Honeywell

GelView Sensor

Overview

6510020176

GelView Sensor Overview

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Contents

List of Figures

Introduction

This manual describes the theory of operation, installation and maintenance of Honeywell GelView Sensor. This manual covers GelView Sensor System Model 4214.

This manual relies heavily on the other documentation listed in the Related Readings, and the philosophy maintained is that information that exists in another document should not be repeated here, but will be referenced. Refer to the latest drawings or schematics for proper documentation.

Audience

This manual is intended for use by Honeywell field and factory personnel and assumes that the reader has some knowledge of the operator of a paper machine and a basic understanding of mechanical, electrical and computer software concepts.

About This Manual

This manual contains 2 chapters.

Chapter 1, **System Information**, provides a high level description of the GelView system, its design and its configuration.

Chapter 2, **Sensor Description,** provides a general description of GelView sensors, including their operation, characteristics, and associated hardware.

Related Reading

The following documents contain related reading material.

Honeywell P/N	Document Title / Description
6510020177	*GelView Sensor Calibration*
6510020178	*GelView Sensor Installation*
6510020179	*GelView Sensor Troubleshooting and Preventative Maintenance*
6510020180	*GelView Sensor Calibration Constants and Technical Specification*

Conventions

The following conventions are used in this manual:

i

NOTE: Unless otherwise specified, you may type all text in uppercase or lowercase.

`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, 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.
i	The information icon appears beside a note box containing information that is important.
!	The caution icon appears beside a note box containing information that cautions you about potential equipment or material damage.
	The warning icon appears beside a note box containing information that warns you about potential bodily harm or catastrophic equipment damage.

Honeywell, Vancouver Operations Part Numbers

Honeywell, Vancouver Operations assigns a part number to every manual. Sample part numbers are as follows:

6510020004

6510020048 Rev 02

The first two digits of the part number are the same for all Honeywell, Vancouver Operations products. The next four digits identify part type. Technical publications are designated by type numbers 1002. The next four digits identify the manual. These digits remain the same for all rewrites and revision packages of the manual for a particular product. Revision numbers are indicated after the Rev.

1. System Information

There is always a need to find new ways of increasing coater line efficiency while improving overall quality. One method to achieve this goal on a coating line is to setup the drying elements to optimize the drying rate to improve coating quality while potentially increasing the overall drying efficiency.

The GelView Sensor System is used to monitor the drying rate of the coating surface during the drying process and to identify the critical drying zone. It is able to detect and control the various drying rates through the drying section of the coater when combined with other measurements, such as incoming and outgoing moisture, temperature measurements, etc. The actual sensors are small, robust, and capable of measuring the reflectivity of the coated web at any point down the web path (either inside or outside of Air/IR dryers).

The GelView Sensor System consists of a series of GelView sensors mounted at different MD locations between the coating head and the end of that coating section. The GelView sensor measures the change in gloss of the paper coating as the coating dries. Sensors are typically installed in the same CD location but at different MD locations. The installed sensors are mounted on mounting brackets opposite turning rolls, inside the air floatation dryers or on a C-frame, which contains an air clamp for sheet stabilization. The sensors are designed to remain clean and survive temperatures up to approximately 350ºC (660ºF) - refer to the high temperature fiber optic cable specification for absolute temperature limitation.

The objective of the measurement is to show the change in the coating surface reflectivity. The gloss of the coating surface changes from a high gloss surface when the coating is wet to a low gloss surface when it is dry (see Figure 1-1 Example Reflectivity Decay Curve). More specifically, the rate of change of gloss has two significant inflection points that correlate to the first and second critical solids locations. This is significant because the drying rate during this central drying area (Critical Solids Region (CSR), which includes the gel point, is extremely critical for minimizing print mottle. By defining the decay in surface reflectivity, the gel point, the location of the first and second critical solids location can be determined.

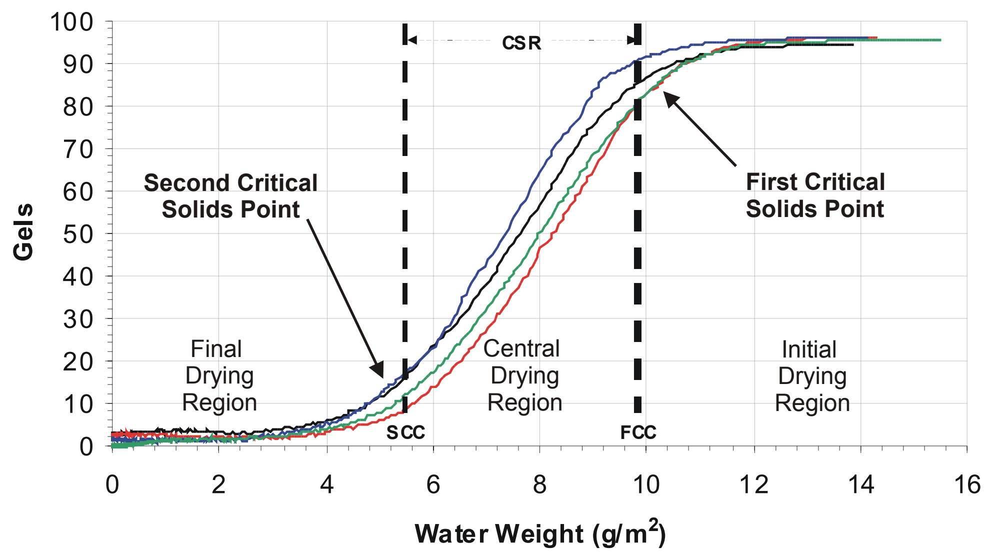


Figure 1-1 Example Reflectivity Decay Curve

1.1. GelView Sensor System Design

The GelView sensor system consists of:

- a set of independent GelView sensors
- an Electronics Interface Cabinet (EIC)
- a Precision Measurement Processor (PMP) cabinet
- a Da Vinci Application Server.

The basic configuration and interconnectivity of these components is shown in Figure 1-2 Basic GelView Sensor System Configuration.

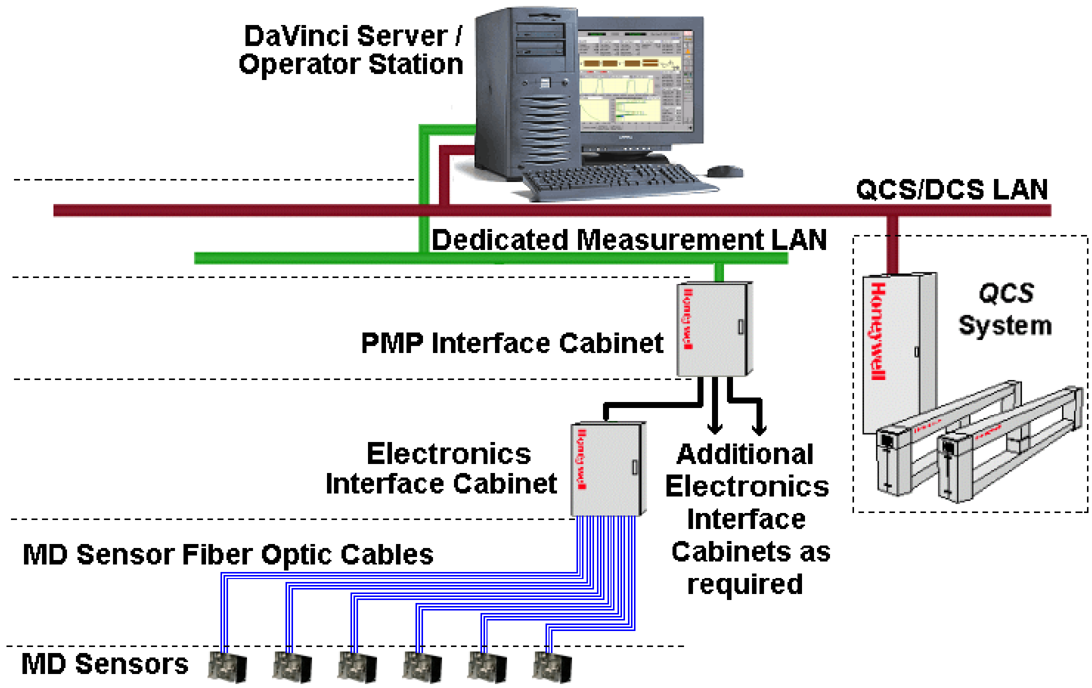


Figure 1-2 Basic GelView Sensor System Configuration

A detailed description into each of these components is covered in the next section.

2. Sensor Description

A basic GelView sensor system consists of six GelView sensors, as shown in Figure 1-2 Basic GelView Sensor System Configuration. Additional sensors can be configured for the same coating station as required. If a coating line has multiple coating stations, any number of sensors can also be installed on any or all of the coating stations.

This section of the manual reviews the core elements and principle of operation of the GelView sensor and the resulting measurement that combined provides an indication of the coating consolidation on the coating machine.

2.1. General Description

The GelView sensor consists of a mechanical housing that contains three optical collimators. The collimators of the sensor are then connected to the Electronics Interface Cabinet (EIC) by three fiber optic cables. The three optical cables are then terminated in the EIC to one LED and two optical detectors. These collective components are necessary to obtain a GelView measurement. This configuration for a single GelView sensor is shown in Figure 2-1 Single GelView Sensor Configuration.

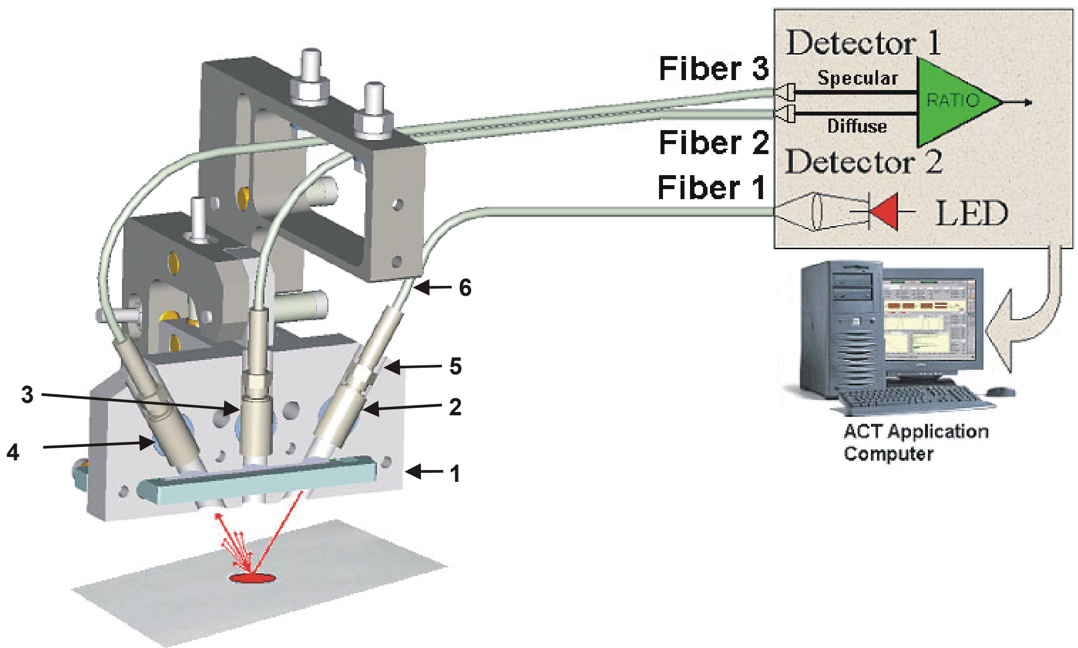


Figure 2-1 Single GelView Sensor Configuration

In Figure 2-1 Single GelView Sensor Configuration, the mechanical housing of the sensor [1] is designed to allow the sensor to be mounted perpendicular to the measurement surface and is described in further detail later in this manual. The three collimators [2], [3] and [4], are locked in place within the mechanical housing at 30 degrees to normal for two of the channels and normal for the third channel. The fiber optic cables are terminated with an SMA connector that is used to connect the fiber optic cables to the collimators [5]. The optical information related to the sensor is transferred to/from the EIC via the three fiber optic cables [6].

For each sensor, the EIC delivers a specific frequency range from a source LED. The fiber optic line delivers the optical source signal to the measurement point and the reflected and scattered optical radiation is transferred back to the detectors via the remaining two fiber optic cables.

Each optical collimator inside the sensor mechanical housing is aligned on the measurement point. The source fiber's collimator [2] creates a parallel optical beam; the receiving optical collimators, [3] and [4], for the diffuse and specular monitoring fibers provide the coupling of the scattered and reflected radiation into the fibers. The source fiber collimator [2] is installed inside the mechanical housing with an angle of 30 degrees to normal. The diffused radiation collimator [3] is placed normally to the paper surface; the second monitoring collimator [4] that monitors the specular reflection, is placed with the same angle (30° to normal from the paper surface) as the source fiber collimator.

These sensors are designed to withstand high temperatures - up to 350 degrees C (660 degree F) and humidity up to 100%. In order to deliver an optical signal to and from the point of measurement, the fiber optic communication line consists of two different fiber types: regular fiber optic cable and temperature resistant fiber optic cable (see Figure 2-2 Normal and Temperature Resistant Fiber Optic Cable Arrangement). The length of the regular fiber optic cable is approximately 30 meters (98 feet) and it is designed to be located in nominal machine hall temperature and humidity conditions. The temperature resistant fibers have a length of 3 meters (9.8 feet) and are capable of performing in very harsh environments. Fibers are connected with each other with the help of special mating sleeve.

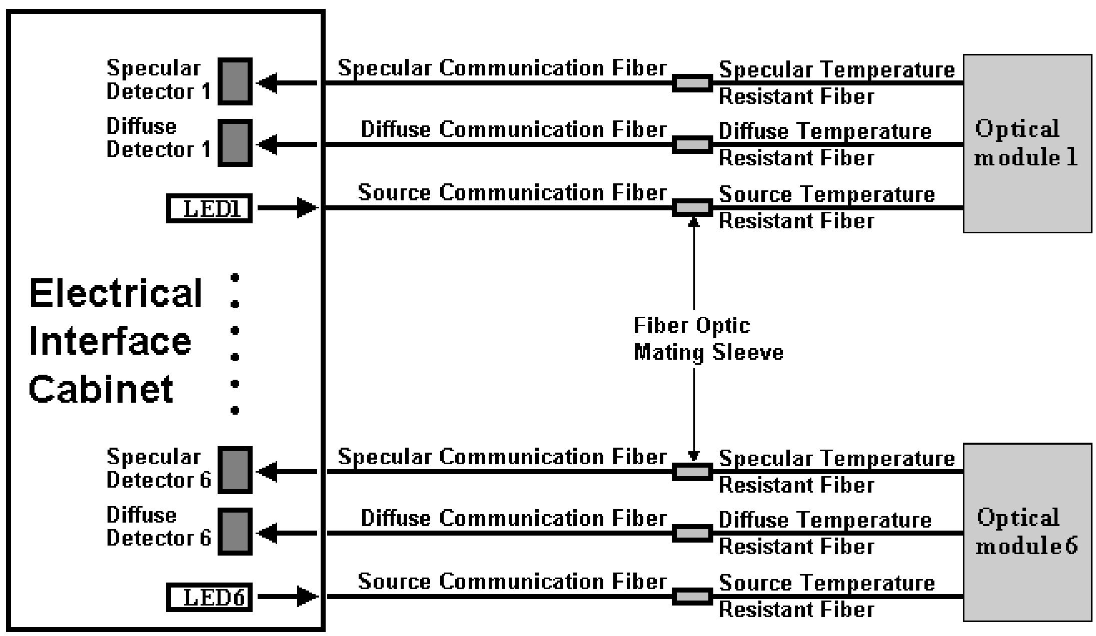


Figure 2-2 Normal and Temperature Resistant Fiber Optic Cable Arrangement

2.2. Principle of Operation

The sensor is essentially a surface reflectivity measurement. The source optical fiber supplies a light source that shines on the surface of the coated paper. As the coating dries, there are two extremes in terms of the coating consolidation, as shown in Figure 2-3 Coating Consolidation.

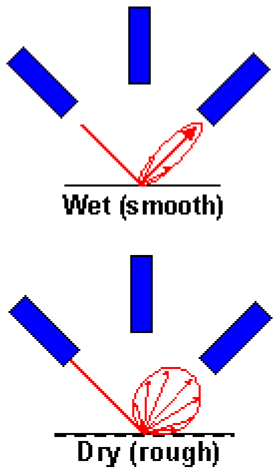


Figure 2-3 Coating Consolidation

In the case of a wet surface, the emitted radiation from the delivering optical fiber collimator has mostly specular reflection off the coated paper surface (wet surfaces are smooth and have very good reflective properties) and this specular reflection is monitored mostly by the specular optical fiber. When the paper coating is dry, the light scattered from the coating's surface would have more diffuse characteristics. In this case the emitted radiation will be more scattered from the paper surface and radiation will be monitored by both optical fibers.

The ratio between the diffuse and specular signals indicates the conditions of the coating. This ratio varies in the range from 0 to 1. If the paper coating is wet, this ratio will be close to 0; if the paper coating is dry, this ratio will be close to 1. For conversion of this ratio into sensor "gels", the system uses a reversed ratio value, which means that the sensor measurement "gels" value is calculated as:

$$gels = 100 \times \left(1 - \left(\frac{Voltage_{Diffuse} - Voltage_{DiffuseBackground}}{Voltage_{Specular} - Voltage_{SpecularBackground}} \right) \right)$$

2.2.1. Pass-line Sensitivity Characteristics

As any other optical sensor, the GelView sensor has some sensitivity to the vertical sample displacement (pass-line or Z sensitivity) between the sensor and the sample surface to be measured.

As the distance between the sample surface and the sensor changes (Z displacement), the position of the measurement spot moves slightly. This means that the specular reflected radiation *X(z)* is not directed to the center of the specular channel collimeter and there will be a corresponding drop in signal corresponding to the shift in intensity distribution of the specular reflected radiation *X(z)* relative to the detecting collimators position. There will also be a corresponding shift in the diffuse scattered radiation *Y(z)* (see Figure 2-4 GelView Sensor Pass-line Sensitivity). If H is the distance from the sensor to the sample's surface and β is the incident and reflected angles, *X(z)* and *Y(z)* can be determined as:

$$X(z) = 2 \cdot z \cdot \sin(\beta);$$
$$Y(z) = z \cdot \tan(\beta).$$

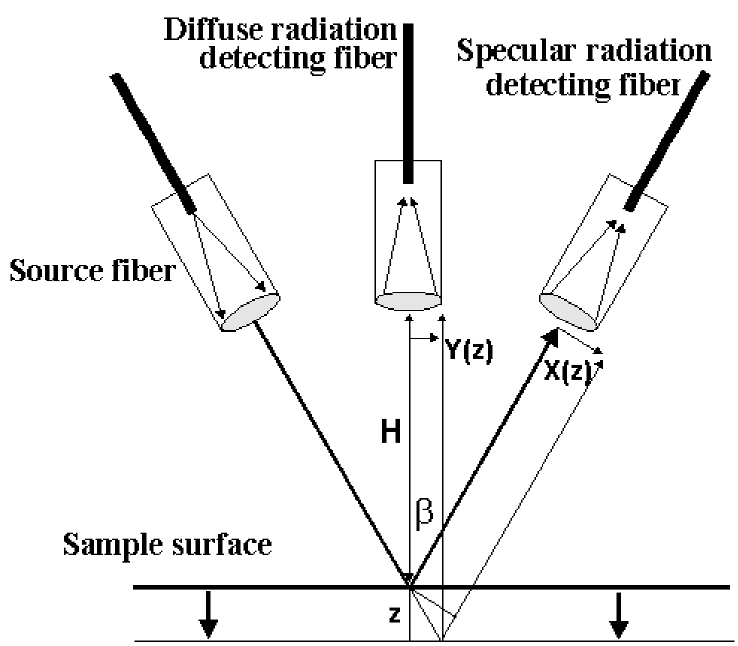


Figure 2-4 GelView Sensor Pass-line Sensitivity

NOTE:	Laboratory tests show that the error in GelView sensor readings is typically less than ± 0.5% for wet coating and less than ± 8% for dry coatings for sample's vertical displacement in the range of ± 2.5mm (± 0.1").

2.2.2. Tilt Sensitivity Characteristics

As with any other optical sensor, the GelView sensor has some sensitivity to any angular displacement (CD or MD tilt sensitivity) between the sensor and the surface to be measured. This sensitivity is dictated by the angle that the collimators for the source and specular channels are set at, compared to the normal, and the diameter of the collimators themselves.

In case of the angular displacement, if **α** is the tilt of the sample surface, this causes the same tilt in the diffuse scattered radiation and a 2**α** tilt of the specular reflected beam relative to optimal positions in the center of their respective collimator lenses (see Figure 2-5 GelView Sensor Tilt Sensitivity).

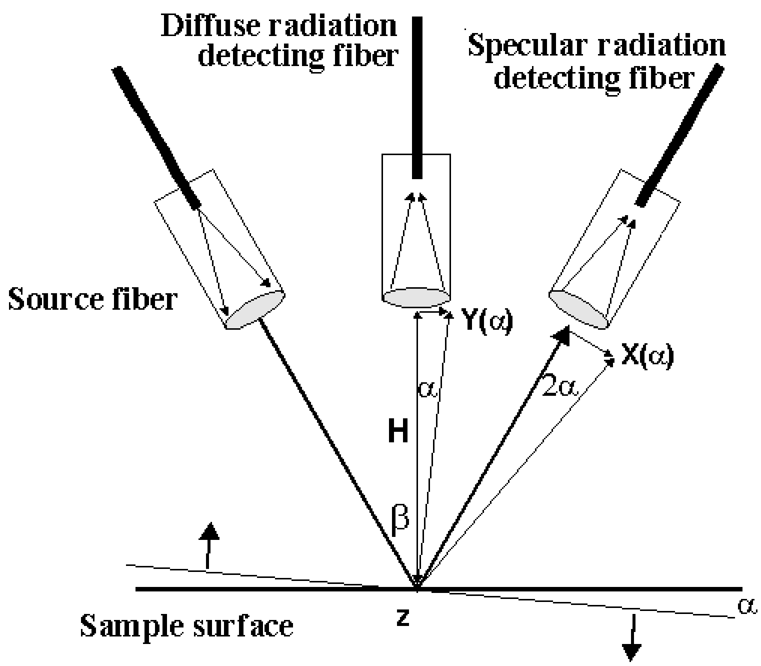


Figure 2-5 GelView Sensor Tilt Sensitivity

Displacements X(**α**) and Y(**α**) of the beam's optical axis relative to the lenses of detecting collimators as a function of **α** can be presented as following:

$$X(\alpha) = \frac{H}{\cos\beta} \cdot \tan\left(\frac{2\alpha\pi}{180}\right);$$

$$Y(\alpha) = H \cdot \tan\left(\frac{\alpha\pi}{180}\right)$$

NOTE: Laboratory tests show that the error in GelView sensor readings is typically less than ± 2.5% for wet coating and lees than ± 10% for dry coatings for a sample's tilt values in the range of ± 1.0º.

CAUTION: Sheet presentation and stabilization are extremely important for GelView sensor performance. We recommend installing GelView sensors against turning rolls or with C-frames with air sheet stabilizers or any other opposing sheet-stabilizing device.

2.3. Hardware Description

This section covers all aspects of the mechanical housing of the GelView sensor along with the fiber optic cables from the mechanical housing to the Electronics Interface Cabinet (EIC). The detailed description of the components and the signal flow within the EIC are described in Electronics Interface Cabinet Overview.

2.3.1. Optical Module

The GelView Optical Module is a combination of the mechanical housing and the optical components, as shown in Figure 2-6 GelView Optical Module.

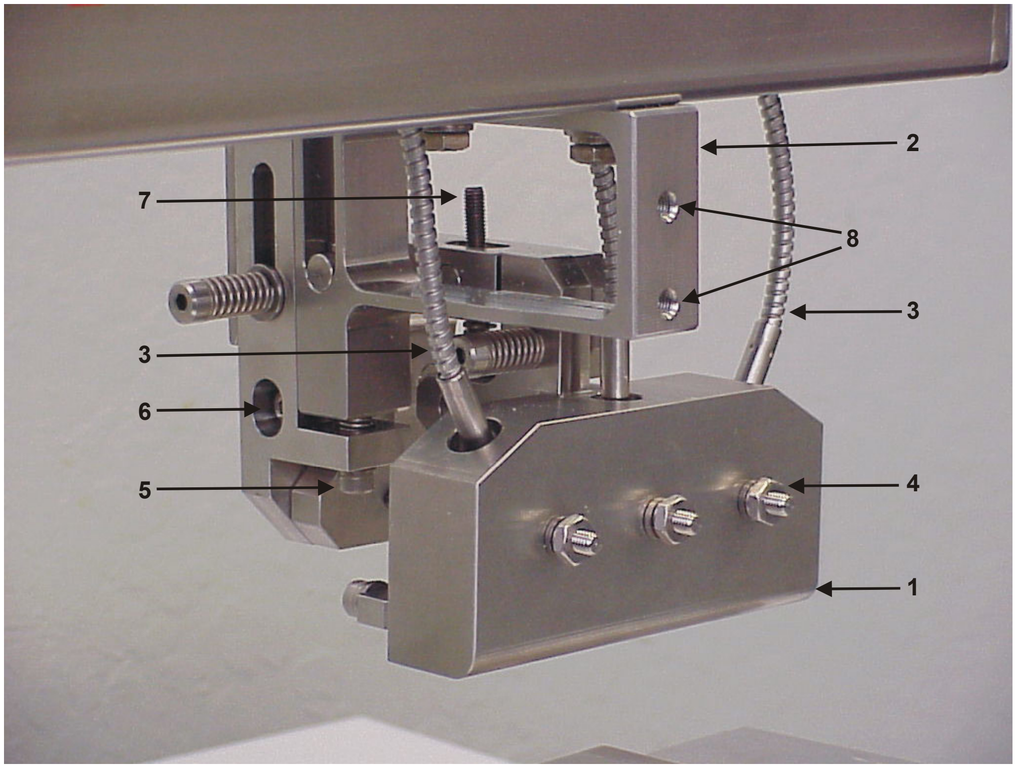


Figure 2-6 GelView Optical Module

In Figure 2-6 GelView Optical Module, the mechanical housing of the optical module's body [1] is attached to a mounting surface using the sensor bracket [2]. Optical fibers [3] with collimators are fixed inside the module with fiber clamps [4]. The position of the optical module's body relative to the sample's surface can be adjusted in both the vertical and horizontal directions. An adjustment screw [5] is responsible for the vertical displacement, while two adjustment screws [6] and [7] (see also Figure 2-7 GelView Optical Module (Rear View)) allow tilting the sensor in the CD and MD directions respectively. Figure 2-6 GelView Optical Module shows the GelView sensor without a protective shield attached. The stainless steel protective shield is attached to the mechanical housing with two bolts screwed into the threaded holes [8] and is used to protect the sensor and the optics from wet coating during a sheet break.

The optical module includes a special glass shield protective assembly [9] (see Figure 2-7 GelView Optical Module (Rear View)), which was designed to protect the sensor's optics from coating, dust and dirt. This assembly can be easily removed from the sensor for cleaning simply by releasing two screws [10] (see Figure 2-8 GelView Optical Module (Protective Glass View)).

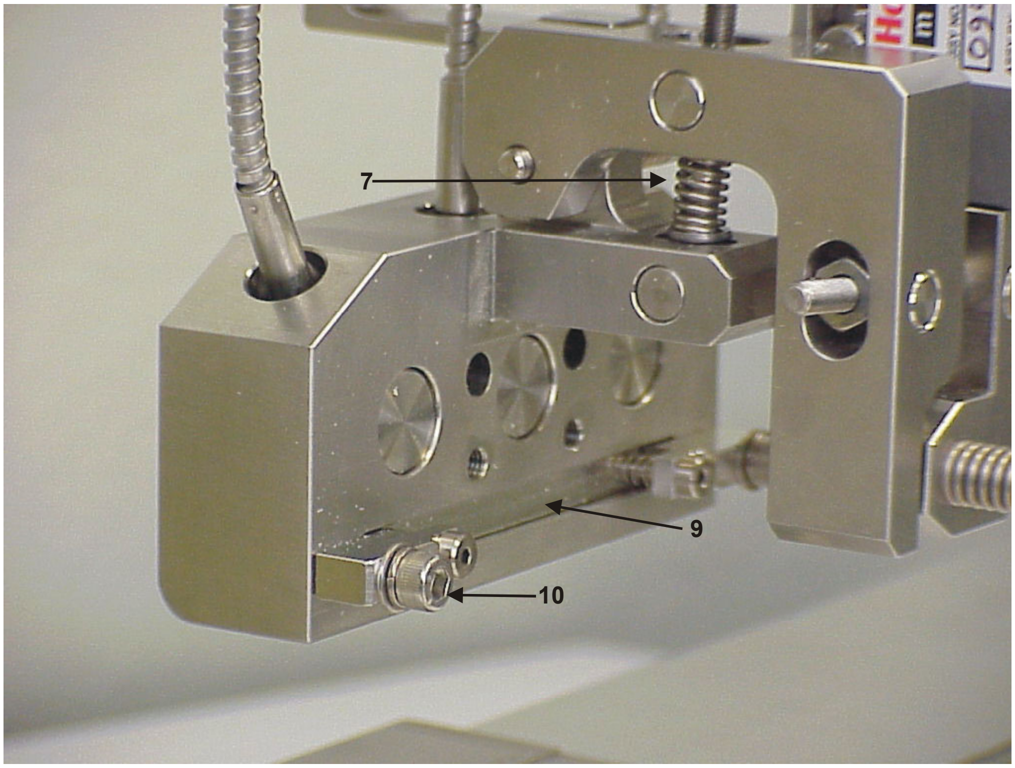


Figure 2-7 GelView Optical Module (Rear View)

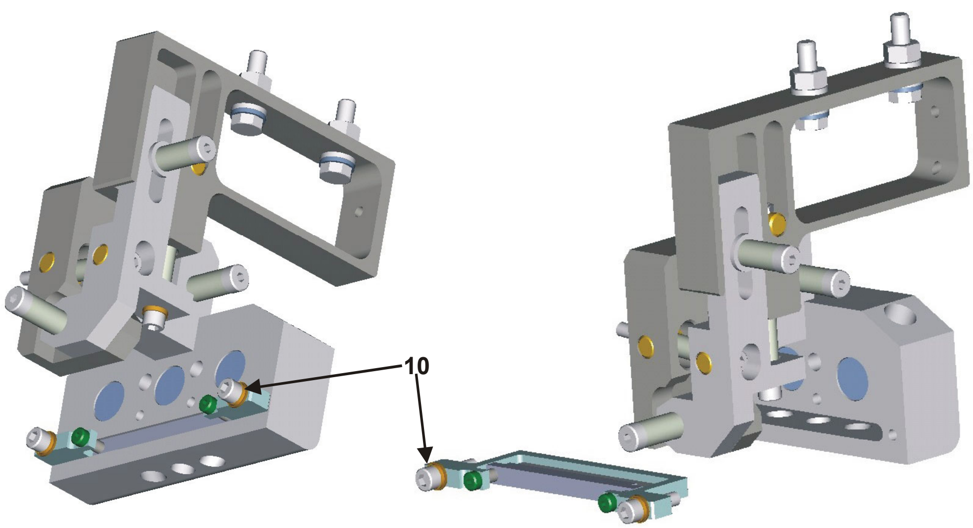


Figure 2-8 GelView Optical Module (Protective Glass View)

2.3.2. Optical Fibers and Collimators

Each GelView sensor collimator is connected to the EIC via two types of optical fibers: "regular" fiber and "temperature resistant" fiber. Both fibers are identical from an optical point of view and differ only by their reinforcement and ability to survive in high temperature and humidity environments. The term "regular" means that this type of fiber was designed for regular room conditions. This optical fiber serves as a communication line between the EIC and the sensor. The length of the regular optical fiber is around 30 meters (98 feet) in Figure 2-9 Regular Fiber Optic Cable.

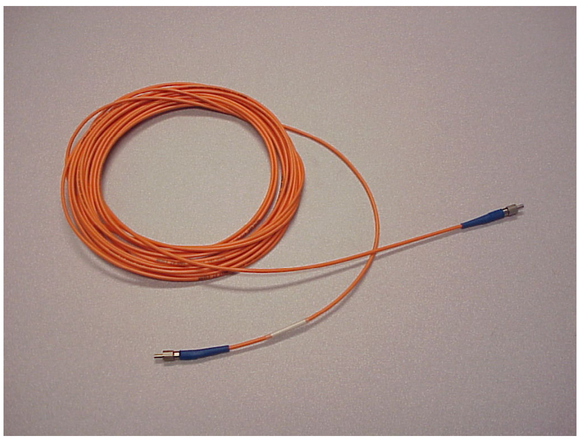


Figure 2-9 Regular Fiber Optic Cable

Figure 2-10 Temperature Resistant Fiber Optic Cable

Temperature resistant fibers in Figure 2-10 Temperature Resistant Fiber Optic Cable are approximately 3 meters (9.8 feet) long and are capable of being installed in very harsh environments - temperatures up to 350 degrees C (660 degrees F) and humidity up to 100%. These fibers deliver the optical signals to and from the optical module in the environmental conditions where regular fiber cannot survive and serve as a main part of a link between optical module and the EIC.

The optical fibers are connected to each other with the help of a special mating sleeve (see Figure 2-11 Optical Fiber Mating Sleeve).

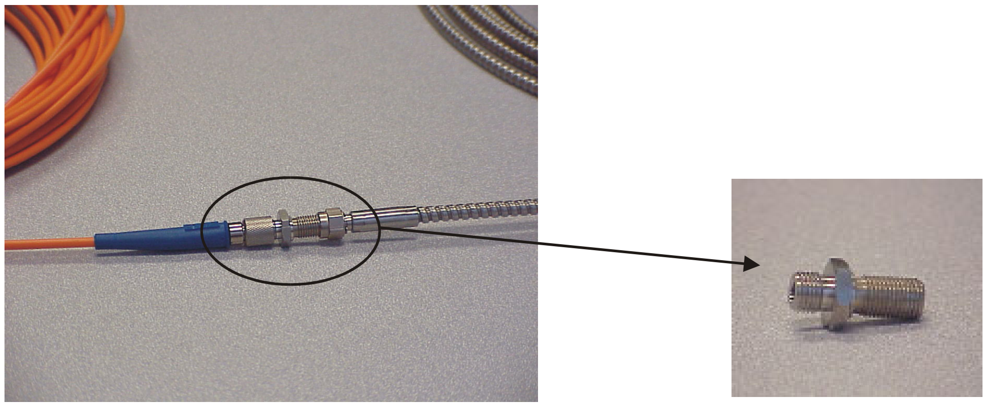


Figure 2-11 Optical Fiber Mating Sleeve

Optical collimators (see Figure 2-12 Optical Collimator) play a very important role in the sensor's performance. The collimator connected to the source fiber presents a quasi-parallel optical beam and sharp measurement spot onto the sample surface. At the same time, the collimators connected to the specular and diffuse receiving fibers collect diffuse scattered and specular reflected optical radiation from the sample surface and focus this collected radiation into the fibers. All the collimators in the sensor have the same mechanical dimensions and optical properties.

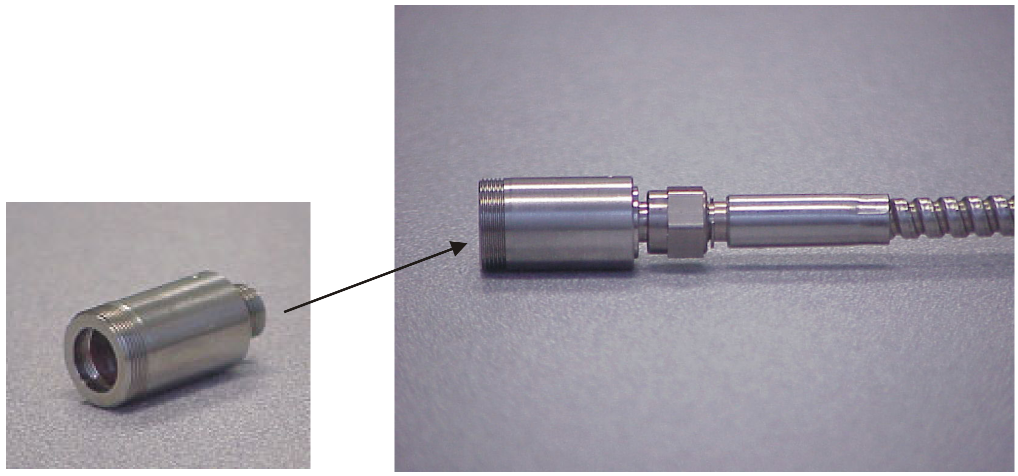


Figure 2-12 Optical Collimator

In Figure 2-13 Optical Module with Collimator and Fiber Optic Cable Arrangement, the source, diffuse and specular channel optical fibers are connected to the three collimators [1] respectively. The collimators are clamped inside the mechanical housing, which also holds the protective glass plate [3]. Glass plate [3] protects optical collimators from dust build-up and can be easily removed for cleaning.

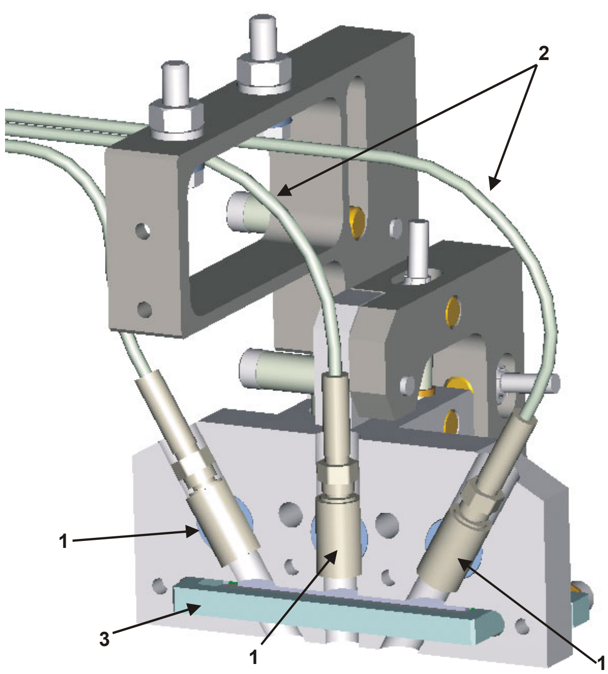


Figure 2-13 Optical Module with Collimator and Fiber Optic Cable Arrangement

2.3.3. C-Frame with Air Stabilization System

For a GelView System, sensors are placed along the path of a coater (on or off-machine coaters) in the same cross-direction (CD) location but at different MD locations between the coating station and the end of the coater dryer sections. Sensors can be placed opposite turning rolls, in open draws, or inside air floatation dryers. When sensors are needed in open draws, a stainless steel C-Frame with an air clamp can be installed (see Figure 2-14 Stainless Steel C-Frame with Air Clamp). This provides the sensor with the web stability the sensor needs in order to obtain a stable and repeatable measurement. Although the air clamp stabilizes the sheet, the air clamp and C-Frame do not physically touch either surface of the web.

Figure 2-14 Stainless Steel C-Frame with Air Clamp

The optical module is mounted in the upper arm of the C-frame, and an air-clamp is mounted in the lower arm for stabilizing the paper for the GelView measurement. The air clamp provides a flat sheet profile as well as an air bearing. This is achieved by an air slot [1] and back step [2] combination (see Figure 2-15 Stainless Steel C-Frame with Air Clamp (Detailed View)). The flat area of the sheet created by the air clamp extends for about 5-10 mm following the back step with the optimal measurement location indicated by a reference tile. Paper tilt in this region should be restricted to no more than 0.1 degrees with slightly higher tilt allowable for heavier grades.

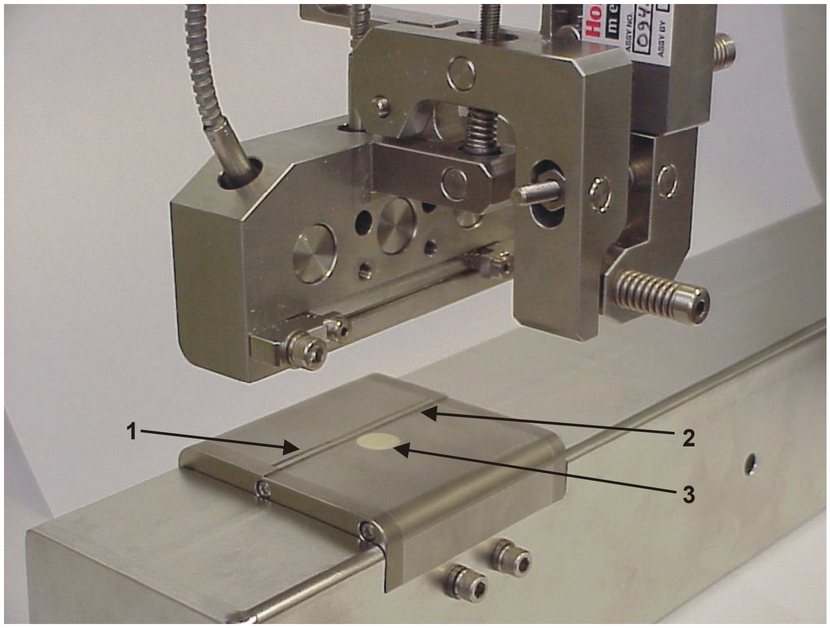


Figure 2-15 Stainless Steel C-Frame with Air Clamp (Detailed View)

There are no electrical requirements for the air clamp. The only requirements for the air clamp are:

- Air supply - 200 SCFH at 40 PSI supply pressure.

Considerably lower or higher settings (± 20%) for the air supply will result in worse paper flatness or sheet breaks respectively.

CAUTION: The supplied air MUST be filtered and free from water and oil.

At installation, the air clamp surface should be adjusted to be parallel to the paper pass line. Although the air clamp stabilizes the sheet without contacting it, dust built-up has been observed on its surface. In order to ensure undisturbed flow, and proper air clamp operation, the slot and top surface of the air clamp needs to be kept clean. Wiping off the surface with a soft cloth is recommended. Any scratches, especially in the slot opening, will compromise the effectiveness of the air clamp.

In Figure 2-15 Stainless Steel C-Frame with Air Clamp (Detailed View), a special white ceramic tile [3] is imbedded in the top surface of the air clamp, immediately after the back step [2]. This tile, which must be kept clean, is a good indication of the sensor's conditions (optics cleanliness, sensor's alignment) during paper absence.

2.4. Electronics Interface Cabinet Overview

The Electronics Interface Cabinet is one of the core components of the GelView sensing system and is responsible for:

- generation of the GelView sensors optical source signals
- coupling of the source signals into the optical fibers
- receipt of the optical diffuse and specular signals
- conversion of the optical signals from GelView sensors into voltages
- amplification and conversion of these voltages into a digital form
- communication of the digital measurement to the PMP

The basic EIC layout is presented in Figure 2-16 Electronics Interface Cabinet Layout.

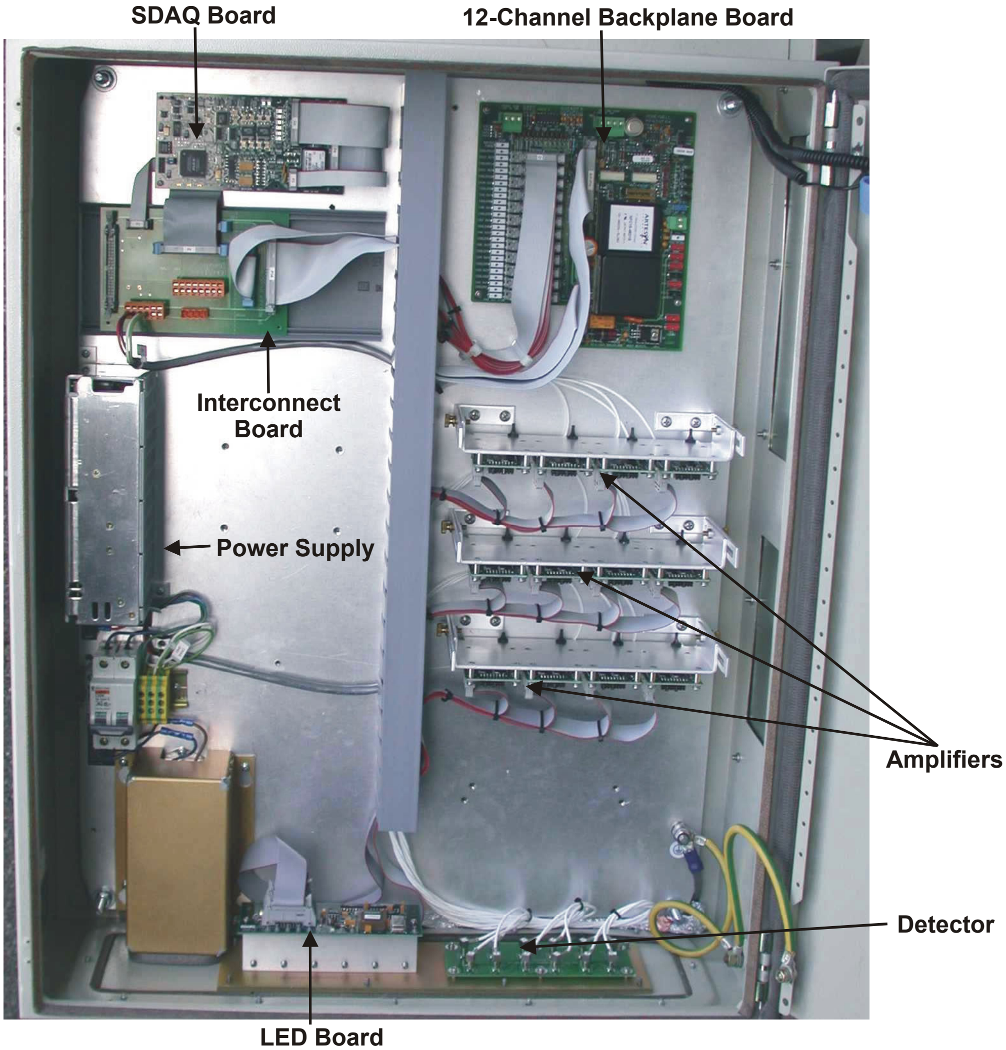
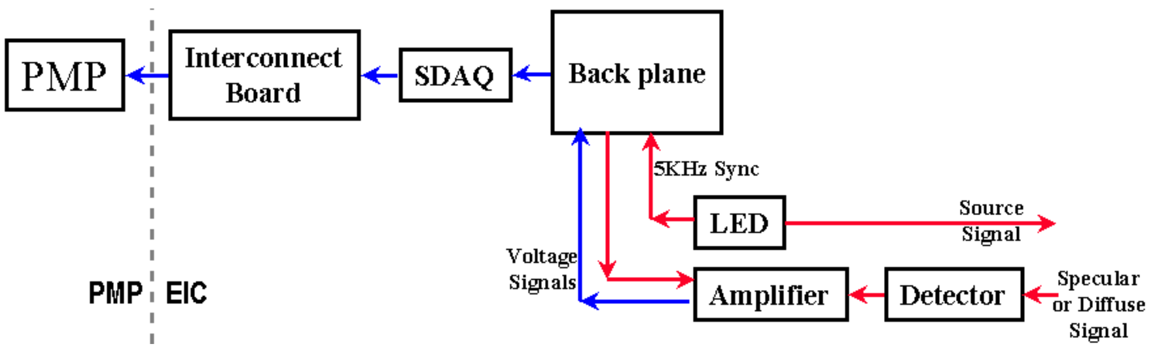
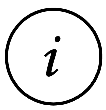


Figure 2-16 Electronics Interface Cabinet Layout

The support box contains a 24V power supply, an LED board, a detector board, up to twelve amplifiers, a 12-channel IR receiver backplane, an SDAQ and an interconnect board.

The basic flow of information in the EIC is as follows:





NOTE: There are static sensitive components in the EIC. Anyone working within the EIC must wear the antistatic wrist strap provided to avoid damage to these components.

An inside view of the enclosure showing LED board (PN 05442400) and detector board (12-channel photodetector board, PN 05442300) is presented in Figure 2-17 LED board and 12-Channel Photodetector Board.

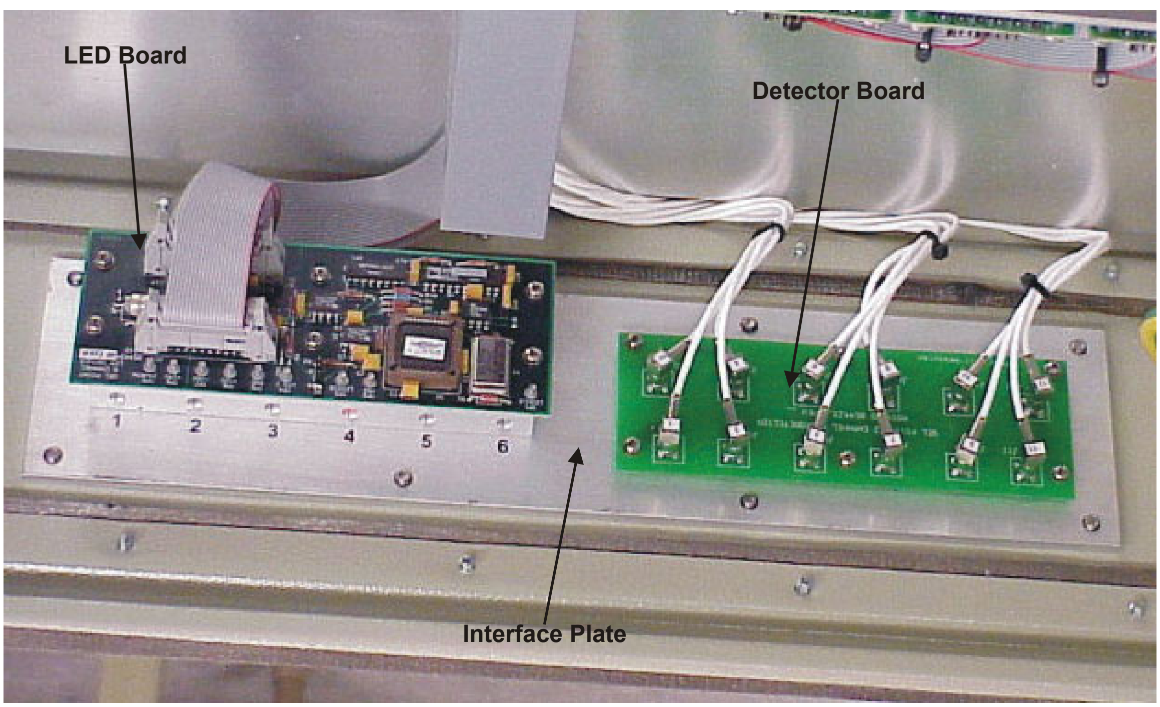


Figure 2-17 LED board and 12-Channel Photodetector Board

The LED board provides 5KHz modulated current into six extra bright LEDs and master phase for demodulation. The detector board contains twelve Silicon photodiodes, which are connected with coaxial cables to the amplifiers. Both boards are mounted on the interface plate from inside. The outside view of the interface plate is presented in Figure 2-18 Source LED Interface Connection and Figure 2-19 Photodetector Interface Connection.

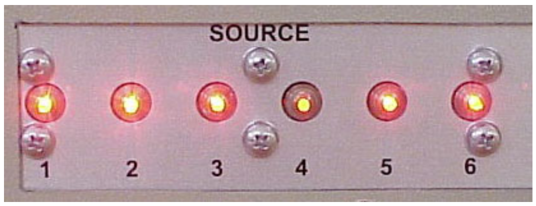


Figure 2-18 Source LED Interface Connection

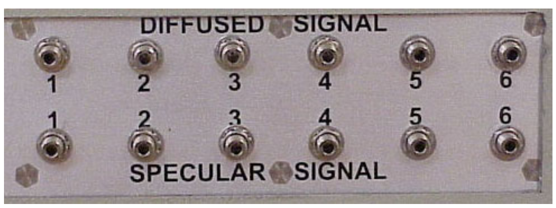


Figure 2-19 Photodetector Interface Connection

Each of support box's six LEDs (see Figure 2-18 Source LED Interface Connection) has an optical collimator, which couples energy into the optical fiber. There are twelve detectors on the other side of interface plate: two detectors for every sensor for specular and diffuse channels.

Signals from the detectors go to the amplifiers boards (Silicon detector signal conditioner board, PN 05441300). The EIC can contain up to twelve amplifiers: one for each detector (see Figure 2-20 Silicon Detector, Signal Conditioning Amplifier Boards).

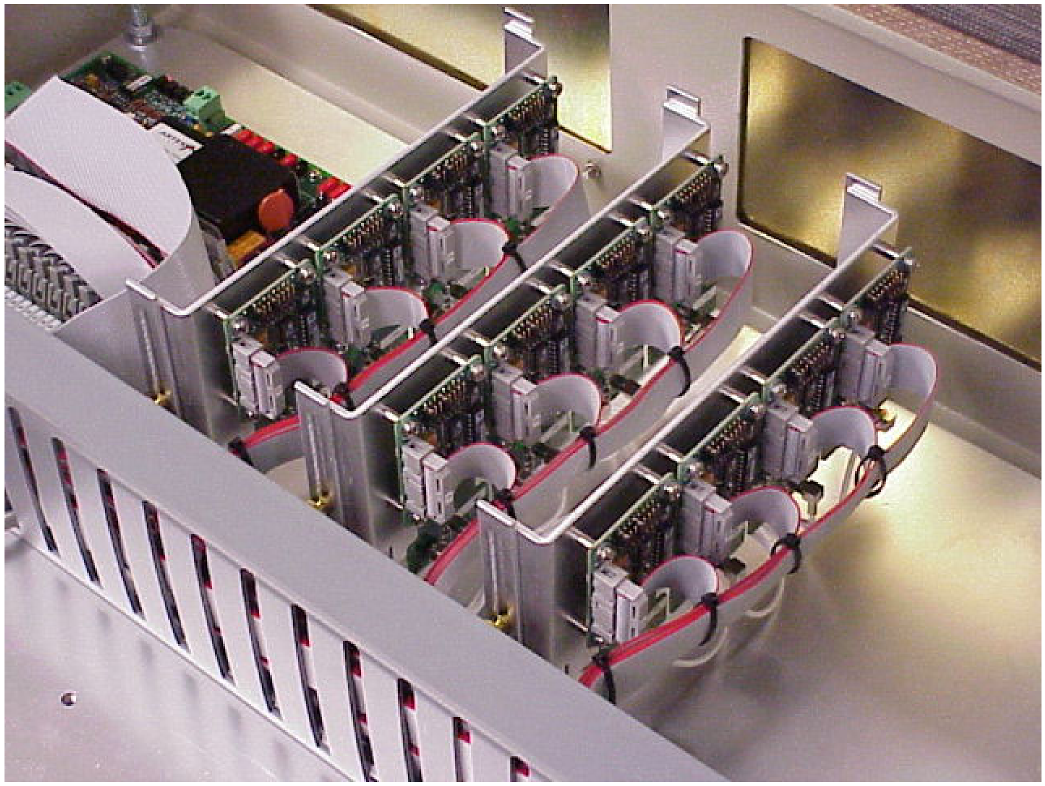


Figure 2-20 Silicon Detector, Signal Conditioning Amplifier Boards

The amplifiers have a 2-stage manually adjustable gain, which can be configured via two sets of gain adjustment jumpers. The configuration of these jumpers dictates the ultimate output gain of the amplifier board (see Figure 2-21 GelView Amplifier Board Gain Jumper Definitions).

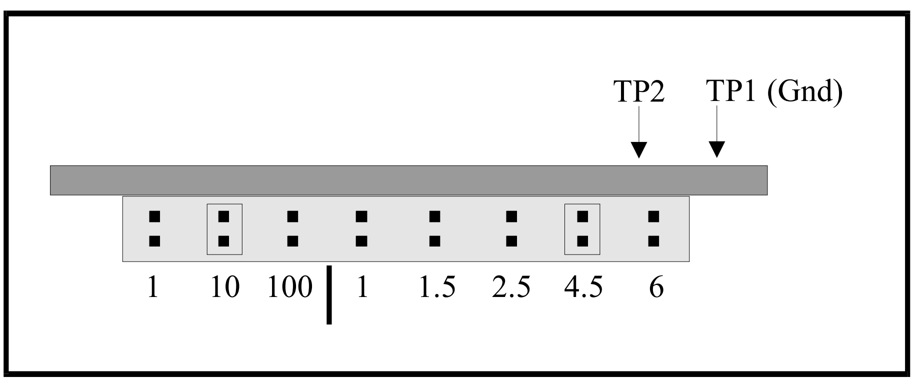


Figure 2-21 GelView Amplifier Board Gain Jumper Definitions

The jumpers are located on the component side of the detector board (opposite side to the test points). The jumpers can be changed with the power turned on, but the jumpers must be in place or the signals will saturate the electronics.

One jumper must be placed in one of the following three positions (Gain 1):

Jumper 1	Gain factor 1
Jumper 2	Gain factor 10
Jumper 3	Gain factor 100

One jumper must be placed in one of the following five positions (Gain 2):

Jumper 4	Gain factor 1
Jumper 5	Gain factor 1.5
Jumper 6	Gain factor 2.5
Jumper 7	Gain factor 4.5
Jumper 8	Gain factor 6

The gain is determined by the product of Gain 1 and Gain 2.The amplifier's DC signal output can be measured at the test points TP1 (Gnd) and TP2.

The 12-channel IR receiver backplane is presented in Figure 2-22 IR Receiver Back Plane. The backplane provides power to the LED board and amplifiers and delivers phasing signal from the LED board to the amplifiers. The backplane also receives signals from the amplifiers and routes them to the SDAQ. The receiver backplane contains a 5A fuse on the 24volt input at F1. Additionally, a spare fuse is located at F2.

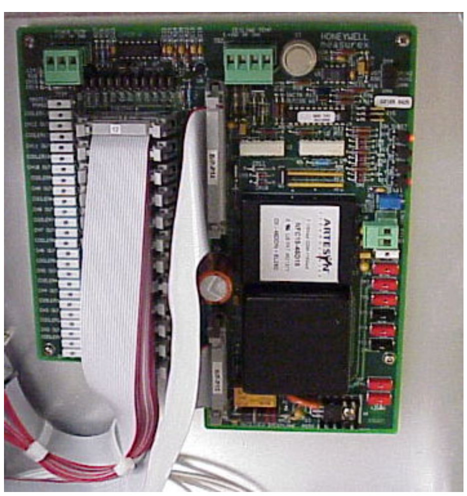


Figure 2-22 IR Receiver Back Plane

The 12-channel SDAQ board and interconnect board are presented in fig223. The SDAQ board provides Analog to Digital conversion of the signals it receives from the amplifiers through the backplane and communicates digitized signals to the PC DAQ in the PMP via a direct RS 485 link. The SDAQ also includes six digital contact outputs, four of which are used in GelView to provide software control of LED output and background modes. Each contact output includes a self-resetting 1A fuse.

The interconnect board provides interconnections between the backplane, SDAQ and power supply using flat ribbon cables.

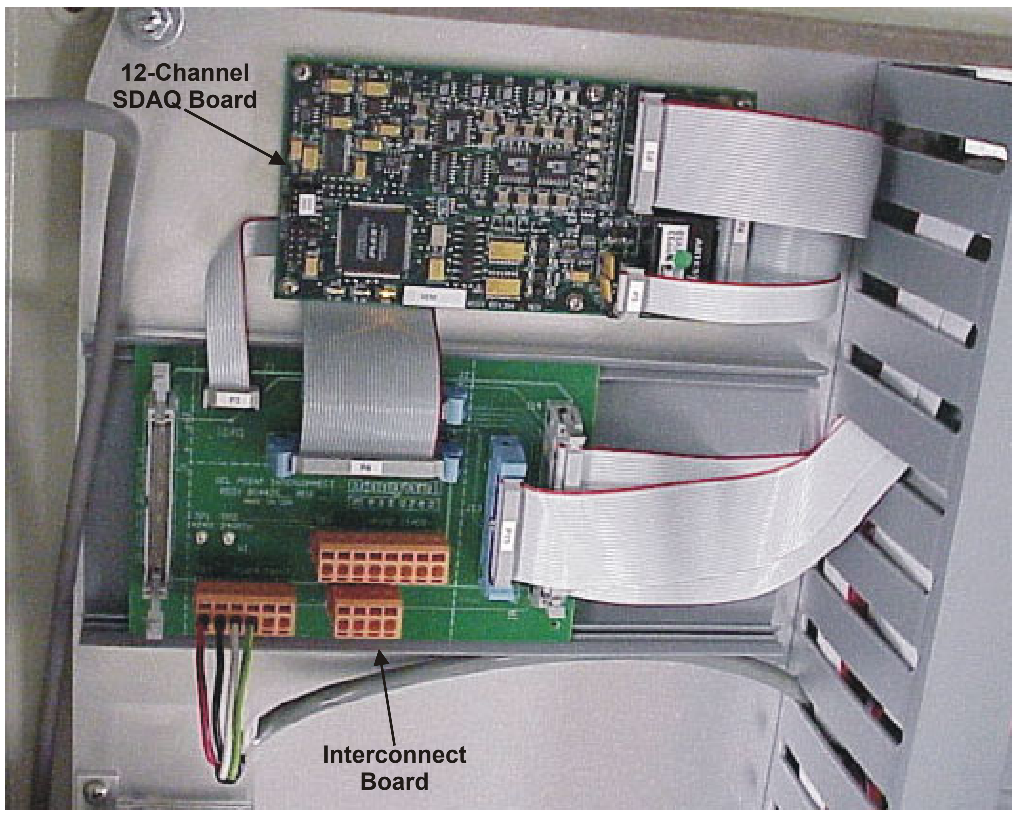


Figure 2-23 12-channel SDAQ Board and Interconnect Board

NOTE:	It is a requirement that the door to the Electronics Interface Cabinet (EIC) be completely closed and latched at all times during normal operations including calibration and repeatability testing. This will prevent stray electromagnetic fields from inducing noise in the sensitive, high impedance electronics, which would adversely affect calibration.