Honeywell

Source 12 Basis Weight Sensor

System Manual

6510020211

Source 12 Basis Weight Sensor Manual

December, 2005

Confidentiality Statement

Notice

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Introduction

This manual provides a description of the installation, operation, and maintenance of the 4202, Source 12 Basis Weight Sensor. Those familiar with earlier model basis weight sensors, see Section 2.3 for a comparison of Sources 6, 9, and 12.

While this manual provides an overview of the operation of the Source 12 Basis Weight Sensor, there are limitations. Two very important considerations are:

- Radiation Safety
- Design Changes

Radiation Safety

There are radiation safety concerns for anyone who works on this sensor. These concerns cannot all be adequately addressed here.

Consult the Honeywell Radiation Safety Manual (6510020199), or, within the United States, the Radiation Safety Manual for Customers (6510020197) for detailed information.

Some procedures referred to in this manual may only be performed by appropriately licensed persons. Such procedures and permission to perform them must be obtained directly from Honeywell Radiological Operations.

Design Changes

While every effort is made to provide correct and current information on the Source 12 Basis Weight Sensor, the contents of this manual cannot be guaranteed to be updated every time there is a change to the design. References to specific part numbers have been minimized so as not to be out of date or obsolete. For the current part number, when ordering spare parts, consult a current bill of material. When first introduced, the sensor was placed only inside a Modular Head (Honeywell part number 09203436). Installation in other heads is expected. This manual only describes Modular Head organization.

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 four chapters.

Chapter 1, **Basic Measurement Principles and Sensor Overview**, describes the physical operating principles of beta emitting basis weight sensors.

Chapter 2, **Sensor Features,** describes the features of the basis weight sensor in more detail.

Chapter 3, **Maintenance and Troubleshooting,** describes preventive maintenance tasks and solvable potential problems.

Chapter 4, **Installation and Service Requirements,** describes installation service requirements and supporting accessory kits.

Related Reading

The following documents contain related reading material.

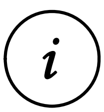
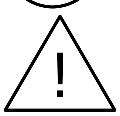
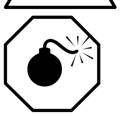
Honeywell P/N	Document Title / Description
6510020197	Honeywell Radiation Safety Manual for Customers
6510020199	Honeywell Radiation Safety Manual including Canadian Standards
Current Bill of Material	094202XX Source 12 Basis Weight Sensor 09203426 Modular Head for Source 12 Basis Weight Sensor 09203427 Modular Head for Source 12 Basis Weight Sensor with Mechanical Indicator

Conventions

The following conventions are used in this manual:

NOTE: 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, 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.
	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. Type numbers 1002 designates technical publications. 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. Basic Measurement Principles and Sensor Overview

1.1. Measurement principles

This chapter describes the physical operating principles of beta emitting basis weight sensors. Readers already familiar with the measurement principles of Honeywell basis weight sensors, see Section 1.2.

1.1.1. Beta particles and basis weight measurement

Beta particles (or betas) are electrons emitted from atomic nuclei during nuclear decay. After leaving the nucleus they may be thought of as an electron beam such as in a cathode ray tube (CRT), found in a televisions and computer monitors. Beta particles from nuclear decay are not of a single energy but are emitted in a continuum of energies up to a maximum value. This maximum energy value depends on the type of source capsule or isotope. Higher energy betas are more penetrating and therefore can be used on heavier products. The most commonly-used capsules, in order of increasing maximum energy are: Promethium-147 (Pm-147), Krypton-85 (Kr-85) and Strontium-90 (Sr-90)[1].

The emitted beta particles will interact with the sheet in two different ways: it may be scattered from the sheet, or it may lose some or all energy in the sheet. The betas that pass through the sheet and into the receiver enter an ionization chamber. This is the detector. The ion chamber outputs a small current (approximately one nano-ampere), which is proportional to

[1] The number (xx-*nn*) signifies the particular isotope used.

the energy deposited in the ion chamber. The current from the ion chamber goes through a short wire to an amplifier whose output is an analog voltage on the order of 0 - 10 volts. This signal is sent to an electronic circuit and is read by a computer which averages the signal for some prescribed time interval. Then using proprietary algorithms, the software converts the average signal to a calculated basis weight of the product.

The more material in the beam of betas, the more scattering and absorption, and the smaller the signal. Beta particles are absorbed nearly uniformly by all substances because normal variations in the chemical composition have very little effect on the absorption or basis weight reading. That is, the absorption is dependent on the basis weight and not on color, texture, state of matter, and so on. This is a principle advantage of using beta sources in basis weight sensors. But this also means that the air in between the source capsule and the ionization chamber as well as any debris in the beam will absorb beta particles just as the product being measured.

1.1.2. Statistical nature of basis weight measurement - sensor repeatability

Nuclear decay process is statistical. The sensor signal will always have some random noise component. We can reduce the noise in two ways:

- increasing the beta ray flux
- increasing the time the signal is averaged.

Increasing the flux is one of the main goals of the beta sensor designer. Remember the measurement always contains a random noise level which may only be reduced by increasing the amount of time that the signal is averaged (for a given set of hardware). Therefore, whenever the sensor stability specification is given, it is always given for some prescribed integration (averaging) time. Generally, the sensor stability improves by the square root of the integration time (This assumes all the noise comes from nuclear statistics, not other factors such as changes in air density). For example, the sensor will be about twice as stable when integrating for four seconds as compared to integrating for one second. Understand that this noise is present in all measurements made by the basis weight sensor, including Standardization, Reference, Sample and On-Sheet measurements.

Random error or variation is expressed using the statistical measure of standard deviation or sigma. Standard deviation is equal to the square root of the sum of the squares of the differences divided by the number of measurements in the group.

$$\sigma = \sqrt{(\sum_{i=1}^{N} (x_i - x_{ave})/N}$$

where

N = number of measurements,

xi = individual measurement,

x ave = measurement average).

For a randomly varying quantity (such as the measured basis weight of a sample, or the F/A ratio), 68% of the numbers (results of the measurements) lie within ±1 sigma of the mean, 95% lie within ±2 sigma of the mean, 99.5% of the numbers lie within ±3 sigma of the mean, and so on. In other words, the sigma is a measure of how tightly grouped, or repeatable, the group of numbers are (Sigma is only valid for groups of numbers greater than a certain size. Thirty readings is standard for laboratory, where that is not practical, do not use fewer than ten).

1.1.3. Correctors

To accurately measure the product, several correction algorithms (correctors) are added. An ideal basis weight sensor signal would change only when the sheet's basis weight changed. Unfortunately, despite the designer's efforts, there remain external influences that affect the signal. For example, any increase in the mass between the source and receiver causes a larger basis weight reading. Several factors can cause this: dirt build up on windows, increase in air mass due to temperature change, or change in the distance between heads. These affects should remain small relative to the raw or uncorrected basis weight reading. To compensate, these external influences are measured and corrected (calculated) out of the basis reading. Correctors, positive or negative, are all calculated in basis weight units and added to the uncorrected basis weight reading. Being in basis weight units allows easy comparison of the relative magnitudes. A brief description of these correctors follows. (See Section 2.4 for a more detailed discussion on this topic).

1.1.3.1. DIRT

Dirt Correction corrects for debris build up on the heads and for changes in air density due to air temperature, or pressure changes. Dirt correction is based on the flag reading from the most recent standardize. If dirt build up is significant between window cleanings, increasing the standardize frequency decreases inaccuracies due to dirt build up.

1.1.3.2. Z

Z correction compensates for basis weight changes due to changes in the height (and thus basis weight) of the air column. Head gap separation will also affect beam geometry. The Z correction will compensate for both. Z correction is based on the on sheet (now) Z readings (Z corrector requires the presence of a Z sensor).

1.1.3.3. KCM

Corrects for any difference in absorption properties between the calibration standard and the customer product. KCM is grade dependent. Typical KCM values are very close to 1.00.

1.1.3.4. PROFILE CORRECTION

Corrects for any sensitivity of the sensor due to head misalignment in the machine direction or cross direction. The Profile Correction must be built (measured) on site. It is best to build the profile correction under conditions which are identical to normal machine conditions, particularly the temperature. (that is, best to build the Profile Correction immediately following a break or other shut down, while the scanner is still warmed to operating temperatures).

1.1.3.5. BWDO (Basis Weight Dynamic Offset)

Corrects for any change in the product in between the position that the sensor measures the product and the position where the sample is taken for dynamic correlation. An example of this would be if the sheet were under tension during the manufacturing process but was allowed to relax after taking a sheet as a dynamic sample. If the sheet stretched on line a dynamic offset would be added to account for this fact.

1.2. Features of the Source 12 Sensor

This section contains an explanation of the major features of the Source 12 Basis Weight Sensor. This explanation starts at the source capsule and continues through the chain of major Source 12 features.

1.2.1. Source body

A new source body is the most prominent feature of the Source 12 Basis Weight sensor. The receiver is based upon the Close Geometry Receiver used in Source 9. The source body holds a Promethium 147 radioisotope 'capsule' configured as an elongated line source, with the long axis aligned in the machine direction. The source body is designed specifically for the characteristics of Promethium, and is not appropriate for higher energy or gamma emitting radioisotopes such as Krypton-85 or Strontium-90.

A normally closed stainless steel shutter provides radiation protection. That is, the shutter is forced closed by a spring unless the linear pneumatic actuator over powers the spring to the open the shutter. The loss of either power or pneumatic (air) pressure will cause the spring to close the shutter. An orifice in the air line slows the action of the shutter to insure repeatable positioning and long life. All mechanical parts involved in shielding the radioactive capsule or connecting those shielding parts together are made from stainless steel for resistance to melting in case of fire. If the temperature exceeds a preset value a fire safety pin will activate, causing the shutter to close until the mechanism has been disassembled.

The shutter, while several times thicker than needed to stop the radiation from Pm, is much thinner than required for an isotope such as Krypton-85, allowing the source capsule to be located very close to the source head window. This minimizes the air gap and optimizes the geometry for delivering large numbers of beta particles to the receiver, ensuring an accurate, highly repeatable measurement.

1.2.2. Basis weight flags

Source 12 has the normal Honeywell flag, here called Flag1. Periodically, the sensor goes offsheet and measures the signal with just this Flag1 in the beam. This measurement is called reference or standardize. By comparing the current Flag1 reading to the reading at calibration, the sensor measures the dirt build up. A dirt correction is based on this standardize flag reading. (This method will attribute to dirt a change anything which has changed since last standardize, not just dirt build up on the windows.)

Source 12 has a second flag assembly. Both flags are activated by linear pneumatic actuators identical to the shutter's. The flags lie in separate planes both directly opposite the thick shutter. Because they are in separate planes, both flags can be inserted into the beam path simultaneously. In addition to the normal Honeywell three point standardization, this allows two point verification. These two points being Flag2 and Flag1 + Flag2. Source 12 software supports this new standardization in the following way: three point standardization provides the usual correction factors, which are then applied to evaluate the weights of Flag2 and Flag1 + Flag2. The combination of Flag1 and Flag2 is called Flag12 (flag one two). The weights of the flags should be constants since corrections have been applied for temperature, Z, dirt, new background, and air readings. The readout of the weights thus constitutes a true quality indicator which can be tracked over time. Differences in the weight readings from the weights at calibration time are referred to as Flag2 error and Flag12 error.

In order to maintain a consistent evaluation for the of Flag2 and Flag12 weights, there is a dedicated set of calibration coefficients used exclusively for flag weight calculations. They are indicated as FA0 - FA7 and FD0 - FD7. FAs are for the clean calibration curve while FDs are for the dirty curve. They are established at the factory using polyester samples, and are themselves made of polyester (Mylar), Flag1 being nominally .001 inch (.025 mm or Å32 gsm) and Flag2 .0005 inch (.013 mm or Å16 gsm), making the combination .0015 inch (.038 mm or Å48 gsm). The exact values are not very important, as the concern is any change in the flag weights, not their absolute values.

Calculating the weights of Flag2 and Flag12 is fundamentally different from the common but sometimes misleading practice of calculating the weight of the single flag (as in Source 6 and Source 9). Calculating the weight of the single flag is not as independent as measuring at another weight. This is because the dirt correction is based on the single flag ratio just as is the weight of the single flag. At this ratio, the nature of the dirt correction tends to compensate exactly, whether or not the correction is appropriate. Using a second flag, at a different weight and ratio, there is both statistical and systematic independence. Thus the Flag2 and Flag12 errors are much better quality indicators than the old style flag weight, and also far better than common attempts to use the F/A (Flag to Air) ratio as a quality indicator. The latter is true because the F/A ratio is, by design, the basis of a corrector, and therefore expected to change, much as the air gap temperatures will.

To allow for influences which can affect the sensor's reading in ways not corrected by the usual means, which would cause the flag weights (Flag2 and Flag12) to vary from their original values, the Source 12 software allows for a correction to be applied to subsequent on-line measurements. Designated as the Source 12 corrector, it can be calculated in four different ways to allow for maximum flexibility in real-world situations. The Source 12 corrector was coded to be as general as possible, so that the optimum algorithm could be easily implemented on site, based on experience. It also allows that different sites may have different influences requiring different approaches.

The default situation is to set the corrector to zero. The corrector can be determined from the error in the flag weights in either percentage terms or in absolute weight units (g/m^2), with arbitrary weighting of the two verification samples. This allows for correction of influences that are percentage or weight based. Finally, the corrector can be a function of weight, determined by a slope and intercept from the errors of the two samples, and this can be either percentage or weight based.

NOTE: It should be noted that at present the flag2 and flag12 results are used for diagnosis and performance monitoring only.

1.2.3. Air curtain

Source and receiver Air Curtains are another new feature in Source 12.

NOTE: The following discussion does not apply to paper application. For paper sensor heads, were the sheet speed is very large, it is preferable to use normal air wipes and sheet guide heaters and to measure the air gap temperatures using external air gap sensors. Air curtain temperature sensor correction should not be applied in software. The air flow to the air curtain should be reduced to zero. For continuous-web-solution (CWS) applications, the air curtain can stabilize air temperatures, eliminate the need for an air gap sensor and provide accurate temperature correction.

Each Air Curtain consists of an air manifold and window frame that replaces the customary window frame. The new frame has a series of holes located at 15 degree intervals through which air from the manifold flows outward into the gap, perpendicular to the window like a curtain. The window frame otherwise is similar to the previous style, and as such is replaceable. This allows for easy changes in the air flow pattern to accommodate special considerations in field applications. Typical flow rates are in the range of 2 - 3 CFM per head. The air curtain eliminates the need for external air wipes, and uses the same hose in the power track that is otherwise used by the external air wipes (the large rubber hose, .5 inch outside diameter and .25 inch diameter inside diameter). The standard air flow pattern has been tested on very thin films (down to 0.6

µm) and does not have any negative effects on the sheet at reasonable flow rates, even scanning on and off the edges repeatedly. At high flow rates, greater than 6 CFM total, a very light sheet can be pulled against one of the heads through the Coanda effect, so caution should be exercised in setting the flow with extremely thin films.

The function of the air curtain is the elimination of external temperature influences from the measuring gap. Because of the sensitivity of Promethium's low energy betas to light weights, uncertainty and fluctuations in the air gap temperature would otherwise limit the sensor's repeatability. The air curtain provides sufficient flow of air at a known and stable temperature to allow the sensor to achieve the desired accuracy. The temperature of the air is measured by a direct readout device in the air manifold, just before the air enters the gap, but after it has dropped to low pressure. No attempt is made to control the temperature, since this would introduce additional complexity, additional cost, and possibly precision limiting temperature gradients. It is without benefit under most circumstances, since one cannot control the temperature any better than one can measure it. Once it is measured the correction is quite straightforward, as it is based on the ideal gas law.

The air gap temperature is measured directly in the air manifold. Therefore, when the air curtain is used in CWS applications there is no need for the external air gap temperature sensors used in previous basis weight sensor designs. This simplifies and cleans up the head design externally, reduces the use of plant air (no vortex supply needed), and eliminates the need for thermister support circuitry. The software is also simplified since the temperature devices read out in voltage proportional to the temperature, for example, 250mV = 25 degree C. Perhaps the biggest benefit of direct readout is in system troubleshooting. All the temperatures related to Source 12 - air gaps, source air column, and head temperature, use the direct readout devices. There is no receiver air column temperature measurement, as there is very little space between the ion chamber window and the head window.

1.2.4. Calibration algorithm

The UniCal calibration algorithm has been extended from 4 to 8 coefficients (from 3rd order to 7th order). This allows for better fits, particularly when the fit is over a wide range. Thus it can help reduce the instances of breaking the fit into separate weight ranges. Since the sensor can measure reliably from 0 to over 250 gsm, the wide range capability can be quite useful. The extra coefficients should not be used unless there is an adequate number of data points to make the fit statistically meaningful. Using no more than one half the number of fit coefficients as there are data points at separate weights is generally a safe thing to do. Under some circumstances, depending on the pattern of behavior of the residual fit errors, somewhat fewer data points may be used.

Another new feature of the Source 12 software allows a standardization to be automatically performed whenever the temperature of either head has changed from the temperature at the last standardization by more than an amount set by the user. This prevents absolute measurement errors caused by temperature induced drift in electronic components. Since the heads are well insulated the temperatures tend to change only slowly, so the periodic standardization is both simpler and more predictable than the alternative of direct head temperature control.

2. Sensor Features

2.1. Versions

When ordering parts, or seeking help troubleshooting, you must know the correct sensor version or model number. Currently there are two versions of the Source 12 Basis Weight Sensor, -00 and -01. Their only difference is the radiation interlock PCB, which comes in two versions. This board is located on the source holder assembly and is visible by opening the Modular Head access cover. The following table describes where the two Source 12 versions are used:

Table 2-1 Source 12 Model Numbers

Model #	Version	Where Used
09420200	-00 Basis Weight Sensor, Line Source, PM147, LED Radiation Lights	Used on scanners with LED radiation warning lights (e.g. 2080)
09420201	-01 Basis Weight Sensor, Line Source, Pm 147, Incandescent Radiation Lights	Used on scanners with incandescent radiation warning lights (e.g. 204X, 2011, 2090, 2200)

2.2. Source 12 hardware

An understanding of the major hardware components and their functions is necessary for proper maintenance. The Source 12 Basis Weight Sensor hardware and its heads consists of the following:

- Source holder assembly containing the radioactive Promethium source capsule.
- Source head containing source holder, backplane, and source air curtain.
- Receiver assembly containing detector, amplifier, and integral air curtain.
- Receiver head containing receiver assembly (with integral air curtain) and backplane.

2.2.1. Source holder

Figure 1 is a view of the Source 12 Source Holder assembly. Major features are identified: aperture, shutter, source air column temperature measuring device, mechanical shutter indicator arm, mounting tabs, Source 12 Radiation Interlock PCB, fire safety pin, and blue cover. Underneath the blue aluminum cover are the air cylinders and solenoid actuators for the shutter and both flags as well, orifice restrictors , and plumbing hoses. Although some parts below this cover are field serviceable, CALL HONEYWELL RADIOLOGICAL OPERATIONS BEFORE REMOVING THIS COVER. There are NO field serviceable parts under the stainless steel side plates.

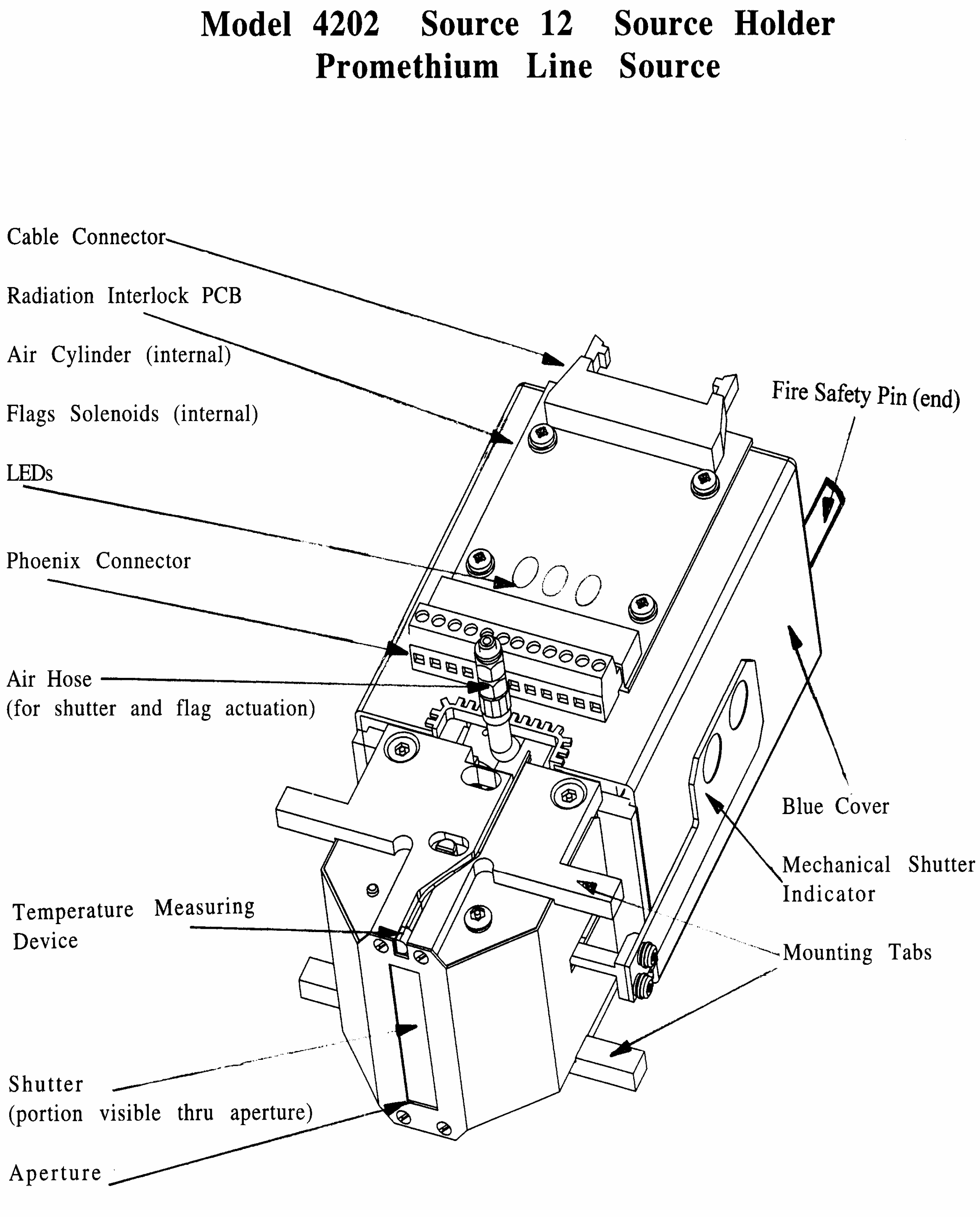


Figure 2-1 Major Features of Source 12 Source Holder Assembly

Note the mechanical shutter indicator is in the closed position, flag closest to the sheet.

The Source 12 Basis Weight Sensor hardware consists of the following parts:

2.2.1.1. Aperture and shutter

An important safety feature of the shutter mechanism requires the presence of both air pressure and electrical power to open. If either air pressure or electrical power is lost while open, the shutter will close.

The shutter opens by a chain of events: electrical, pneumatic, and finally mechanical. First, the computer closes a switch, sometimes referred to as making a contact output closure. This signal is sent to the head, through the source backplane and Source 12 radiation interlock board to the shutter solenoid. The energized solenoid then opens allowing pressurized air into the shutter air cylinder. When inflated, this air cylinder pulls on the shutter, which rotates open. Unless so pressurized the shutter is closed by the air cylinder's internal spring. This spring is an important shutter safety mechanism, forcing the shutter closed if electrical power or air pressure is lost.

Through the source capsule's rectangular window passes the beam of beta particles. The aperture is a rectangular hole in a stainless steel cover. This is close to the stationary source capsule and covers the capsule window and lower portions of two sides. When commanded to open, the shutter rotates away from its normal resting position between the aperture and the source capsule. This allows the beta particles out through the open aperture.

2.2.1.2. Side plates with mounting tabs

On two sides of the aperture cover are the side plates. These are attached with tamper resistant screws to prevent disassembly. As the source capsule holder is inside, it would pose a potential radiation safety hazard were these plates removed. Four rectangular stainless steel extend outward from the source holder assembly. These are sized 6 x 8 mm (1/4 x 5/16 inch) extending out about 19 mm (3/4 inch) from the source holder. These are the mounting tabs where the source body is clamped to the head, or safety cap. Three mounting blocks are used to hold the source holder in place (One tab is not accessible in the Modular Head).

2.2.1.3. Mechanical shutter arm

This arm indicates when the shutter is open or closed. It is also possible to open and close the shutter manually by this arm. When this arm is in its normal non-energized state, the position closest to the sheet, the shutter is closed. When away from the sheet, the shutter is open. Green and red sheet dots are on the indicator. In the 09203427 Modular Head option, there is a special head cover with a hole, so these dots are visible outside the head, green for shutter closed, red for shutter open.

2.2.1.4. Temperature measuring device

Temperature measurement is simplified in Source 12 compared to Source 6 and Source 9. Source 12 has five temperature measurements : Source column, Source backplane, Source air curtain, Receiver air curtain, and Receiver backplane. All Source 12 temperatures are measured by a direct readout temperature device. The voltage output of this device is linear with temperature. To convert to degrees Centigrade multiply the signal output voltage by 100 (For example, 220 mV is 22 C). This device looks very much like a transistor, having three pins extending out of a small plastic bead.

There is a separate maintenance procedure for replacement of the source air column temperature measurement device. Replacing this device requires removing the source body holder, and working close to the capsule. There is an assembly for easier field replacement, Honeywell part number 08672000, which contains the temperature device and three wires attached.

WARNING:	Only personnel qualified under radiation safety license and with clearance from Honeywell Radiological Operations are allowed to replace the temperature measuring device on the source body assembly (Source air column measurement).

2.2.1.5. Fire safety pin

The fire safety pin prevents accidental opening of the shutter after a fire. The design is much like previous fire safety pins. The actual pin has a new part number, but its working principles are the same as in the earlier version, solder holds a compressed spring. In case of high temperature from a fire, the solder melts releasing the spring which forces a pin down to close the shutter.

There is a separate maintenance procedure for replacement of the fire safety pin.

WARNING: Only personnel qualified under radiation safety license and with clearance from Honeywell Radiological Operations are allowed to replace the fire safety pin.

2.2.1.6. Source 12 radiation interlock PCB (054237XX)

The board mounts on the Source 12 source assembly. It provides termination for the ribbon cable to the backplane as well as providing termination to the solenoids, green light switches and for the source air column temperature measurement device. Beside these functions, the board's primary function is to provide radiation interlock.

Radiation interlock

The shutter and the flags are on the same plane. In theory, if the shutter were closed and the flag or flags actuated, they could push open the shutter permitting radiation to escape. The board prevents either flag air valve from receiving +24V when the shutter is not activated; lessening the chance of this fault condition.

Versions

There are two versions of the board -00 and -01; the difference is for the various radiation warning lamps employed. The -00 version requires low current to operate the shutter and is used with such scanners such as the 09208000 (those with LED radiation warning lights). The -01 version is designed to be placed in series with four incandescent red rad lamps such as the ones found in the 092040XX and 092106XX (those with incandescent radiation warning lights).

LEDs

A red LED illuminates when the shutter air valve receives power and amber LEDs are illuminated when the flag air valves receive power. These are clearly labeled 'SHTR' (shutter), 'FLAG1', and 'FLAG2'.

Fuse

A pico fuse, labeled 'F2', is in series with the shutter signal and a spare fuse is provided on the board. This spare is labeled 'F1 SPARE'. These fuses are inserted and not soldered.

2.2.2. Source head

The Source 12 head contains several parts besides the source holder: the source backplane, the air regulator, an air manifold, and the Z sensor (when the Z sensor option is used).

2.2.2.1. Source backplane (054238XX)

This board provides the following features: head-split interlock, head temperature measurement, Z-sensor support, over temperature cut-out and sheet guide heater support. The backplane contains 14 test points, besides being numbered and color coded (red for positive voltages, green for returns, white for signals) the test points' functions are clearly labeled.

Head-split interlock

The Source12 head has a magnetic (reed) switch mounted in the sheet guide and the Receiver12 has a magnet mounted opposite. When the heads are split, the reed switch opens. This switch is used to drive a relay. When the switch is closed, the relay is closed which permits the computer to drive the shutter. When the switch is open the relay is open which not only breaks the line from the computer, but pulls the line going to the shutter high, preventing the shutter from opening. An amber LED provides the status of the switch. It is lit when the heads are not split (switch closed). Silk-screened on the backplane is 'HEADS NOT SPLIT = ON'. This feature permitted the removal of the head-in-place switches and met the requirements for head-split when used on the IsoTherm scanner.

Head temperature measurement

A direct readout temperature device is mounted on the board to provide head temperature status. This device provides linearized centigrade measurement. For example, .257V = 25.7°C.

Z-sensor support

A connector is provided to install the optional Z-sensor. A 24 VDC to ±15V DC converter mounted on the board provides power for it. This converter also provides power for the head temperature sensor.

Over temperature cut-out

An over temperature cutout device opens the +24 VDC electrical line when the temperature in the head exceeds 165 - 170°F. This is to protect the electronics should an over temp. condition occur.

Sheet guide heater support

A terminal block is provided for connection of the sheet guide heaters should they be installed and required on the head.

Connections

There are four connectors and four term blocks on the backplane. All connectors are keyed so it is impossible to invert the cable. With the exception of two 2-pin green Phoenix connectors, the remaining connections are all different sizes so it is not possible to interchange the connectors.

To connect the sensor to the head, there are two ribbon cable connectors, J1 and J2, 40 pins and 10 pins respectively. J3 is the 20 pin edge connector for the Z sensor board. J4 is the 26 pin connector for the ribbon cable to the source holder

Test points

There are 14 test points on the backplane. These allow easy access to measure electrical signals. As a further aid for trouble shooting the test points are labeled as follows:

Table 2-2 Source Backplane Test Points

Source 12 Source Backplane Test Points (054238XX)		
Label	**TP #**	**Color**
+24V Sol	1	Red
24VS RTN	2	Green
+24V ELECT	3	Red
24VE RTN	4	Green
SX COL TEMP #1	5	White
SX COL TEMP RTN #1	6	Green
SX COL TEMP #2 (Not Used)*	7	White
HEAD TEMP	8	White
-15V	9	Black
15VRTN	10	Green
+15V	11	Red
AIR CURTAIN TEMP	12	Green
Z	13	White
Z RTN	14	Green

*There is no #2 Sx col temp, therefore test point 7 not used.

2.2.2.2. Regulator

Although the regulator is mechanically attached to the manifold for the air curtain, the air curtain and shutter pneumatic lines are separate. The regulator is on the air line to the shutter solenoid. It prevents a high pressure surge on the supply air line from reaching the air cylinder.

2.2.2.3. Manifold and hoses

There are several hoses to supply steady air flow. These hoses must not to be kinked or twisted so as to block the air flow. The large air hose supplies the air curtain manifold with a ample flow of air. The manifold distributes the air evenly to the four smaller hoses which go to the air curtain. To help ensure equal flow these four hoses are of equal length. Swivel fittings on the manifold allows the fittings and hoses to rotate when assembling.

2.2.2.4. Source air curtain

The source air curtain is a separate assembly from the source holder assembly. This air curtain contains a temperature measuring device, contained in assembly Honeywell part number 08659900. As with all temperature measurements on the Source 12, the voltage output of this device is linear with temperature.

Externally there is a ring with holes. This ring hold the 3.75 inch diameter conductive windows, Honeywell part number 00462200. (The silver-colored side is mounted outwards.) The pattern of the holes allow uniform air flow. This air management is a major feature of the Source 12.

2.2.3. Receiver assembly

The receiver assembly consists of a compensator, the ion chamber detector, the amplifier card with jumper selectable gain, and an integral air curtain.

The ion chamber is the same as used on the earlier Source 9 Promethium Basis Weight sensors.

The detector amplifier card uses a 20 Meg ohm resistor. The gain is changed by soldering jumpers. See the schematic for the particular board used for gains and their jumper connections.

The air curtain is a major design improvement. Its purpose is to control the air temperature in the gap and stabilize the sheet. In order to accomplish both objectives, the air flow must be uniform. Feeding the integral air curtain are four 6 mm (1/4 inch) outside diameter air lines. These are the same length to help equalize air flow to the air plenum. If any hose is replaced, be certain to use the same length as the other three hoses.

2.2.4. Receiver head

The receiver head contains the receiver assembly, a backplane, and a manifold for the air curtain.

2.2.4.1. Receiver assembly (086561XX)

The receiver assembly used in Source 12 is the same as the Close Geometry Receiver assembly used in Promethium Source 9 basis weight sensors. This receiver has the following tests points. The board with these test points, 053239XX, is sometimes referred to as the 'Nevada' board because its shape is similar to that of Nevada.

Table 2-3 Receiver Assy Backplane Test pts 053239XX (Nevada PCB)

Tests Points 053239XX Receiver Assembly Backplane (Nevada board)	
TP #	**Label**
1	RTN
2	+24
3	RCVR RTN
4	+12
5	-12
6	-350
7	BW (Basis weight signal)
8	T1 (Not Used)
9	T2 (Not Used)

2.2.4.2. Source 12 receiver backplane (054247XX)

The board is designed to be mounted in the modular head and provides termination between the cable that connects to the ion chamber assembly and the cable that connects to the 41 position military connector on the modular head.

Features

Aside from the above mentioned function, the board provides the following features: Head temperature measurement, over temperature cut-out and sheet guide heater support.

Head temperature measurement

A LM35 direct readout temperature device is mounted on the board to provide head temperature status. This device provides linearized centigrade measurement. For example, .257V = 25.7°C.

Over temperature cut-out

A over temperature cutout device opens the +24 VDC electrical line when the temperature in the head exceeds 165 - 170 °F. This is to protect the electronics should an over temp. condition occur.

Sheet guide heater support

A terminal block is provided for connection of the sheet guide heaters should they be installed on the head.

Test points

The following test points are provided:

Table 2-4 Source 12 Receiver Backplane Test pts (054247XX)

Source 12 Receiver Backplane Test Points (054247XX)		
Label	**TP #**	**Color**
+24 V S(Solenoid)	1	RED
24V RTN	2	BLACK
+24 V E(Electric)	3	RED
24VE RTN	4	BLACK
RX IN PLACE IN	5	WHITE
RX IN PLACE OUT	6	WHITE
+12V	7	RED
HEAD TEMP	8	WHITE
12V RTN/TEMP RTN	9	GREEN
AIR GAP TEMP	10	WHITE
BW	11	WHITE

Source 12 Receiver Backplane Test Points (054247XX)		
Label	**TP #**	**Color**
BW RTN	12	GREEN
RX COL TEMP (not used)	13	WHITE
AIR CURTAIN TEMP	14	WHITE

There is a manifold for the receiver air curtain just as there is for the source. These are the same design. The receiver manifold however, does not have a regulator attached.

2.3. Differences between sources 6, 9, and 12

Table 2-5 summarizes hardware differences between Sources 6, 9, and 12. This table is provided primarily for those already familiar with earlier Honeywell basis weight sensors, to speed their understanding of Source 12 (This chart is a discussion of sensors and not their related heads).

Table 2-5 Differences between Source 6, Source 9, Source12

	Source 6	**Source 9**	**Source 12**
Radionuclides	Kr-85, Sr-90, Am-241, (Pm-147 obsolete)	Kr-85, Pm-147	Pm-147 only
Source Capsule/ Beam Spot	Round disk	Round disk	Rectangular line
Air Curtain	None	None	Internal to both source and receiver heads.
Flags	1	1	2
Shutter Actuator	Electric solenoid	Pneumatic capsule rotator	Linear pneumatic
Flag Actuator	Electric solenoid	Electric solenoid	Linear pneumatic
Air Supply (head internal)	None	1 line for shutter (1/4 inch OD) 45 ± 5 psi	1 line for shutter, flags (1/4 inch OD) 45 ± 5 psi 2 for air curtain :1 Sx , 1 Rx. (1/2 inch OD)

	Source 6	Source 9	Source 12
Green light switches (Sense shutter closed)	1	2	2
Temperatures Measured	Sx air column Rx air column	Sx air column Upper and lower air gap (External to head)	Sx air column Air curtain (Sx and Rx) Head temperatures (Sx and Rx[2]
Temperature Algorithms	Various non linear thermisters	Various non linear thermisters	1 linear algorithm 100* Volts = Degrees C
Source Window	3.46 inch diameter	3.46 inch diameter	4.75 inch diameter
Receiver Window	3.46 inch diameter	4.75 inch diameter	4.75 inch diameter
Interlocks	Rx assembly position switch[3]	Rx assembly position switch[4]	Rx assembly position switch Head separation magnetic switch[5]

2.4. Correctors

2.4.1. General

An understanding of correctors is vital for obtaining best sensor performance. It is important to understand the magnitudes of the various correctors. The correctors are all displayed in absolute values (that is, not as ratios) and typically in customer basis weight units. When an operating sensor gives questionable results, you need to know nominal corrector values so you can compare them with the current values, to help determine what area to troubleshoot.

The physical basis of the correctors will be explained in this section. There are two general approaches to handle external influences on the sensor: one is to design the hardware to minimize the effect of the external

[2] Head temperatures measured on backplanes, which reports to the head assembly.
[3] Head position interlock external to modular head.
[4] Head position interlock external to modular head. Often mounted in Rigel heads which have magnetic separation.
[5] Magnet and switch mounted in modular head. Logic on source backplane.

influence on the sensor, the other is to measure the quantity doing the influencing and make a correction in software. Both approaches, individually and in combination, are used. Ash in the sheet is an example of the first, air temperature is an example of the second and X-Y head alignment sensitivity is an example of both approaches being used.

2.4.2. Source 12

To allow for influences that can affect the sensor's reading in ways not corrected by the usual means, and that would cause the flag weights to vary from their original values, the Source 12 system software allows for a correction to be applied to subsequent online measurements. Designated as the Source 12 corrector, it can be calculated in four different ways to allow for maximum flexibility in real-world situations. The Source 12 corrector was coded to be as general as possible, so that the optimum algorithm could be easily implemented on site, based on experience. It also allows for the fact that different sites may have different influences requiring different approaches.

The default situation is to set the corrector to zero. The corrector can be determined from the error in the flag weights in either percentage terms or in absolute weight units (g/m^2), with arbitrary weighting of the two verification samples. This allows for correction of influences that are percentage or weight based. Finally, the corrector can be a function of weight, determined by a slope and intercept from the errors of the two samples, and this can be either percentage or weight based.

2.4.3. Ash

Basis Weight sensors using beta ray attenuation are inherently sensitive to higher atomic number additives (ash). This sensitivity may be reduced significantly by the design of the compensator. However reducing this sensitivity in general has other effects on the sensor such as changing the usable basis weight range and sensor repeatability so that the sensor family has a model which is optimized for the parameters of a particular product.

Sensitivity to ash is commonly expressed as the percentage measured basis weight change for a 1% change in ash loading.

The ideal sensor would have a sensitivity to ash of 0%/1% change in ash. In other words, ash would have absorption characteristics exactly like that of paper (no change from paper). Insensitivity to ash is a key attribute of the sensor in order to have a single grade group for all products. There is no correction made in software for ash.

2.4.4. Dirt

Dirt as used here means any change in mass between the source and receiver from one standardization to the next. Examples are: debris on the source or receiver window, change in air density due to air temperature or pressure changes, and change in window mass due to window replacement. It is important to understand that changes in air temperature between standardizations (on-sheet) are handled by means of the air temperature correction, not the dirt correction. Updating the air counts will make a linear dirt correction but this still leaves non-linear dirt effects. These nonlinearities can be quite large, and are handled by a Honeywell patented dirt correction technique.

A quantity called DFRAC (Dirt Fraction) is computed at each Standardize/Reference and it depends on: the F/Alast, T0FA and T0CF. DFRAC is multiplied by the (dirty-clean) curve computed at the now ratio to form an additive dirt correction in gsm. The best way to understand DFRAC is through an example.

If F/A_{last} = T0FA then DFRAC = 0.0

If F/A_{last} = (T0FA +T0CF) then DFRAC = 1.0

Note that T0FA + T0CF = F/A_{dirty}
and that T0FA = F/A_{clean}
where $F/A_{dirty} \equiv$ reference at calibration time with dirt (Mylar)

2.4.5. Air temperature

Beta particles are absorbed by the air just as they are by the web, so that as the basis weight of the air between the source and receiver changes, the beta absorption will change also. It is a convenient rule of thumb that one inch of air (25.4 millimeters) at standard temperature and pressure has a basis weight of 32 gsm. Air density effects due to air temperature changes are one of the principal sources of potential error in the basis weight sensor, particularly for lighter weight sheets, so this is a very important correction. According to the Ideal Gas Law, the change in basis weight of an air column is proportional to

$[1/T_{initial} - 1/T_{final}]$

where temperature is expressed in

degrees Kelvin = degrees C + 273.

The air temperature correction for each air column is expressed as

$AGAn * [1/T_{Stdz} - 1/T_{Now}]$

where

AGAn is a calibration constant.

Thus it is necessary to measure the air temperature in each zone between the source and receiver where the air temperature may change in order to make a correction. The air temperature corrections for each zone are added together to give the total correction, which is an additive correction with units of gsm. The AGAn values for each sensor type are specified in the Calibration Specification and are entered with the calibration constants.

2.4.6. Z head displacement

Head displacement in the Z-direction changes basis weight readings primarily due to the change in the mass of air between the heads. Correcting for Z is similar to correcting for air temperature changes. In both cases, a real time correction is calculated based on the differences from the last standardize to the current value. Unlike the air temperature, the Z sensor is optional. CFZ is the Z correction calibration constant that is entered at calibration. The Z correction is an additive correction with the units of gsm.

2.4.7. X-Y head displacement (profile correction)

Basis Weight Sensors are inherently sensitive to relative head displacements in the X-Y directions (CD-MD). To correct for any remaining sensitivity we use Profile Correction. The profile correction is an additive correction with units of gsm.

For optimal Source 12 performance, it is very important to properly build the profile correction arrays. It is important to build the correction on a light weight sample in the gap, not an internal flag. The flag is not in the same plane as the sample, therefore it has different X-Y sensitivity. It is also very important to build the profile correction arrays with a total of at least four seconds integration per CD resolution (correction profile CD resolution). This is to reduce the nuclear noise. For example if the sheet is 100 inches wide with 0.5 inch minislices scanning at 5 inch per second, 40 scans would be required for 4 seconds per minislice. This is when smoothing is not available. With smoothing, the time required to build is less.

2.4.8. Sheet passline variations

Basis Weight Sensors are inherently sensitive to relative sheet displacements in the Z direction, commonly known as passline sensitivity or flutter sensitivity. The compensator greatly reduces this sensitivity. Different models of basis weight sensors have different residual sensitivities to flutter. Moreover, for a given model of basis weight sensor the sensitivity to passline is generally basis weight dependent. There is no software correction for sheet passline changes.

2.4.9. KCM

Although beta particles are relatively insensitive to anything other than the basis weight of the sheet, there may be slight differences in beta absorption between the calibration standard and the customer product. During calibration a quantity called KCM is determined for each grade of product. KCM determines the offset of the customer product (paper, plastic, and so on) calibration relative to the calibration standard (Mylar).

2.4.10. Dynamic offset

The dynamic offset, BWDO, corrects for differences between static and on sheet conditions. This offset is only used onsheet (not at sample) and accounts for effects such as moisture flash-off and sheet stretch. That is, effects where the basis weight of the sheet at the scanner is physically different from that as measured at the mill lab. BWDO should not be changed just because a dynamic check does not agree with a measurement but should be used as a last resort when it is clear that the sensor and all corrections are reading properly.

3. Maintenance and Troubleshooting

3.1. Tools

- Digital Volt Meter (at least 3 1/2 digits i.e. 1.999)
- Hex Drivers with ball ends (Imperial units, that is, inches)
- Personal Computer with spreadsheet and graphics programs (very helpful but not required)
- Calculator (a calculator that can calculate standard deviations is very helpful)
- Calibration sample set
- Sample paddle
- Transfer sample set
- Log book

3.2. General preventive maintenance

Periodically performed preventive maintenance avoids many failures and prevents small problems growing larger. Table 3-1 is an initial preventive maintenance schedule. With experience, you may want to make your own additions.

3.3. Preventive maintenance schedule

Table 3-1 Preventive Maintenance Schedule

Action	Weekly	Monthly	Semi Annually
Log: Flag counts, Air counts, Background counts, F/A ratio, Flag (1+2) Weight, Flag 2 Weight, Upper and Lower Head Temperatures, Upper and Lower Air Temperatures, Source Temperature from Standardize print-out. A good way to do this is to average 5 consecutive readings each day and enter into a spreadsheet and then plot the data. (See graph next page.)	X		
Keep one Standardize print-out/week as a log.	X		
Take note of and keep one daily sensor report	X		
Perform dynamic check and record result in log book.	X		
Read transfer samples using sample paddle. Do both clean and dirty readings to check calibration and dirt correction. Plot percent deviation from nominal for each sample as a function of time as shown on following graph.	X		
Make a copy of Status Frame and Frame containing calibration data and place in log book. Compare to last values.		X	
Visual inspection of windows (be sure there are no tears and that aluminized side is facing out toward the gap). The actual frequency that this needs to be done is site dependent so adjust accordingly.		X	
Have six month radiation tests performed by licensed individual.			X

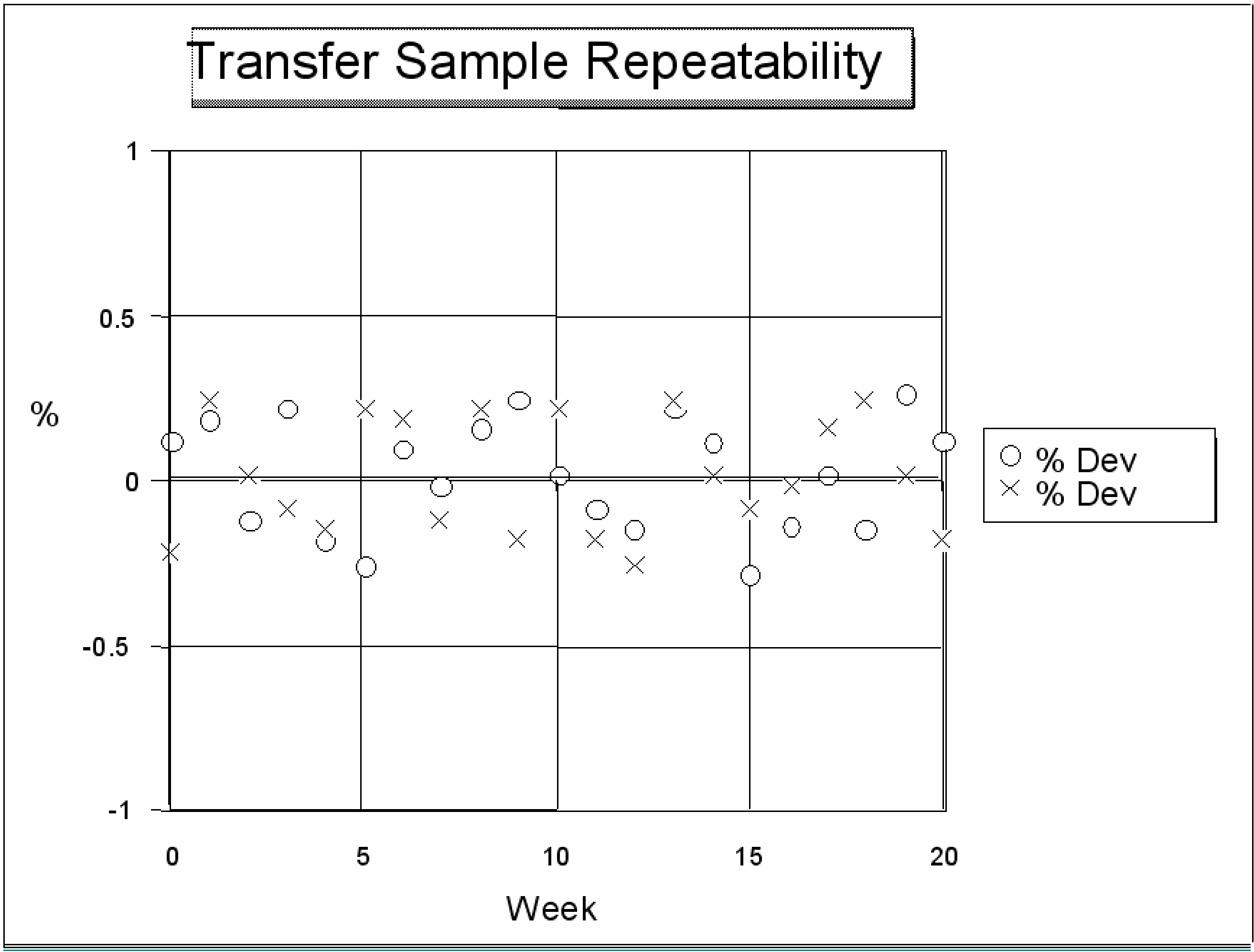


Figure 3-1 Example Data Weekly Plotting a Single Transfer

Graphing transfer sample readings each week helps identify long term trends. By graphing, long term trends can be differentiated from short term statistical variations. For example, if the only data recorded were from weeks 5 and 15, then the clean reading of week 19 would appear too high, with more data this point is revealed as just part of the normal statistical fluctuation, which does not require any calibration change.

3.4. Troubleshooting

3.4.1. Basic guidelines

These basic guidelines are provided for both beginning and experienced service personnel. While they are a refresher for the experienced, a wise beginner will follow this list until they become automatic.

Some basic troubleshooting actions are:

- Isolate the problem to: source, receiver, wiring, VFC/counter - ADC, or software, for example, calibration constants. (Narrow the problem location to a more and more specific location.)
- Use standardize values to plot information to help diagnose problem.
- Refer to log book data taken during Preventive Maintenance.
- Record in a log book, dedicated to the system, all malfunctions and actions (including data base changes to calibration constants, all hardware changes...) for future reference.
- If time or sensor access allow, make only one change at a time.
- Remember Jansen's Law: 85% of all problems can be found by a visual inspection.

3.4.2. Troubleshooting guide

There are radiation safety concerns for anyone who works on this sensor. These concerns cannot all be adequately addressed here. Consult the Honeywell Radiation Safety Manual (6510020199), or, within the United States, the Radiation Safety Manual for Customers (6510020197) for detailed information.

Some procedures referred to in this manual may only be performed by appropriately licensed persons. Such procedures and permission to perform them must be obtained directly from the Honeywell Radiological Operations.

Table 3-2 Troubleshooting Guide

Symptom	Probable Cause(s)	Solution
Low or no on-sheet, sample, flag or air counts		
	1. Not enough pressure at pneumatic actuator	1. Check pressure at source body and adjust supply regulator or look for air leaks (especially at hose to actuator)
	2. Fire safety pin has partially or fully mistakenly activated	2. Contact Honeywell Radiological Operations
	3. Red light bulb has burned out	3. Replace light bulb
	4. Red light circuit logic PCB malfunctions or blown fuses	4. Replace fuses, if problem persists replace board. Check connections for shorts.
	5. Pneumatic solenoid valve in source	5. Check valve by removing exit hose and listening or feeling for air
	6. Orifice at inlet of pneumatic actuator in source is plugged	6. Contact Honeywell Radiological Operations for orifice cleaning or replacement procedure (IMPORTANT: always replace with an identical orifice from spare parts since size of hole is critical to operation)
	7. Water or debris on inside or outside of head window	7. Visually inspect and clean
	8. Excessive friction in bearing	8. Contact Honeywell Radiological Operations
	9. Leaking pneumatic gasket or O-rings. Note that a small leak down stream of the regulator can disable source from operating since the source has high pneumatic input impedance	9. Contact Honeywell Radiological Operations
	10. Corrosion on actuator shaft.	10. Contact Honeywell Radiological Operations
	11. Something external to pneumatic actuator is catching on rotating pin	11. Visual inspection of pneumatic actuator
	12. Pressure regulator in source head malfunctions	12. Replace
	13. Actuator fails	13. Try to move manually, call Radiological Operations to receive instructions for replacement
	14. Internal stops	14. Call Engineering to receive instructions
	15. Ion chamber leak, symptoms are a decrease in air and flag counts but an increase in F/A	15. Replace ion chamber
Background counts drifting or noisy		
	1. Bad ground	1. Check all grounds, VFC and Q-counter

Symptom	Probable Cause(s)	Solution
	2. If background counts follow head temperature where the counts go down as the head temperature goes up	2. Replace detector amp.
	3. Problem is either a bad detector amp or dirty insulator on ion chamber.	3. Replace them one at a time.
Drifting or noisy air, flag or F/A ratio Note: the F/A is supposed to vary during on-line conditions since this is how the dirt correction is made. The questions is whether the excess variation is caused by the environment, in which case nothing should be done, or is caused by a faulty component, in which case something needs to be done.		
	1. Test under stable environmental conditions. Run several sets of 30 F/A stability tests with mill off for long enough to be cool. If F/A values meet or nearly meet lab stability spec, cause is likely to be an environmental one rather than due to a sensor component malfunction.	1. If F/A meets specification under stable thermal conditions, system is probably behaving properly
	2. Check 24 VDC at sensor head not at bay power supply. (Significant voltage drops can and do occur between head and bay). Also check receiver test points.	2. Adjust or replace 24 VDC power supply, take appropriate action if test points do no measure satisfactorily.
	3. Check for extraneous material on window, or broken window.	3. Replace or repair as necessary
	4. F/A ratio drifting such that as the air counts go down and the F/A goes up	4. Replace leaky ion chamber.

Table 3-3 Source-Receiver Testing

Component	Function	Power Req's	Test Points	Failure Modes
Source				
Hoses on body 1. Head-to-regulator 2. Regulator-to-source assembly	Pressurized air transport	N/A	Visually inspect for contamination (oil, bits of rubber, etc.)	1. May come loose 2. May clog

Component	Function	Power Req's	Test Points	Failure Modes
Source				
Flag/ Flag solenoid	Rotate flag (internal standard) into inserted or retracted positions	20 – 26 VDC		1. Flag may tear 2. Flag may become bent and jam 3. Solenoid can overheat and jam
Fire safety pin	Forces capsule to retract in event of high temperature condition	Activated by temperatures exceeding 500 degrees F	Visually see if rod is still attached to housing by solder. Try to move actuator with source in head by manually lifting and lowering mechanical indicator flag	1. May creep (slowly move under pressure) 2. May inadvertently activate
Temperature measuring device for source air column (is located near aperture)	Measure the air temperature in the air space between the source capsule and the head window	5-24 VDC	Backplane TP5-TP6 Interlock TB2 11,10 ϒC=100*volts accuracy ±0.25 ºC at 25ºC ±0.75 ºC-55to150C	Physical damage
Green light switches (2)	These switches are in series and provide a positive indication that the capsule has been closed	None	NO contact/COM contact: measure continuity when power is off (shutter closed)	

Component	Function	Power Req's	Test Points	Failure Modes
Receiver				
High Voltage Bias Supply	Provides -350 VDC ion chamber bias.	On detector back-plane.	Output voltage goes to nearly zero volts is most common failure mode	Check test points on receiver backplane. The ion chamber output is rather insensitive to changes of a few volts of bias although in general bias voltage is stable to within a volt.

Component	Function	Power Req's	Test Points	Failure Modes
Receiver				
Ion Chamber	Converts beta flux to current for conversion in detector amplifier	none	1. Gas leak: Output voltage will go down and flag and sample ratios will go up. 2. Insulator around center post exit becomes dirty and provides a variable leakage path across ion chamber bias which results in drifting background. 3. Intermittent short between ion chamber and housing. This can induce a down going spike in sensor output. 4. Loose leads	1. Refer to Preventive Maintenance graphs of F/A and sample ratios and air and flag counts versus time. 2. Refer to Preventive Maintenance graphs of background counts versus time. 3. Physical inspection of ion chamber and casting. Look for metal labels peeling off, debris or casting burrs. 4. Physical inspection of ion chamber and casting.
Detector Amplifier	Convert small current from ion chamber to voltage	none	1. Offset (Background) voltage wanders 2. Thermal drift of amplifier 3. Damage to wire that connects to Ion Chamber	1. Monitor background counts (should be .010-.020 VDC) and check ±12 VDC 2. Monitor head temperatures 3. Visual inspection
Receiver Power Supply Temperature PCB	24 VDC to ±12 VDC and provide processing for receiver air column (if available)	±12 VDC on receiver backplane	±12 VDC output bad	±12 VDC output on receiver backplane

Component	Function	Power Req's	Test Points	Failure Modes
Source and Receiver				
Windows	Protect sensor	Visual inspection Monitor air and flag counts and F/A.	Window Breaks	1. Visual inspection 2. Monitor air and flag counts and F/A. 3. Replace window if broken
Air Curtain Direct Readout Temperature Devices	Measure air curtain temperature	Status Frame air gap temperatures Air gap temperature print-outs at standardize Test points on backplanes	Direct readout temperature device breaks	Status Frame air gap temperatures indicate very low reading Air gap temperature print-outs at standardization
24 VDC Power	Provide head power	Test points in source and receiver heads	1. Voltage too low at head due to IR drop in line 2. Noisy 24 VDC power at head	1. Always monitor voltage at head and be sure it is 24-26 VDC 2. Verify with scope noise at head on 24 VDC
Cooling (details differ from type head to the next)	1. Provides head cooling 2. Provides stable temperature environment for electronics, particularly important for the high voltage power supply and the detector amplifier.	Monitor head temperature print-out at standardize	1. Cooling lines clog reducing the flow 2. Coolant flow shut-off	1. Monitor head temperature print-out at standardization 2. Check coolant circuit, valves, etc.

4. Installation and Checkout

4.1. Installation service requirements

Installing the Source 12 basis weight requires setting two air regulators in addition to the normal head mechanical and electrical connections. System hardware requirements are:

- Air curtain air 4 to 6 SCFM.
- Shutter air 45 ± 5 psi, very little flow.
- +24 volts DC electrical power less than 1 amp.
- 3 contact outputs, shutter and two flags.

4.2. Accessory kits required to support the sensor

- 09716500 Air Regulator and Flow Meter, 20-200 SCFH required for air supply to source actuator. Use Qty 1 per sensor
- 09716501 Air Regulator and Flow Meter, 1-10 SCFM required for air supply to air curtains. Use Qty 1 per sensor