips with small and medium tips. Hex wrench set (inch)		

To replace the CMM window and lenses, refer to *Technical Bulletin 6510493004*.

11.1.11. Replace the Color Processor

Do be done if the color processor fails or breaks.

Activity Number:	Q4215-60-ACT-011	**Applicable Models:**	Q4215-60
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):**	At failure
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 08655014 CMM color processor		
	Part Number	Quantity	Lead Time
Required Tools:	Screwdriver set, both flat and Philips with small and medium tips. Hex wrench set (inch)		

To replace the color processor:

1. Power-off the scanner.
2. Open the head.
3. Remove the sensor from the scanner and take it to a clean work bench.
4. Unplug all the cables (ensure that you keep track of all connectors coming to the processor board).
5. Remove the four screws, and remove the color processor PCBA.
6. To reinstall, follow Steps 3–5 in reverse order.
7. Close the head.
8. Power-on the scanner.
9. Schedule a standardize operation.
10. Observe the results and verify sensor stability.

11.2. Color Backing Module

11.2.1. Clean Tiles

Although the color sensor is designed to protect the standards from contamination, they may eventually be degraded by oil in the head purge air supply or by a dusty environment. You may want to perform a before-and-after reference to determine if the cleaning had a discernible effect.

Activity Number:	Q4215-60-ACT-012	**Applicable Models:**	Q4215-60
Type of procedure:	Maintain	**Expertise Level:**	Operator
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 week
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	Clean water clean microfiber cloth		

To clean the tiles, separate the heads of the scanner.

To clean the black/white backing tile:

1. Inspect the backing tile (the tile surface must be at a lower level than the top surface of the vortex):

   The tile surface must be scratch-free and the black part of it should work like a mirror when looked at, at an angle.

   The black part must be evenly black.

   Otherwise, replace the backing tile.

2. Clean the tile:

   You may either clean it in place or momentarily remove it. To remove the tile, grasp the tile module with your fingernails and lift (for easy re-insertion ensure that you note the orientation of the key).

   Use a dry, clean microfiber cloth. If required, dampen the cloth with water, or isopropyl alcohol.

To clean the white tile:

1. Using **HW Request** from the **Color Diagnostic** display, rotate the wheel to position 2. Push the bezel down for access to the tile.
2. Inspect the white tile:

   The tile surface (glass) must be scratch-free and it should work like mirror when looked at, at an angle. The white powder below the glass window must look homogeneously the same color.
3. Clean the white tile:

   You may either clean it in place or momentarily remove it. Use a dry, clean microfiber cloth. If required, dampen the cloth with water, or isopropyl alcohol.

To clean the fluorescent tile:

1. Using **HW Request** from the **Color Diagnostic** display, rotate the wheel to position 3. Push the bezel down for access to the tile.
2. Inspect the fluorescent tile:

   The tile surface (plastic matrix) must be scratch-free.
3. Clean the fluor tile:

ATTENTION

Never use solvents, including isopropyl alcohol, to clean the fluorescent tile.

   You may either clean it in place or momentarily remove it. Use a dry, clean microfiber cloth. If required, dampen the cloth with water.

To clean the yellow-checked tiles:

1. Using **HW Request** from **Color Diagnostic** display, rotate the wheel to position 3. Push the bezel down for access to the tile.

2. Inspect the yellow-checked tile:

   The tile surface (ceramic) must be scratch-free.

3. Clean the yellow-checked tile:

   You may either clean it in place or momentarily remove it. Use a dry, clean microfiber cloth. If required, dampen the cloth with water, or isopropyl alcohol.

4. Return the tile wheel to its original position and lower the bezel by clicking the **End Diagnostic return to Normal Condition** button.

5. Close the heads.

6. Clear **Emergency Stop error** by pressing the **Local Offsheet** button on the scanner.

7. Request two standardizations and check the standardization values.

11.2.2. Scan Without the Color Backing Module

Due to required maintenance of the CBM it may be necessary to be able to scan without CBM.

Activity Number:	Q4215-60-ACT-013	**Applicable Models:**	Q4215-60
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):**	At failure
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	A small fat head screw driver.		

To scan without the CBM, see Subsection 3.2.6.

11.2.3. Replace the Color Backing Module Timing Belt and Bezel Switch

It may be more reliable to replace the CBM entirely and leave this procedure for Honeywell service engineers who do this more often.

Activity Number:	Q4215-60-ACT-014	**Applicable Models:**	Q4215-60
Type of procedure:	Replace	**Expertise Level:**	Honeywell Expert
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	1 week
Overdue Grace Period:		**Frequency (time period):**	2 years
Duration (time period):	6 hours	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	.
	Part Number	Quantity	Lead Time
Required Parts:	07689100 Wheel shaft 36000113 Timing belt 25000622 Retaining rings 2cps 51000183 Bezel switch 16000074 Nut lock adhesive 16000212 Anti-seize compound		
	Part Number	Quantity	Lead Time
Required Tools:	Screwdrivers, hex wrench (inch), needle nose pliers, soldering iron and solder, ring extractor		

To replace CBM timing belt and bezel switch, refer to *Technical Bulletin 6510493010*.

11.2.4. Inspect the Color Backing Module for Wear

Inspect and adjust the CBM tile wheel quarterly. Also, check the wear of the timing belt.

When the CBM tile wheel is properly adjusted, the tiles should be centered and horizontal in the bezel at each wheel position. The timing belt should not show signs of wear or stretch, and it should not be too tight.

Activity Number:	Q4215-60-ACT-015	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Technician

Priority Level:	Low	**Cautions:**	
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	4 months
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	A good flash lamp, a set of hex wrenches		

To inspect CBM for wear:

1. Take the scanner offsheet.
2. Open the head to access the CBM.
3. Check the tightness of the timing belt. It should flex at least 1–2 mm (0.04–0.08 in) with small side force. A too-tight timing belt causes the step motor to stay warm or hot.
4. Check the surface temperature of the step motor. It should not feel warm or burning hot for your fingers. If it is hot, reduce the tightness of the timing belt, refer to *Technical bulletin 6510493010*.
5. Inspect the condition of the timing belt. Does it looked worn? If yes, schedule a replacement.
6. Inspect the micro-switch to detect the bezel position. It should open and close properly.
7. Inspect the horizontal level of each tile at its position. Use **HW Request** from the **Color Diagnostic** display, and rotate the wheel to positions 1–4. Push the bezel down for access to the tile.
8. If the tiles are not horizontally level:
    a. Separate the scanner heads.
    b. Power-off the scanner.

c. Locate the small gray **S1** push button on the CBM processor board.

d. Power-on the scanner, and within 10 seconds press the **S1** push button. The bezel rises to the up position; the bezel is in the gap.

The CBM has now entered Diagnostic mode. To exit CBM Diagnostic mode, power-off the scanner, then:

1. Loosen the hub clamp on the motor gear.
2. Press the **S1** push button on the CBM again to have the CBM hunt for the optical encoder home position.
3. If the wheel is not in the black/white backing tile position, rotate it by hand until it is. The motor should not rotate when you do this.
4. Drop the bezel by removing the J3 Molex connector at the side of the board.
5. Check that the backing tile is centered in the bezel opening. If necessary, adjust the wheel position again.
6. Using a hex key, tighten the hub clamp.

ATTENTION

With the wheel locked in position, take care to not over-tighten the hub clamp and damage it.

7. Reconnect the bezel actuator J3 Molex connector.
8. Double-press the gray **S1** push button. The wheel should rotate through one position. Repeat until the wheel has returned to the backing tile position.
9. Press the bezel down against the wheel, and confirm that the tile is centered in the bezel aperture.
10. Rotate the wheel again, and recheck centering at least three more times.
11. Repeat 8–10, if necessary, until satisfied that the wheel is correctly phased.
12. Close heads.

ATTENTION

To eliminate the possibility of belt periodic errors, you must check the alignment for four revolutions since the wheel rotates approximately four times for one transit of the belt.

The CBM LED statuses are listed in Table 11-2.

Table 11-1 CBM Processor Board LED Indicators

LED	Description
DS1	Motor drive indicator
DS2	Motor drive indicator
DS3	Motor drive indicator
DS4	Motor drive indicator
DS5	Bezel switch indicator
DS6	Z0, home, (Optical encoder positions 396-3)
DS7	Q,(Optical encoder on/off positions 0-50/50-100/100-150)
DS8	Bezel solenoid indicator
DS9	Indexing detent solenoid indicator
DS10	Not connected
DS11	Zero, (Optical encoder position 0)
DS12	WZ, home, (Optical encoder position 399-1)

Table 11-2 CBM Processor Board LED Statuses

When/DS	1	2	3	4	5	6	7	8	9	10	11	12
After power-up	OFF	OFF	OFF	OFF	ON	ON	OFF	OFF	ON	OFF	OFF	ON
1st hit S1	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	ON	OFF	OFF	ON
2nd hit S1	ON	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF
Rotate POS 1	OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF
Rotate POS 2	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF
Rotate POS 3	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF
Rotate POS 4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF

11.2.5. Inspect Supplied Air Pressure to the Color Backing Module

If the bezel does not rise properly or there is problem with the tile wheel position status, it is good idea to check that the supplied air pressure for the CBM is greater than 45 psi.

Activity Number:	Q4215-60-ACT-016	**Applicable Models:**	Q4215-60
Type of procedure:	Inspection	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 year
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Take scanner to offsheet.
2. Have access to the CBM and the air supply of the head of the scanner.
3. If the air line into the CBM has a pressure gauge, inspect the reading. The supplied air pressure for the CBM should be greater than 45 psi. If the air line does not have the pressure gauge, schedule to add it (p/n 61000694).
4. Check that the bezel rises smoothly and does not fit hard against the CMM unit.
5. Close the heads.

11.2.6. Replace the Fluor and the Backing Tile

Replace the fluor tile every five years because the level of fluorescent activity reduces as the sample is in use and ages. This applies also the backing tile, as the black part ages under UV illumination. New fluor tiles are delivered with the value of Fluor Std: Fluor Strength (FI).

Activity Number:	Q4215-60-ACT-017	**Applicable Models:**	Q4215-60
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	1 month
Overdue Grace Period:		**Frequency (time period):**	5 years
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 08647900 Fluorescent tile p/n 08647200 White/black backing tile		
	Part Number	Quantity	Lead Time
Required Tools:			

To replace a fluorescent tile or backing tile:

1. Write down the serial number of the fluorescent tile and its certified value.
2. Enter the certified value for the new tile into the COLORP## Calibration Parameters table.
3. Take the scanner to offset.
4. Separate heads.
5. The backing tile should be visible. Use finger nails or a narrow straight head screw driver to lift the tile up from the side.
6. Using the **Color à Color space window à Color Diagnostic** display, make a **HW diagnose Request**. Rotate backing wheel to position 3 (fluor tile). Click the **HW request** button.

7. Push the raised bezel down. Use finger nails or a narrow straight head screw driver to lift the tile up from it side.

8. When inserting the new tile, observe the key on the bottom of the tile and align it properly so that the tile will properly insert.

9. Request **End Diagnostic return to Normal Conditions**. Click the **HW request** button.

10. Realign the heads after separation.

11. Made standardization and observer results.

11.2.7. Replace the White Tile

Replace the white tile every eight years due to aging while in use. The white tile is delivered with the value of Y_{STD}.

Activity Number:	Q4215-60-ACT-018	**Applicable Models:**	Q4215-60
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	1 week
Overdue Grace Period:		**Frequency (time period):**	8 years
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 08647100 white tile		
	Part Number	Quantity	Lead Time
Required Tools:			

To replace the white tile:

1. Write down the serial number of the white tile and its certified value.

2. Enter the certified value of the new tile into the COLORP## Calibration Parameters table.

3. Take the scanner to offsheet.

4. Separate heads.
5. Using the **Color à Color space window à Color Diagnostic** display, make a **HW diagnose Request**. Rotate backing wheel to position 2 (white tile). Click the **HW request** button.
6. Push the raised bezel down. Use finger nails or a narrow straight head screw driver to lift the tile up from the side.
7. When inserting the new tile, observe the key on the bottom of the tile and align it properly so that the tile is properly inserted.
8. Request **End Diagnostic return to Normal Conditions**. Click the **HW request** button.
9. Realign the heads after separation.
10. Make standardization and observe results.

11.2.8. Replace the Color Backing Module Processor

Replace the CBM processor if it fails.

Activity Number:	Q4215-60-ACT-019	**Applicable Models:**	Q4215-60
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):**	At failure
Duration (time period):	2 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	p/n 08658801 CBM processor		
	Part Number	Quantity	Lead Time
Required Tools:	Screwdriver set, both flat and Philips with small and medium tips. Hex wrench set (inch)		

To replace the CBM:

1. Power-off the scanner.

2. Remove the CBM from the scanner. Take it to a clean work bench.
3. Unplug all the cables (ensure that you keep track of all connectors coming to the CBM processor board).
4. Remove the four screws, and remove the color processor PCBA.
5. Install the new CBM by following Steps 1–4 in reverse order.
6. Schedule a standardize operation.
7. Observer the functionality of the CBM, standardization results, and stability.
8. Close heads.

11.3. Quality Control System Server

11.3.1. Inspect Standardization Report

Activity Number:	Q4215-60-ACT-020	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 week
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	11.3.3 and 11.4.2
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Using the standardization report, check that none of the color measurement standardization values are close to exceeding the given standardization limit value in Table 3-1, and that characteristics of the readings over time stay the same or at least similar.

2. Look for any bad standardization. If they exist, determine a reason based on the standardization values on the report.

3. If blue intensity (tungsten) or UV intensity (xenon) is close to the limit, schedule a lamp change and/or supply voltage check for the tungsten lamp.

4. Check also that no color sensor firmware errors exist as listed in Table 4–2 (also refer to the **Color à Color space display à Color Firmware Errors** display).

11.3.2. Inspect Configuration Parameters

Activity Number:	Q4215-60-ACT-021	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 year
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To inspect configuration parameters, such as D0’, D1’, D2’:

1. Go to the **Setup à Recipe Maintenance** display.

2. Click **Code**, and select **Color code**.

3. Click the long button with the text **color code**. A popup window opens.

4. Select COLORP** calibration table.

5. Check that values on lines 9–14, MMS channel 1 and channel 2 D0', D1', D2' match the given values for the spectrometers in use. Each spectrometer has unique calibration values and serial numbers.

6. If there is an error, update the fields and save the table.

11.3.3. Inspect Bad Standardization

Activity Number:	Q4215-60-ACT-022	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To inspect a bad standardization:

1. Go to **Scanner/Sensor à Sensor Maintenance**.

2. Select the applicable color sensor processor.

3. At the middle of the bottom of the **Sensor Maintenance** display, inspect the list of **01 BadS **** to 14 BadS:******. If the value is 1, this is a cause for the bad standardization.

11.3.4. Disable STDZ Limits

Activity Number:	Q4215-60-ACT-023	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None

Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	At failure
Duration (time period):	15 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To temporally disable STDZ limits:

1. Go to **Scanner/Sensor à Sensor Maintenance**.
2. Change from production mode to maintenance mode.
3. Select the applicable color sensor processor.
4. In the **Stdz Limits** table at the top-middle of the **Sensor Maintenance** display there is a parameter named **Limits Enable**. A value of 0 means standardization limits are not in use. A value of 1 means the standardization limits are in use. See Section 12.1.
5. Save setting.
6. Change back to production mode.

11.3.5. Inspect Spectral Measurements

Activity Number:	Q4215-60-ACT-024	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	3 months
Duration (time period):	15 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	

	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To inspect spectral measurements, especially FS:

1. Go to **Color à Color space window à Color Spectrum**.
2. Select **Measured spectrum FS** plot.
3. Determine that %R reflectance of the FS does not exceed a value of 100%.
4. If 100% is exceeded at wavelength band of 420–460 nm, see Subsection 12.1.4.

11.4. Functionality

11.4.1. Inspect Repeatability

To make a base reference and/or solve stability related problems, the medium-term repeatability of the color measurement should be done when the color sensor is installed. It takes approximately 35 minutes to perform, and describes more mechanical stability of the color sensor, especially functionality of parts taking part of the standardization routine.

Activity Number:	Q4215-60-ACT-025	**Applicable Models:**	Q4215-60
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	1 week
Overdue Grace Period:		**Frequency (time period):**	1 year
Duration (time period):	45min	**# of People Required:**	1
Prerequisite Procedures:	Clean Tiles	**Post Procedures:**	
	Part Number	Quantity	Lead Time

Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Clean tiles following the procedure in Subsection 11.2.1.
2. Using the **Sensor Maintenance** display, perform 30 References at 60 second intervals with the stable, warmed-up sensor.
3. Verify that the repeatability criteria listed in Table 11-3 are met.
4. If the sensor fails to pass any of the tests, see Chapter 12.

Table 11-3 Criteria for Medium-term Repeatability of the Standardization

Description	**Criteria**
2σ of Channel 1 and 2 maximum	≤ 0.5 or 1% of the average, whichever is greater
2σ of Channel 1 and 2 minimum	≤ 0.1
Average of Channel 1 and 2 Noise (reported as σ)	≤ 0.03
2σ of QTH lamp blue intensity	≤ 0.2
2σ of QTH lamp UV intensity	≤ 0.2
2σ of xenon lamp UV intensity	≤ 0.35
2σ of QTH lamp blue balance	≤ 0.01
2σ of xenon lamp UV balance	≤ 0.01
2σ of [yellow] check tile: L*, a*, b* or X, Y, Z	≤ 0.1
2σ of [yellow] check tile balance	≤ 0.2
Color sensor error messages	None

11.4.2. Inspect Communication

The color sensor communicates with the MSS and the CBM. In a case of link failure, identify which of the communication links has a problem.

Activity Number:	Q4215-60-ACT-026	**Applicable Models:**	Q4215-60
Type of procedure:	Maintain	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:		**Reminder Lead Time:**	

Overdue Grace Period:		**Frequency (time period):**	At failure
Duration (time period):	30min	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Open **MSS Summary** page displaying EDAQ status.
2. Ensure **Job Set is Enabled** is checked for the color sensor.
3. Open the **PHP MSS Page** web page (see Section 2.6).
4. Check MSS communication with EDAQ with the color measurement module. Look at the list of active hosts, items *094215 top*, *094215 bottom*. Check that *proc run* has **ok** status and *SSH active* has **yes** status.
5. If this procedure works properly, the issue is most likely between the CBM and the CMM; so-called CBM link failure.

11.5. Create a Code and a Color Code

This section describes the creation of two codes, each one having a color code. The name of the codes are:

- CODE_COLOR_CHECK
- CODE_COLOR_CUSTOM

Activity Number:	Q4215-60-ACT-027	**Applicable Models:**	Q4215-60
Type of procedure:	Set up	**Expertise Level:**	Engineer, Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	

Duration (time period):	2 hours	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

When creating a new code containing a new color code, first the new color code has to be created:

1. Log on to the station using the security level **Mngr**.
2. Select **P3 Navigation Bar**.
3. Select the **Setup** tab, then select the **Recipe maintenance** tab.

11.5.1. Name a New Color Code

First the new color code has to be created for the new code.

To create and naming the new color code, COLOR_CHECK:

1. Click the **CODE** button, under the **Initialize** button on the **Recipe Maintenance** display
2. Select **color code**.
3. Select **color code** under the text **Selected Recipe**, and click **Save As**.
4. A pop-up window appears with the text *Is this a new group?*.
5. Select **No**.
6. A DSR alphanumeric panel appears. Enter the new color grade name COLOR_CHECK and click **Enter**.

To create and name the new color code, COLOR_CUSTOM, repeat Steps 1–6, and for Step 6 enter the new color grade name COLOR_CUSTOM:

11.5.2. Create and Name Color Tables

Click on the long button to the left of the **Initialize** button.

This long button may now have the label **color code**, but this label varies and will be later just called the **XXXX** button.

A pop-up window appears with six color tables:

- **Color alarm limits##**
- **COLORP## Calibration** table
- **COLORP## Color Standard** table
- **COLORP## Configuration** table
- **COLORP## MSS Setup** table
- **COLORP## Standard Spectra Array**

To create and name the **Color alarm limits##** for both codes:

1. Select **Color alarm limits##** on the pop-up display. This table should now be shown under the text **Selected Recipe**, from where you need to select **Color alarm limits00**.
2. Click **Save As**, and enter the new name **AlarmLim_CHECK**.
3. Select **Color alarm limits00**.
4. Click **Save As**, and enter the new name **AlarmLim_CUSTOM**.

To create and name the **COLORP## Calibration** table for both codes:

1. Click the long button **XXXX** to the left of the **Initialize** button.
2. Select **COLORP## Calibration** table on the opened pop-up display. This table should now be shown under the text **Selected Recipe**, from where you need to select **COLORP## Calibration table00**.
3. Click **Save As**, and enter the new name **CalTab_CHECK**.
4. Select **COLORP## Calibration table00**.
5. Click **Save As**, and enter the new name **CalTab_CUSTOM**.

To create and name the **COLORP## Color Standard** table for both codes:

1. Click the long button **XXXX** to the left of the **Initialize** button.
2. Select **COLORP## Color Standard table** on the pop-up display. This table should now be shown under the text **Selected Recipe**, from where you need to select **COLORP## Color Standard table00**.
3. Click **Save As**, and enter the new name **StandardTab_CHECK**.
4. Select **COLORP## Color Standard table00**.
5. Click **Save As**, and enter the new name **StandardTab_CUSTOM**.

To create and name the **COLORP## Configuration** table for both codes:

1. Click the long button **XXXX** to the left of the **Initialize** button.
2. Select **COLORP## Configuration table** on the pop-up display. This table should now be shown under the text **Selected Recipe**, from where you need to select **COLORP## Configuration table00**.
3. Click **Save As**, and enter the new name **ConfTab_CHECK**.
4. Select **COLORP## Configuration table00**.
5. Click **Save As**, and enter the new name **ConfTab_CUSTOM**.

To create and name the **COLORP## MSS Setup** table for both codes:

1. Click the long button **XXXX** to the left of the **Initialize** button.
2. Select **COLORP## MSS Setup table** on the pop-up display. This table should now be shown under the text **Selected Recipe**, from where you need to select **COLORP## MSS Setup table00**.
3. Click **Save As**, and enter the new name **MssSet_CHECK**.
4. Select **COLORP## MSS Setup table00**.
5. Click **Save As**, and enter the new name **MssSet_CUSTOM**.

To create and name the **COLORP## Standard Spectra Array** for both codes:

1. Click on the long button **XXXX** on the left of the **Initialize** button.

2. Select **COLORP## Standard Spectra Array** on the pop-up display. This table should now be shown under the text **Selected Recipe**, from where you need to select **COLORP## Standard Spectra Array00**.
3. Click **Save As**, and enter the new name **StdSpecArray_CHECK**.
4. Select **COLORP## Standard Spectra Array00**.
5. Click **Save As**, and enter the new name **StdSpecArray_CUSTOM**.

11.5.3. Set Up Color Table Pointers

Click the long button **XXXX** on the left of the **Initialize** button. Select **color code** on the pop-up display. Under the text **Selected Recipe** there should be following color codes:

- **color code00**
- **COLOR_CHECK**
- **COLOR_CUSTOM**

Select **COLOR_CHECK** to first set up color table pointers for this color grade. To set pointer for the color alarm limits:

1. Select **COLOR_CHECK**.
2. On the line with **Description color alarm limits**, delete the current table name in green text, and press `ENTER` on the keyboard.
3. Select **AlamLim_CHECK** in the pop-up window.
4. Click **SELECT**.
5. Click **Save**.

To set pointer for the **COLORP## Calibration** table:

1. Select **COLOR_CHECK**.
2. On the line with the **Description COLORP## Calibration** table, delete the current table name in green text, and press `ENTER` on the keyboard.
3. Select **CalTab_CHECK** in the pop-up window.

4. Click **SELECT**.

5. Click **Save**.

To set pointer for the **COLORP## Color Standard** table:

1. Select **COLOR_CHECK**.

2. On the line with the **Description COLORP## Color Standard** table, delete the current table name in green text, and press `ENTER` on the keyboard.

3. Select the **StandardTab_CHECK** in the pop-up window.

4. Click **SELECT**.

5. Click **Save**.

To set pointer for the **COLORP## Configuration** table:

1. Select **COLOR_CHECK**.

2. On the line with the **Description COLORP## Configuration** table, delete the current table name in green text, and press `ENTER` on the keyboard.

3. Select **ConfTab_CHECK** in the pop-up window.

4. Click **SELECT**.

5. Click **Save**.

To set pointer for the **COLORP## MSS Setup** table:

1. Select **COLOR_CHECK**.

2. On the line with the **Description COLORP## MSS Setup** table, delete the current table name in green text, and press `ENTER` on the keyboard.

3. Select **MssSet_CHECK** in the pop-up window.

4. Click **SELECT**.

5. Click **Save**.

To set pointer for the **COLORP## Standard Spectra Array**:

1. Select **COLOR_CHECK**.
2. On the line with the **Description COLORP## Standard Spectra Array**, delete the current table name in green text, and press **ENTER** on the keyboard.
3. Select **StdSpecArray_CHECK** in the pop-up window.
4. Click **SELECT**.
5. Click **Save**.

To set pointer for the **COLOR_CUSTOM**:

1. Click the long button **XXXX** on the left of the **Initialize** button.
2. .Select **color code** in the pop-up window.
3. Under **Selected Recipe**, select **COLOR_CUSTOM**.
4. Keep **COLOR_CUSTOM** selected, and set a pointer for each color table by deleting the current table name in green text and pressing **ENTER** on the keyboard.
5. Select the appropriate color table (with *****_CUSTOM** ending).

11.5.4. Create and Name Codes

To create **CODE_COLOR_CHECK** code:

1. Click **CODE** under the **Initialize** button.
2. Select **CODE**.
3. Under the text **Selected Recipe**, select **CODE00**.
4. Enter the new code name **CODE_COLOR_CHECK** in the pop-up window.
5. Click **Enter**.

To create **CODE_COLOR_CUSTOM** code:

1. Click **CODE** under the **Initialize** button.
2. Select **CODE**.

3. Under the text **Selected Recipe**, select **CODE00**.
4. Enter the new code name **CODE_COLOR_CUSTOM** in the pop-up window.
5. Click **Enter**.

11.5.5. Set Up Color Code Pointers for a Code

1. Under the text **Selected Recipe**, select **CODE_COLOR_CHECK**.
2. On the line with **Description color code**, delete the current table name in green text, and press `ENTER` on the keyboard.
3. Select the correct color code, **COLOR_CHECK**, in the pop-up window.
4. Click **SELECT**.
5. Click **Save**.
6. Under the text **Selected Recipe**, select **CODE_COLOR_CUSTOM**.
7. On the line with **Description color code**, delete the current table name in green text, and press `ENTER` on the keyboard.
8. Select the correct color code, **COLOR_CUSTOM**, in the pop-up window.
9. Click **SELECT**.
10. Click **Save**.

11.5.6. Test the Codes

Load each created grade into the system using **Simple Recipe**, change:

- **CODE00**
- **CODE_COLOR_CHECK**
- **CODE_COLOR_CUSTOM**

Check that there are no error messages.

Make a backup of new successfully created recipes.

11.6. Change Values in Color Tables

Activity Number:	Q4215-60-ACT-028	**Applicable Models:**	Q4215-60
Type of procedure:	Set up	**Expertise Level:**	Engineer, Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:		**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	1 hours	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To change values in color tables:

1. Click **CODE**, under the **Initialize** button.
2. Select the desired code, which uses the color code to be changed, under the text **Selected Recipes**.
3. Under the text **Description**, select the code's color code, for example, **COLOR_CUSTOM**.
4. Click **CODE**, under the **Initialize** button, and select **color code**.
5. Under the text **Selected Recipes**, select the correct color code, for example, **COLOR_CUSTOM**.
6. Study the names of the tables showing the parameters or nominal color values that need to be changed.
7. Click the long button **XXXX** to the left of the **Initialize** button.

8. Select the table, for example, **COLORP## calibration table**, on the pop-up display. All calibration tables will be shown under the text **Selected Recipe**, from where you need to select, for example, **CalTab_CUST**.

9. Replace the current value by entering the new parameter value.

10. Click **Save**.

Load the changed code, for example, **CODE_COLOR_CUSTOM**, using **Simple Recipe change**. Using the **Color Config/Calib Download** display, check that the desired change has been successfully loaded into the Experion MX system. Standardization is needed to determine updated parameters in use in the color measurement.

11.7. Perform Manual Standardization

Activity Number:	Q4215-60-ACT-029	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Operator
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	30 min	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

Load the code/grade into the system using **Simple Recipe change**. Take the scanner to off-sheet position. Using the **Scanner control** display, click the **Manual Stdz** button.

If there are standardization errors, resolve them using the *Table 3-2 Standardization check limit values* PDF.

Store the achieved values of reference for later usage, especially if this is the initial installation of the color sensor. This can be understood as time-zero reference point.

11.8. Select Maintenance or Production Mode

The Experion MX system has two modes: *production* and *maintenance*. Maintenance mode is used during sampling, reference, and stability analysis.

Activity Number:	Q4215-60-ACT-030	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Operator
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:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Click the **Modes & Recipes** button on the upper right of the **Sensor Maintenance** display.
2. The **Scanner modes & Maintenance recipes** pop-up display will appear.
3. Select the scanner where the color sensor exists.

To enter maintenance mode, both the code and color code need to be loaded.

1. Select **Color code** under the text **Top Recipe Group**.
2. Select the recipe from the **Recipe ID** drop-down menu, then click **Retrieve**. If a different recipe than the one selected is needed, under **Recipe ID**, select the required recipe. Click **Retrieve** to load the recipe.

3. Click **Enter Maint.** to enter maintenance mode, then click the special close **X** button on the upper left to close the pop-up display. The **Sensor Maintenance** display will indicate that the sensor is in maintenance mode.

4. To return to production mode, activate the pop-up **Scanner modes & Maintenance recipes** display, click on **Exit Maint.**, and then click on the special close **X** button. The **Sensor Maintenance** display will indicate that it is in production mode.

11.9. Perform a Reference in Maintenance Mode

A reference can be performed to compare the current sensor performance to its performance at initial installation.

Activity Number:	Q4215-60-ACT-031	**Applicable Models:**	Q4215-60
Type of procedure:	Inspect	**Expertise Level:**	Operator
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:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To perform a reference:

1. Under the **Scanner/Sensor** tab, open the **Sensor Maintenance** display and select the desired color sensor.

2. Enter the maintenance mode of the display following the procedure described in Section 11.8.

3. If necessary, select the number of operations, the number of sets, and the intervals of the operations and sets to be performed.

4. Click on the **Reference** button in the **Sensor Maintenance** display.

The scanner takes approximately 35 seconds to complete a reference. After the reference is completed, the results are stored in the sensor report database. The reference report can be found on the **Sensor Reporting** display. If the reference did not complete, refer to the *Table 3-2 Standardization check limit values* PDF, and see Section 12.

11.10. Change the Sensor Configuration

To temporarily test new calibration and configuration parameters for the color sensor, use the **Color Config/Calib Download** display in production mode. After testing, remember to save the new tested parameters into the appropriate color tables.

Activity Number:	Q4215-60-ACT-032	**Applicable Models:**	Q4215-60
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):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Select the **Color** tab, **Color Space Window**, and **Color Config/Calib Download**.

2. To take a new color calibration or color configuration parameter in use, perform a manual standardization (the change in dynamic offset will be taken in use immediately, without needing a standardization).

3. When a new configuration or calibration parameter value is entered on top of the current value as green text, the **Download Configuration** button starts to flash. To download the new parameter into the color

sensor, click **Download Configuration**. To take the new parameter in use, perform standardization using the **Scanner control** display.

ATTENTION

Loading code or color code will always overwrite existing code on the **Color Config/Calib Download** display. Loading code would also download the parameters into the color sensor, but a standardization/reference is required for them to take in use.

11.11. Shoot Paper Samples

Two procedures exist to shoot paper samples:

- Use the **Sensor Maintenance** display to perform a sample when the reflectance values of the spectra do not need to be obtained.
- Use the **Color Spectrum** display to perform a sample when the reflectance values of the spectra do need to be obtained.

You do not need to perform a reference before taking a sample, but a reference should be done at least once before taking a collection of samples.

Activity Number:	Q4215-60-ACT-033	**Applicable Models:**	Q4215-60
Type of procedure:	Set up	**Expertise Level:**	Technician
Priority Level:	Low	**Cautions:**	None
Availability Required:	Scanner Offsheet,	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	2 hours	**# of People Required:**	1
Prerequisite Procedures:	Select Maintenance or Production Mode Perform a Reference in Maintenance Mode	**Post Procedures:**	Select Maintenance or Production Mode
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

11.11.1. Shoot Samples Using the Color Spectrum Display

Place the system in maintenance mode to shoot samples.

Check that the CBM vortex blows air to pull the sheet toward the backing module and to keep it flat during sampling.

If more than one sheet is needed for sample measurement, a ring may be needed to hold the samples together.

1. Under the **Scanner/Sensor** tab, open the **Sensor Maintenance** display, and select the desired color sensor.
2. Load the wanted code and color code, and enter maintenance mode.
3. Perform a reference.
4. Select the **Color** tab, open the **Color Spectrum** display through the **Color Space** window and select **Sampling Enable**. The **Take Sample** button on the display will become available. The **Color Spectrum** display defaults to **Sampling Disable** whenever you navigate to a different display.
5. To have the new data appear as the only entries in the table (if this is desired), click **Empty Data Table** to delete old measurements from the data table.
6. Before taking a new sample, it is recommended that you choose a name for it. Click **Sample Name** (in green) on the display to call up a pop-up alphanumeric keypad. Enter a name for a new sample and press [**ENTER**].
7. The index shown above the **Sample Name** box will increment with every sample regardless of the sample name, so the same name can be chosen for each sample.
8. To cancel a sampling operation in progress, click the **Cancel** button.
9. Hold the paper sample in the gap. If possible, position the sample sheet so, that is has the same orientation as it would have during on-line measurement.

10. Click the **Take Sample** button in the **Color Spectrum** display, or use the **Sample** switch on the scanner to initiate sampling.

11. Move the sheet slightly in a circular motion over the CBM while sampling to average out paper non-uniformity.

Each time a sample is acquired using the **Color Spectrum** display, color values and four different spectra are retrieved by the sensor. The first three of these spectra are fluorescence-corrected R'(λ|S), and the last is fluorescence-suppressed data R(λ). These data sets are placed into the sample acquisition buffer. The first sample data entered is overwritten after 20 samples (80 spectra) have been collected. This maximum number of samples can be changed.

Clicking the button **Write sample data to file** stores the measured data into the directory and file name shown under the text **Sample File Name**.

11.12. Sample a Tile

Activity Number:	Q4215-60-ACT-034	**Applicable Models:**	Q4215-60
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):	1 hour	**# of People Required:**	1
Prerequisite Procedures:	Select Maintenance or Production Mode Perform a Reference in Maintenance Mode	**Post Procedures:**	Select Maintenance or Production Mode
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To sample a tile located on the CBM tile wheel, perform the following:

1. Set KM: Enable = 0.

2. Perform a reference.

3. From the **Color Diagnostic** display, activate the drop-down **Hardware Request** menu. The selections include four choices for backing wheel position:

   Position 1: black/white backing tile.

   Position 2: white standard tile.

   Position 3: fluorescent tile.

   Position 4: yellow-checked tile.

4. Select the desired tile position and click on **HW Request** on the **Color Spectrum** display.
5. Return to the **Sensor Maintenance** display.
6. The system should still be in maintenance mode from the reference operation in Step 2. If not, enter maintenance mode.
7. Click on **Sample** to obtain a measurement. You can also use the **Sample** switch on the scanner, but the color sensor must already be selected from the **Sensor Maintenance** display.
8. Go to Step 3 if another tile needs to be sampled.
9. When finished, select **End Diagnostic return to Normal Condition**.

You can see the results from either the **Sensor Maintenance** display or the **Color Spectrum** display.

CAUTION

Keep the exposure of the fluorescent tile (wheel position 3) to the color sensor light source to a minimum to avoid degrading the tile's fluorescence.

11.13. Sample a Verification Tile

Activity Number:	Q4215-60-ACT-035	**Applicable Models:**	Q4215-60
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):	1 hour	**# of People Required:**	1
Prerequisite Procedures:	Select Maintenance or Production Mode Perform a Reference in Maintenance Mode	**Post Procedures:**	Select Maintenance or Production Mode
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To shoot an external tile, perform the following:

1. Place the system in maintenance mode using the **Sensor Maintenance** display.
2. Reference the color sensor.
3. Separate the heads using the declutching mechanism in the endbell, and push the heads apart.
4. Remove the black/white backing tile from the backing module. No tools are necessary because it is held in place by a magnet.
5. Insert the selected external standard in place of the black/white backing tile.
6. Line up the notch on the tile and the pin in the backing module for the tile to drop into place.
7. Push the heads back together and re-engage (lock) the clutching mechanism.
8. Clear **Emergency Stop error** by pressing the **Local Offsheet** button on the scanner.
9. Select the **Sensor Maintenance** display or the **Color Spectrum** display.
10. To obtain a measurement of the external standard, click on **Take Sample**, or use the **Sample** switch on the scanner.
11. Separate the heads again, and replace the external standard with the black/white backing tile.

12. View the results on the **Sensor Maintenance** display or the **Color Spectrum** display.

CAUTION

Keep the exposure of the fluorescent tile (wheel position 3) to the color sensor light source to a minimum to avoid degrading the tile's fluorescence.

11.14. Retrieve Diagnostic Spectra

Activity Number:	Q4215-60-ACT-036	**Applicable Models:**	Q4215-60
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):	1 hour	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To retrieve diagnostic spectra, perform the following steps (the sensor will send these only while in IDLE mode):

1. On the **Color Diagnostic** display, activate the long button under the text **Spectra Diagnose Request**. Select the type of spectrum you want to see.

2. Click on **Spec Request**. For a description of each type of spectrum listed in this display, refer to the **Color Diagnostic** display.

3. **Store Spectra** saves the diagnostic spectra to a text file for later review.

12. Troubleshooting

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

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

12.1. Alarm-based Troubleshooting

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

12.1.1. Stdz Check Limit: Channel Maximum

Symptom	Possible Cause(s)	Solutions (Tasks)
Channel maximum is too low: Nominal 50–85	Failure of the QTH lamp	Adjust the Quartz Tungsten Halogen Lamp Supply Voltage
		Replace the Quartz Tungsten Halogen Lamp
	Dirt on the optical path	Clean Optics
		Clean Tiles

12.1.2. Stdz Check Limit: Channel Minimum

Symptom	Possible Cause(s)	Solutions (Tasks)
Channel minimum is too low: Nominal is 0.25–10	Problem with A/D conversion level with spectrometers	Replace the Matched Pair of Spectrometers (primary)
		Replace the Color Processor (may help)

12.1.3. Stdz Check Limit: Channel Noise

Symptom	Possible Cause(s)	Solutions (Tasks)
Channel noise is too high: Nominal ≤ 0.2	A loose electrical connection	Inspect cables and connectors of spectrometers
	Failure of the spectrometer units	Replace the Matched Pair of Spectrometers

12.1.4. Stdz Check Limit: Blue Intensity (Tungsten)

Symptom	Possible Cause(s)	Solutions (Tasks)
The intensity of tungsten lamp at blue end of the spectrum is too low: Nominal > 35	Too low supply voltage for QTH	Adjust the Quartz Tungsten Halogen Lamp Supply Voltage
	Failure of tungsten lamp	Replace the Quartz Tungsten Halogen Lamp
	Dirt on the light path	Clean Optics

12.1.5. Stdz Check Limit: UV Intensity (Xenon)

Symptom	Possible Cause(s)	Solutions (Tasks)
UV intensity (xenon) is too low: Nominal > 7	Failure of the Xenon lamp	Replace the Xenon Lamp
	Dirt on optics	Clean Optics
		Replace Color Measurement Module Window and Lenses
	Xenon power and trigger	Replace the Xenon Lamp Trigger and Power Supply

12.1.6. Stdz Check Limit: Stability (Tungsten)

Symptom	Possible Cause(s)	Solutions (Tasks)
Tungsten lamp is unstable: Nominal < 0.25	Failure of the QTH lamp	Replace the Quartz Tungsten Halogen Lamp
		Replace the Quartz Tungsten Halogen Lamp Socket

12.1.7. Stdz Check Limit: Stability (Xenon)

Symptom	Possible Cause(s)	Solutions (Tasks)
Xenon lamp is unstable: Nominal < 0.4	Failure of the Xenon lamp	Replace the Xenon Lamp
	Failure of Xenon trigger and power module	Replace the Xenon Lamp Trigger and Power Supply

12.1.8. Stdz Check Limit: Blue Channel Balance (Tungsten)

Symptom	Possible Cause(s)	Solutions (Tasks)
Color measurement stack estimate may be unstable: Nominal 0.85–1.15	Dirt on the optics	Clean Optics
		Pre-age the Quartz Tungsten Halogen Lamp
		Replace the Quartz Tungsten Halogen Lamp
		Replace Color Measurement Module Window and Lenses
		Replace the Matched Pair of Spectrometers

12.1.9. Stdz Check Limit: Xenon Lamp UV Balance

Symptom	Possible Cause(s)	Solutions (Tasks)
Fluorescence index measurement unstable: Nominal 0.85–1.15	Dirt on the optics	Clean Optics
		Replace Color Measurement Module Window and Lenses

12.1.10. Stdz Check Limit: Check Tile Channel Balance

Symptom	Possible Cause(s)	Solutions (Tasks)
Check tile channel balance: Nominal < 0.39	Spectrometer wavelength calibration parameters D0’, D1’, D2’ not correct	Inspect Configuration Parameters (D0’, D1’, D2’)
	Tile wheel alignment off. Tiles are not horizontal	Inspect the Color Backing Module for Wear

12.1.11. Stdz Check Limit: Backing Tile Y (white)

Symptom	Possible Cause(s)	Solutions (Tasks)
Measured Y of the white part of the packing tile is too low: Nominal > 75	Dirty packing tile, dirty white tile	Clean Tiles
	Aged backing tile	Replace the White Tile
	Aged white tile	Replace the White Tile

12.1.12. Stdz Check Limit: Backing Tile Y (black)

Symptom	Possible Cause(s)	Solutions (Tasks)
Measured Y of the black part of the packing tile is too high: Nominal < 5	Dirty packing tile, dirty white tile	Clean Tiles
	Aged backing tile	Replace the Fluor and the Backing Tile

12.1.13. Stdz Check Limit: To Be Temporally Disabled

Symptom	Possible Cause(s)	Solutions (Tasks)
Color sensor does not pass the standardization due to stdz check limit	A part failure. Order replacement parts based on Bad STDZ status	Inspect Bad Standardization
		Disable STDZ Limits

12.1.14. CBM Wheel Position Error

Symptom	Possible Cause(s)	Solutions (Tasks)
Repeated CBM position does not agree with requested position	Failure in CBM module	Inspect Supplied Air Pressure to the Color Backing M
	Too loose or tight timing belt, optical encoder has loosed its home position or is broken	Replace the Color Backing Module Timing Belt and Bezel Switch
		Replace the Color Backing Module Processor

12.1.15. CMM Link Down

Symptom	Possible Cause(s)	Solutions (Tasks)
QCS server cannot communicate with the color sensor	The color sensor is not powered on, loose cable, power track problem, CMM/CBM processor has broken	Inspect Communication

12.1.16. Ready To STDZ

Symptom	Possible Cause(s)	Solutions (Tasks)
After power up of the color sensor it requires standardization before able to measure	Standardization value(s) has not passed the STDZ check limit	Request Standardization

After downloading code/color code standardization is required to take downloaded parameters in use		Inspect Bad Standardization
Performed standardization contains one or more bad standardization vales		Disable STDZ Limits

12.2. Non-alarm Based Troubleshooting

12.2.1. Unstable Color Measurement

Symptom	Possible Cause(s)	Solutions (Tasks)
Unstable color measurement	QTH lamp unstable	Replace the Quartz Tungsten Halogen Lamp
	Over heat: max 50 °C (122 °F) for color	Inspect Repeatability
		Inspect Spectral Measurements
		Check that head temperature stays below 42 °C (107.6 °F) ± 1°
	Web flattering, process variations (FWAs, fillers)	Check sheet guides, and usage of broke/recycle

12.2.2. CMM Processor Does Not Start Up

Symptom	Possible Cause(s)	Solutions (Tasks)
CMM processor does no power up, LED does not link green and red	A spike of static electricity from the web	Check connectors and cables
		Re-start CMM processor pushing the gray button on the color processor board
		Replace CMM processor board
		Install or inspect static charge device

12.2.3. Temporarily Freezing Color Value

Symptom	Possible Cause(s)	Solutions (Tasks)
Temporarily freezing color value	Too high R($^{\lambda}$), FS spectrum value being 100%R causing problems Kubelka-Munk calculations	Inspect Spectral Measurements
		Inspect Configuration Parameters
	A measurement limit value too tight	Inspect validity check limit values for measurements

12.2.4. Poor Online Versus Offline Correlation

Symptom	Possible Cause(s)	Solutions (Tasks)
Some color or brightness measurements correlate poorly with the laboratory measurements	Non-matching setup of configuration parameters for color and/or brightness measurement setup	Fill the form Coloring Process Study in Appendix B, and contact TAC for guidance

13. Storage, Transportation, End of Life

13.1. Storage and Transportation Environment

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

Duration of Storage	Acceptable Temperature Range	Acceptable Humidity Range
Short Term: less than one week	-20 to 55 °C (-4 to 131 °F)	20–90% non-condensing
Long Term	-10 to 45 °C (14 to 113 °F)	20–90% non-condensing

13.2. 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.

Guidelines for disposal of equipment by Honeywell or the customer for sensor-specific materials are as follows.

13.2.1. Solid Materials

- metals should be recycled, and in many cases have value as scrap
- remove all non-metallic parts (except plastic) from the sensor and dispose through the local refuse system

- recycle plastic parts if possible
- wire and cabling should be removed and recycled; the copper may have value as scrap

Electrical and electronic components (for example, solder, circuit boards, batteries, and oil-filled capacitors) should be recycled or handled as special waste to prevent them from being put in a landfill, as there is potential for lead and other metals leaching into the ground and water.

14. Glossary

Accuracy	Accuracy of measurement is the closeness of agreement between a test result (measurement) and an accepted reference value. Commonly the reported accuracy must be interpreted as a combination of bias and precision.
Banana Roll	A specific roll used to remove wrinkles and slack edges. They are also called bowed rolls, spreader rolls, or curve rubber expanders.
Bias	A systematic difference between the sample mean of the measurements or test results, and an accepted reference value. Bias is the systematic component of accuracy.
CD	Cross machine direction
CIE	La Commission Internationale de l'Éclairage
CBM	Color backing module of the Q4215-60 color sensor
CMM	Color measurement module of the Q4215-60 color sensor
COM	Communication port
DWL	Dominant wavelength length
EOS	End of scan
FBA	Fluorescent brightening agent
FC	Fluorescence corrected color measurement: estimates color with the effect of fluorescence under specified CIE illuminant
Fluorescence	A process by which electromagnetic radiation in one spectral region is absorbed and re-emitted at other wavelengths, usually longer.
FS	Fluorescence suppressed color measurement: estimates color without effect of fluorescence.
FWA	Fluorescent whitening agent. Synonym for FBA.
GCC	Ground calcium carbonate

Infinite thickness	A stack of sheets so thick that doubling the thickness does not change its reflectance.
Inter-instrument Reproducibility	This is a special case of repeatability where instruments of identical design (inter-instrument) are compared. The closeness of agreement between test results (measurement) obtained under described conditions. A measure of is the standard deviation. is the random component of accuracy. Also see Reproducibility
ISO	Internal Organization for Standardization
MD	Machine direction
MI	Metamerism index
MSS	Measurement Sub System
OBA	Optical brightening agent. Synonym for FBA.
PCC	Precipitated calcium carbonate
PRD	Perfect reflecting diffuser
QCS	Quality control system
QTH	Quartz tungsten halogen
Repeatability	The closeness of agreement between the results of successive measurements of the same test specimen carried out on a single laboratory (a single scanner), by the same method of measurement, operator, and measuring instrument with repetion over a specified period of time. Repeatability is precision under repeatability conditions.
Reproducibility	The closeness of agreement between the results of successive measurements of the same test specimen carried out under changed conditions of measurement. The changed conditions may include: measuring instrument, laboratory (scanner), operator, time. The set of specified condition is termed reproducibility conditions. Reproducibility is precision under reproducibility conditions.
SCE	Specular component excluded in sphere measurement
SCI	Specular component included in sphere measurement
SPD	Spectral power distribution of an illuminator
Stability	The ability of a measuring instrument (sensor) to maintain constant its metrological characteristics with time.
TAPPI	Technical Association of the Pulp and Paper Industry
Traceability	A measured result can be related to stated references, usually national or international standards, through an unbroken chain of comparisons, all having stated uncertainties.
UV	Ultraviolet light

A. Part Numbers

Table A-1 Part Number List for Color Measurement Module

Part Name	Part Number	Description
Color Measurement Module, Da Vinci	08646810	Color measurement module (CMM) for Experion MX and Da Vinci
PCBA W/FW 3.20 DAVINCI COLOR SENSOR PROCESSOR	08655014	CMM processor for Experion MX and Da Vinci with firmware version 3.10
FW UPGRADE KIT	09886800	F/W 3.10 upgrade kit only for 08655013 and older CMM processors
VERIFICATION,PREC PLUS COLOR SNSR ACCY KIT	09834700	Includes white, black, blue, and fluorescent tiles
Color Sensor Window Assembly (Includes Lenses)	09881300	Spare part kit. Includes CMM window, conical mirro,r and lenses
Spare part kit, CMM SPECTROMETERS	09887300	Spare part kit. Includes CMM spectrometers (a matched pair)
SOLENOID,ROTARY, 44VDC NOM,45 DEG CCW ROTATION	22000146	Dark solenoid to close light path for dark readings
XENON LAMP HOLDER ASSY	08704600	Xenon lamp holder assembly with lens
LAMP,FLASH,20W,XENON SHORT ARC,225-100NM	39000239	Xenon flash lamp
MODULE,LAMP TRIGGER, 20 WATT	39000240	Xenon trigger module
POWER SUPPLY,FLASH LAMP,11-28VDC IN,10W	39000241	Xenon power module
LAMP, PROJECTOR 12V 20W 2 PIN BASE W/REFLECTOR	39000238	QTH lamp
PRECISION PLUS COLOR SENSOR QTH CABLE ASSY	08773400	QTH cable assembly includes ceramic socket
BRACKET,LAMP HOLDER 35/36MM QUARTZ HALOGEN BULB	39000243	Metal bracket holding the QTH lamp in place
FILTER,BACKING,UV	00471600	A glass filter with 420 nm UV cut-off coating
PCBA,LAMP POWER SUPL	05422600	QTH lamp power supply PCBA

Part Name	Part Number	Description
FUSE, 2.5 AMP EURO SB 250V UL,VDE	51000349	Fuse used on the QTH lamp power supply
LABEL (10-PK), TEMP RECORDER 8-DOT 105-160F/40.6-71C	42000879	Temperature record label to be taped on the body of the color sensor
BARREL, AIR, PRECISION PLUS COLOR SENSOR, IMPROVED	07690701	Air barrel, CMM noise
Cable Assembly, Color, CMM, Q4000	6580801649	Cable assembly for the CMM for the Q4000 scanner
Sensor Module, EDAQ BRKT ASSY	6580801513	EDAQ sensor assy
Sensor Base, 4 in Hole Assembly, Q4000	6580801424	A Sensor base plate where a color sensor module is mounted

Table A-2 Part Number List For Color Backing Module

Part Name	Part Number	Description
COLOR BACKING MODULE ASSY	08646700	Color backing module (CBM)
PCBA W/F/W 15, COLOR BACKING CONTROLLER	08658801	CBM processor
F/W 15 Upgrade kit for CBM processor	09886900	A firmware upgrade for CBM processor, contains only the chip with flashed code
Holder, Std White, Prec Plus Color Sensor	08647100	White tile, supplied with certified value
Holder, White/Black Assy, Prec Plus Color Sensor	08647200	White and black backing tile
Holder, Std Fluorescent, Prec Plus Color Sensor	08647900	White fluorescent tile, supplied with certified value
Ceramic Holder, Yellow, Prec Plus Color Sensor	08648000	Yellow tile, supplied with certified value
Holder, Ceramic Blue - Precision Plus Color Sensor	08660800	Blue tile, supplied with certified value
HOLDER,BLACK BACKING ASSY	08661500	Black tile
Motor Assy, Precision Plus Color Sensor	08651600	Motor assembly includes step motor and encoder
Wheel Detent Actuator Assembly	08664300	The tile wheel locking actuator assembly
VALVE,SOLENOID,4-WAY 24 VDC,10-32 PORTS,LEAD WIRES	22000143	A four-way valve to control air flow to raise bezel and vortex
GASKET,STD WHEEL, PRECPLUS COLOR SENSOR	00465900	A gasket to seal CBM around the backing tile
SHAFT,STD WHEEL, PRECPLUS COLOR SENSOR	07689100	A shaft for the tile wheel
RING,RET,.125EXT SS	25000622	Locking ring for the tile wheel shaft
BELT,TIMING,ENDLESS 3/32 DIA.,32 PITCH,112 PINS	35000113	Timing belt

Part Name	Part Number	Description
Switch, SPDT, 5 Amp, 28V	51000183	Bezel position micro-switch
GASKET, .125IN ID 19/ 64IN OD	25000324	Gasket small, 3.18 mm (0.125 in)
CABLE ASSY, COLOUR, CBM, Q4000	6580801650	Cable assembly for the CBM for the Q4000 scanner
SENSOR MODULE, EDAQ BRKT ASSY	6580801513	EDAQ sensor assy
SENSOR BASE, 4" HOLE ASSY, Q4000	6580801424	A sensor baseplate where a color sensor module is mounted

B. Coloring Process Study

Table B-1 Color Process Study

- [ ] A1 Location
- [ ] A2 Location
- [ ] A3 Country
- [ ] A4 Machine Number
- [ ] A5 Customer Contact:
- [ ] A6 Honeywell Contact:

Online Color Measurement

- [ ] B1 Width of the paper machine?
- [ ] B2 Paper machine speed?
- [ ] B3 Location of the online color measurement(s)?
- [ ] B4 One or two sided color measurement?
- [ ] B5 Scanner type to mount Q4215-60 color sensor?
- [ ] B6 Sheet temperature at the color measurement location?
- [ ] B7 Minimum and maximum moisture level of web at online location?
- [ ] B8 How large is the moisture difference between the middle and edges of the web?

- [ ] B9 Is there a curved spreading roll (banana roll) just before or after on-line color measurement?
- [ ] B10 Is the web tension kept constant?
- [ ] B11 How stable is the web at color measurement location z-direction?

Color Measurement

- [ ] C1 Used color space: CIE L*,a*, b*; LAB, Hunter Lab, and so on?
- [ ] C2 Used CIE illuminant: A, C, D65, D50, and so on?
- [ ] C3 Used CIE observer: 1931 being 2° or 1964 being 10°?
- [ ] C4 Is fluorescence included for the color measurement?
- [ ] C4 (cont.) Or is fluorescence excluded with a 420 nm UV cut-off filter or some other UV cut-off filter?
- [ ] C5 Is the same color measurement setup used for all grades?

Appearance Measurements

- [ ] D1 Other appearance measurements: CIE whiteness, yellowness, and so on?
- [ ] D2 What are the used CIE illuminant and observer for these?
- [ ] D3 Is fluorescence included for the color measurement?
- [ ] D3 (cont.) Or is fluorescence excluded with a 420 nm UV cut-off filter or some other UV cut-off filter?
- [ ] D4 Is the same setup used for all grades?

Brightness Measurement

- [ ] E1 Is the brightness measured using the same color instrument?
- [ ] E2 Is fluorescence index based on brightness difference?
- [ ] E3 Utilized brightness: ISO, TAPPI, D65?

Offline Color Instrument

- [ ] F1 Is a color measurement done by an automated paper quality measurement system, such as L & W Autoline, Metso’s PaperLab, Technodyne’s PROFILE/Plus?
- [ ] F2 If automated system is used, specify is a single sheet measured and what kind backing is used (black and white, stack of papers)?
- [ ] F3 Manufacturer of the laboratory color instrument.

- [ ] F4 Model of the laboratory color instrument.
- [ ] F5 Is a 420 nm UV cut-off filter utilized to produce the fluorescent excluded measurements?
F5 (cont.) If not, explain used method.
- [ ] F6 Is the color measurement traceable?
- [ ] F6 (cont.) Are STFI/VTT/Technodyne's paper standards used to calibrate the laboratory sensor?

Sample Reparation and Measurement

- [ ] G1 Is a sample taken from every reel?
- [ ] G2 How is a sample taken from the reel? A cross direction strip?
- [ ] G3 Is color measured always from a specific cross direction location?
- [ ] G4 How is the precondition of the sample made?
- [ ] G4 (cont.) Just left on the table in the quality control laboratory for time x?
- [ ] G5 Is the top side of paper measured?
- [ ] G6 A stack of samples: How many sheets of paper is in the pile?
- [ ] G6 (cont.) Is the pile made from cut sheets always a same side on the top or just folded?
- [ ] G7 How many sheet's measurements is averaged to form a measurement?
- [ ] G8 How many measurement positions are averaged in automated measurement system for color?

Paper Product

- [ ] H1 Type of produced products? Fine, news, calendared, multi-ply, board, and so on.
- [ ] H2 Surface treatment for the products? Sized, coated, machine finished, calendared, and so on.
- [ ] H3 Is recycled paper used? It origin/quality, includes FWAs?
- [ ] H4 Basis weight range of products?
- [ ] H5 Ash range of products?
- [ ] H6 Used filler/ash types? CaCO2, PCC, or TiO2?
- [ ] H7 Color range of products? High whites, whites, pastels, bright fluorescent colors, deep shades.
- [ ] H8 Is FBAs/OBAs/FWAs dosed both at wet-end and size press?

- [ ] H9 Is any day-light fluors or pigments used?
- [ ] H10 Do some grades have water markings?
- [ ] H11 Do some grades have specific surface structure? Very high or low gloss?

Coloring Process Information

- [ ] I1 Is lining containing fibers used in stock?
- [ ] I2 Type of the dyes used? Anionic/cationic direct dyes, basic dyes, pigments, and so on.
- [ ] I3 Colorant supplier(s) for the dyes?
- [ ] I4 Total number of dyes used in the mill?
- [ ] I5 Maximum number of dyes used at the time?
- [ ] I6 Where the dyes are dosed at the wed-end?
- [ ] I7 Are all dyes added continuously or as batch process?
- [ ] I8 Are all dyes dosed into stock using a single pipe with carrying water?
- [ ] I9 Are the dyes diluted before dosage?
- [ ] I10 Dosage range of dyes as kg/ton?
- [ ] I11 Type of the used FWAs/OBAs wet-end?
- [ ] I12 Colorant supplier(s) for the wet-end FWA and product name?
- [ ] I13 Where the FWA is dosed at the wed-end?
- [ ] I14 Is wed-end FWA added continuously or as batch process?
- [ ] I15 Dosage range of FWA as kg/ton at the wed-end?
- [ ] I16 Colorant supplier(s) for the size-press FWA and product name?
- [ ] I17 Dosage range of FWA as kg/ton at the size-press?
- [ ] I18 Are any filler dosed with the FWA at the size-press?

☐ I19 Issues with two-sided of the color?

Specialty and Security Papers

☐ J1 Are separately colored fibers used, which show up under visible light?

☐ J2 Are colored pigments used, which show up as spot under visible light?

☐ J3 Are specially colored fluorescent fibers used, which show up under UV light?

☐ J4 Are special security fluorescent pigments used, which show up under UV light?

☐ J5 Do security band(s) exist in measured product?

Color Control

☐ K1 Is Fluorescence Suppressed L*, a*, b* values controlled using dyes?

☐ K2 Is fluorescence index FI controlled using a FWA?

☐ K3 Max and min number of dyes?

☐ K4 Max and min number of FWAs?

☐ K5 Max and min number of pigments?