Extensional Stiffness Measurement

System Manual

6510020357 Rev 01

ESS Measurement

September, 2012

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Introduction

Paper mills have a vested interest in quantifying and controlling the strength of their product. One of the main drawbacks of conventional paper production is that strength is measured in a lab after the reel is built.

The operator has no real-time view of how different aspects of the paper-making process are affecting strength. To compensate, the mill will over-build the reel to ensure it meets end-user strength specifications.

While this strategy limits the amount of product culled, it also results in higher production costs. In addition, lack of real-time strength data limits the operator's ability to address runability issues on the machine.

The goal of the Extensional Stiffness Measurement is to provide real-time strength information to the operator to build a higher quality sheet at a lower cost.

This manual explains the operation of the Experion MX Model Q4225-60 Extensional Stiffness Measurement Sensor (ESS).

ATTENTION

NOTE: All references to ESS in this manual are to Experion MX Extensional Stiffness Measurement Sensor Model Q4225-60, unless otherwise specified.

Audience

This manual is intended for use by Honeywell field personnel. It assumes a basic understanding of mechanical, electrical, and computer software related to the Honeywell QCS system.

About This Manual

This manual contains these chapters :

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

Chapter 2, **System Components,** describes ESS Measurement System components.

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

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

Chapter 5, **Operations,** describes signals, modes of operation, and standardize and scanning operations.

Chapter 6, **Dynamic Calibration,** describes the process of dynamic calibration.

Chapter 7, **Preventive Maintenance,** describes a schedule for recommended ongoing maintenance tasks.

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

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

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

Chapter 11, **Acronyms,** provides an explanation of acronyms used in the manual.

Appendix A, **Default Values of Database Contents,** provides explicit tables of all the software variables related to the ESS, and their default values for installation.

Appendix B, **Part Numbers**, lists current part numbers for parts and spares.

Conventions

The following conventions are used in this manual:

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

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

CAUTION — The caution icon appears beside a note box containing information that cautions you about potential equipment or material damage.

WARNING — The warning icon appears beside a note box containing information that warns you about potential bodily harm or catastrophic equipment damage.

1. Sensor Overview

1.1. Extensional stiffness and strength

1.1.1. Introduction

The Extensional Stiffness Measurement Sensor (ESS) provides the following real-time *elastic* strength measurements:

- MD tensile stiffness
- MD tensile stiffness index (TSI_{MD})
- CD tensile stiffness
- CD tensile stiffness index (TSI_{CD})
- MD/CD stiffness ratio

1.1.2. Strength measurement elastic versus destructive

Paper has two regimes when stretched.

- The first regime is *elastic* in that the product will return to its' original state when the stretching force has been removed.
- The second regime is when the stretching force is strong enough that the paper does not return to its' original state afterwards, but instead incurs permanent damage (but does not break). This is known as the *inelastic* regime.

When the stretching force continues to increase within this inelastic regime, the paper will eventually break. Due to the fact that ESS is an online measurement tool, it operates within the elastic regime and does not cause any damage to the sheet.

1.1.3. Extensional stiffness laboratory

Extensional Stiffness is defined as the force per unit width (stress) required to give a fractional increase in length (strain). In the laboratory, Extensional Stiffness is measured by stretching a thin strip of material in a tensile tester and measuring the force of resistance.

The force per unit width increases linearly with strain and then rises less quickly as the material passes its elastic limit and permanently deforms. The Extensional Stiffness of paper is directly proportional to the slope of the linear part of the response curve. The typical units for extensional stiffness are kN/m.

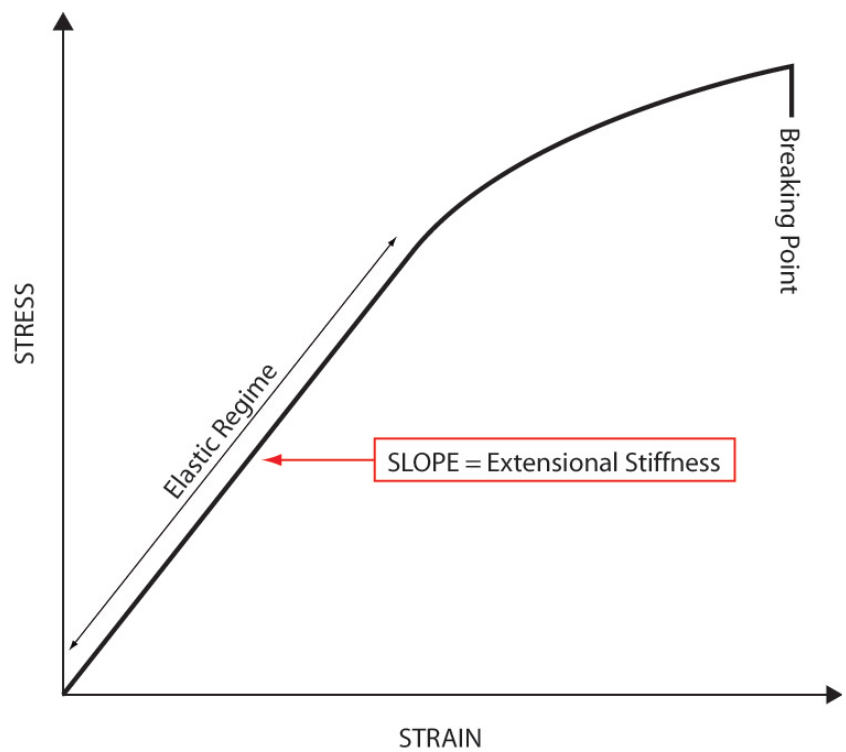


Figure 1-1 Stress-Strain Curve

1.1.4. Extensional stiffness electro mechanics

The ESS re-creates this elastic stretching motion online by means of a freely-rotating wheel in the lower head that pushes upwards on the moving paper sheet. The sheet is stretched inside a transducer cavity that has been divided into four segments. Each segment, or quadrant, of the ring is mounted on a load-cell that measures the force in which the sheet resists stretch.

The MD load-cells are in line with the sheet motion and produce signals that are added to give the total MD force. The CD load-cells are in line with the cross-sheet direction and provide signals that are added to give the total CD force. A displacement sensor, the Z-sensor, is used to measure the wheel position and corresponding sheet deflection and stretch. The force measurements from the MD and CD load-cells are combined with the sheet stretch to calculate Extensional Stiffness.

The ESS does not measure a complete stress-strain curve like that shown in Figure 1-1. The ESS measures two points in the elastic region of the curve in order to determine slope and subsequent paper stiffness.

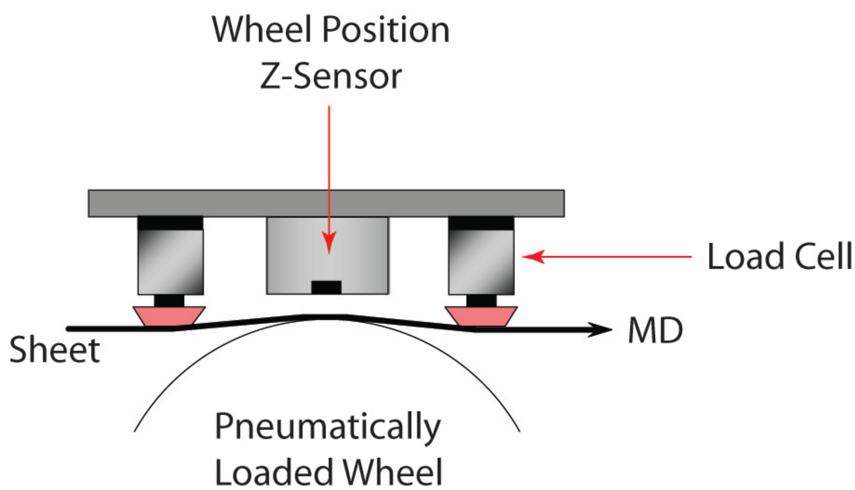


Figure 1-2 Sheet Deflection by Pneumatically Loaded Wheel

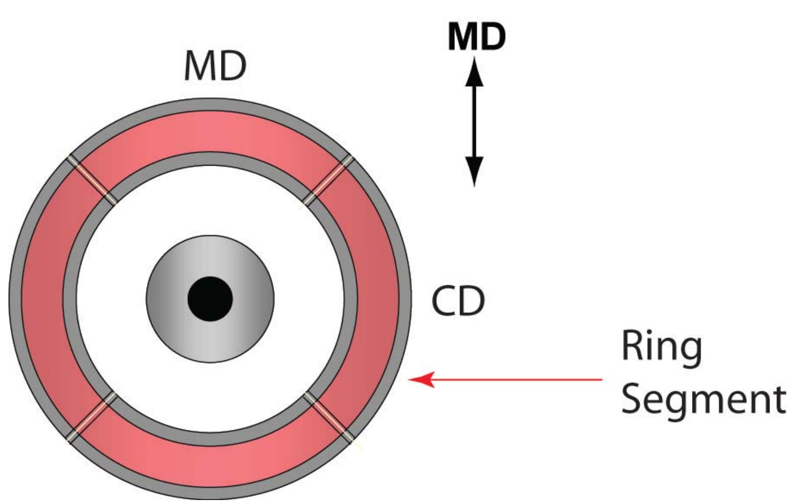


Figure 1-3 Transducer Cavity (View from Lower Head)

1.1.5. Tension correction

The force measured by the MD and CD load cells is actually the sum of three force components that must be separated in order to calculate Extensional Stiffness. These three components of force are:

- Extensional Stiffness
- Sheet tension produced by the paper machine drive
- Bending stiffness

The Extensional Stiffness force has a stronger dependence on the sheet deflection than do the tension and bending stiffness forces (which are linearly dependent on deflection). These differences allow for the separate calculation of Extensional Stiffness.

The sheet is pushed to a deflection point where the Extensional Stiffness dominates the measurement. Then the sheet is pushed to a smaller deflection where each of the forces is roughly the same magnitude. This is accomplished by mounting the wheel slightly off center-axis creating a 1.5mm change in height per revolution.

The force measurements at the two deflection points are compared, and the linear forces are subtracted out, leaving the Extensional Stiffness force. In many grades of paper, the bending stiffness is a negligible consideration. The calculation to obtain the Extensional Stiffness is called *tension correction*.

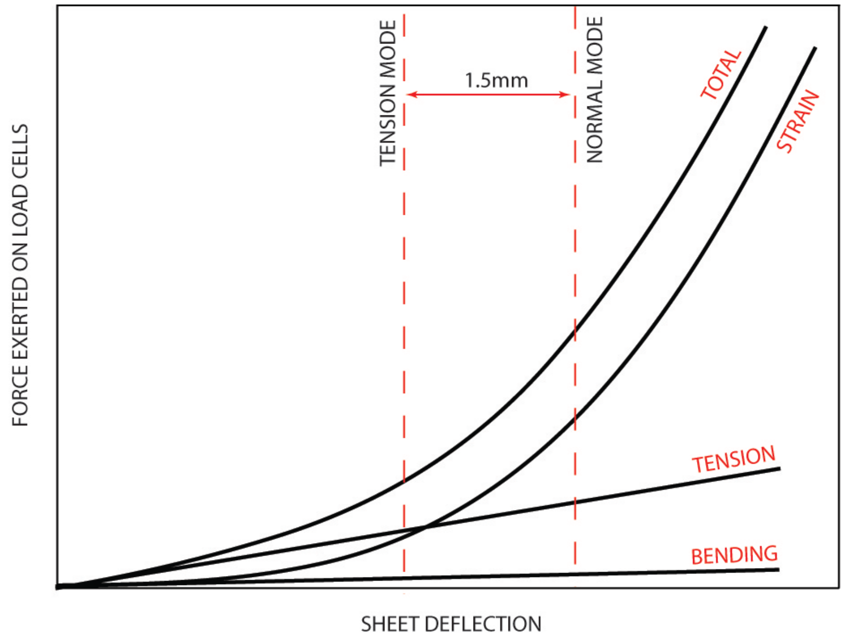


Figure 1-4 Tension Correction

1.1.6. Moisture correction

Stiffness properties are affected by relative humidity and temperatures of the ambient air and current moisture content of the product. In addition, moisture depends on current climate and earlier climate conditions, a characteristic known as the Moisture Hysteresis Effect.

The ESS works to compensate for moisture effects by applying a moisture corrector for online measured Extensional Stiffness data - compared to lab stiffness measurements at a different moisture level. The rule of thumb is a 5% change in stiffness for every 1% change in moisture, although this could be modified depending on the customer's process.

The ESS moisture corrector corrects stiffness values with reference to the lab conditioned moisture. For example, if the lab conditions their samples to 7.5% before measurement but the ESS online measurements are performed on a sheet with 8.5% moisture, the ESS moisture corrector will *increase* the online stiffness by 5% to reflect the fact that the sheet will be drier during lab measurement.

2. System Components

The Extensional Stiffness Sensor is mounted externally on the main scanner head, normally on the tending side of the scanner. The sensor is fastened to the main scanner head with mounting bars. Sheet rollers on the upstream and downstream sides of the lower ESS head act to stabilize the sheet as it enters the gap.

The main sensor housing is made up of a Control head and Wheel head.

Requirements for operation are:

- Scanner water (approximately 25 deg C) (upper head only)
- 40 PSI Air (control head and wheel head)
- Moisture and Basis Weight sensor

2.1. Wheel head

The wheel head houses the majority of the sensor's electro mechanics. In particular:

- A rotating wheel used to stretch the moving sheet as it passes through the sensor gap.
- A high precision stepper motor providing accurate positioning of the wheel inside the control head transducer cavity, thereby controlling the degree of sheet stretch.

The wheel head also performs a number of functions necessary for standardization of the sensor such as braking the wheel, locating it to a pre-defined position, and insertion/retraction of the wheel depending on the mode of operation.

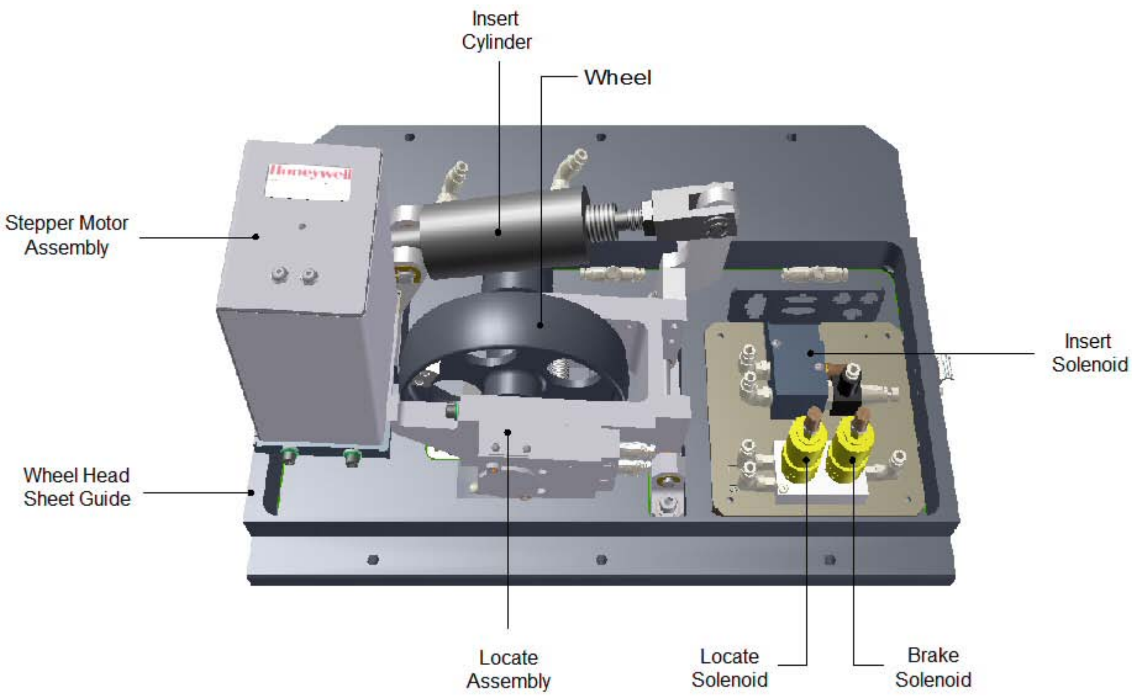


Figure 2-1 Wheel-Head Assembly (View 1)

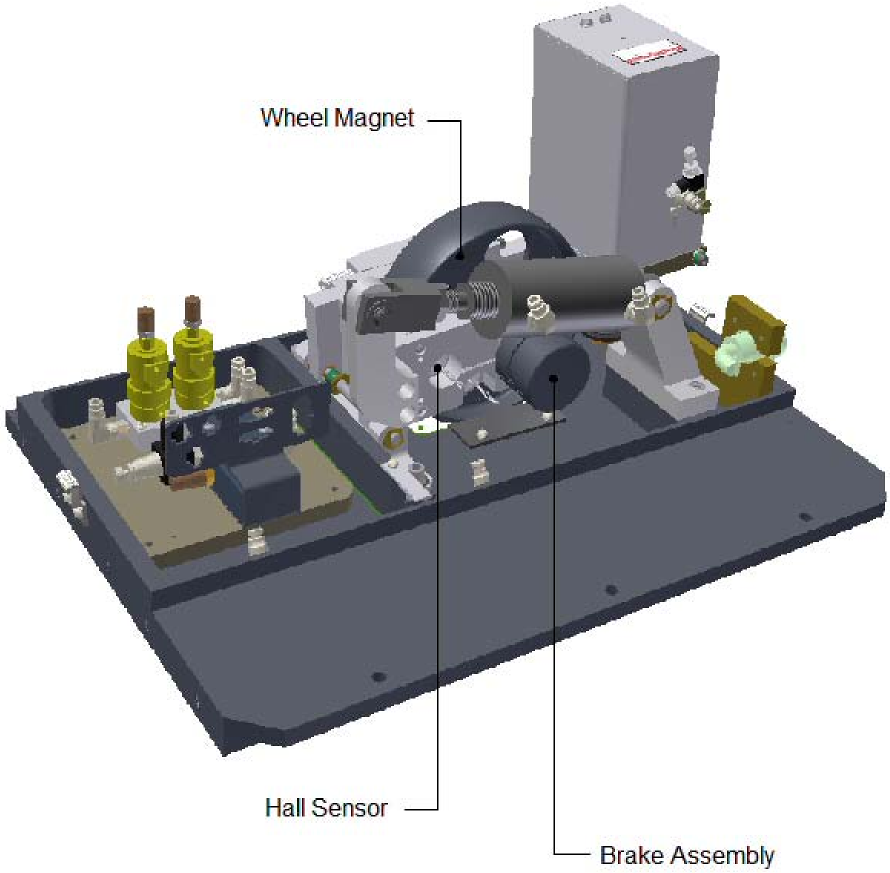


Figure 2-2 Wheel-Head Assembly (View 2)

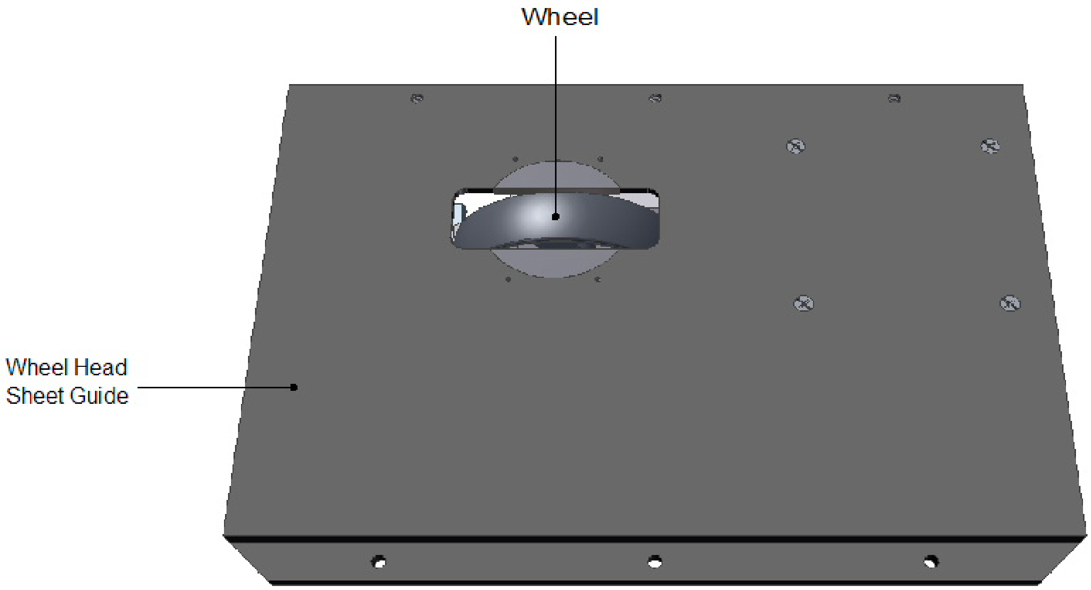


Figure 2-3 Wheel-Head Assembly (View 3)

2.1.1. Wheel assembly

The wheel needs to spin in order for the ESS to operate. This spinning motion is created by the sheet itself, ramping the wheel up to sheet speed during the initial scan after standardize and generally keeping it at that speed for the remainder of the scanning session.

The wheel is used to stretch the moving sheet into the transducer cavity of the control head. It is mounted 0.77mm (0.030 in) off center, resulting in a wobble of 1.54mm (0.060 in) per revolution. This wobble allows the sensor to measure two states of sheet stretch necessary for tension corrected extensional stiffness measurement (see Chapter 1).

A counterbalance is used to dynamically balance the wheel and minimize wear on the bearing.

Imbedded in the wheel are three magnets. These magnets are used in conjunction with two Hall Sensors (magnet detectors) mounted adjacent to the wheel. The Hall Sensors are used to detect wheel position during rotation. The Hall sensor on the inner diameter (home) tells the ESS control card the wheel orientation, the Hall sensor on the outer diameter (acquisition) indicates when the wheel is at the *normal* (high) or *tension* (low) positions. The control head reads the load-cell, Z-sensor and temperature probe values at two acquisition positions which are then passed forward to Experion MX for stiffness calculation.

Insertion and retraction of the wheel into the control head transducer cavity is accomplished by a positive activation of the insert cylinder. The air to the cylinder is controlled by a four-way solenoid valve that is mounted in the lower head. The exact insertion height of the wheel is controlled by the stepper motor assembly. This stepper assembly acts as a moveable precision stop for the wheel insertion against the force of the insert cylinder.

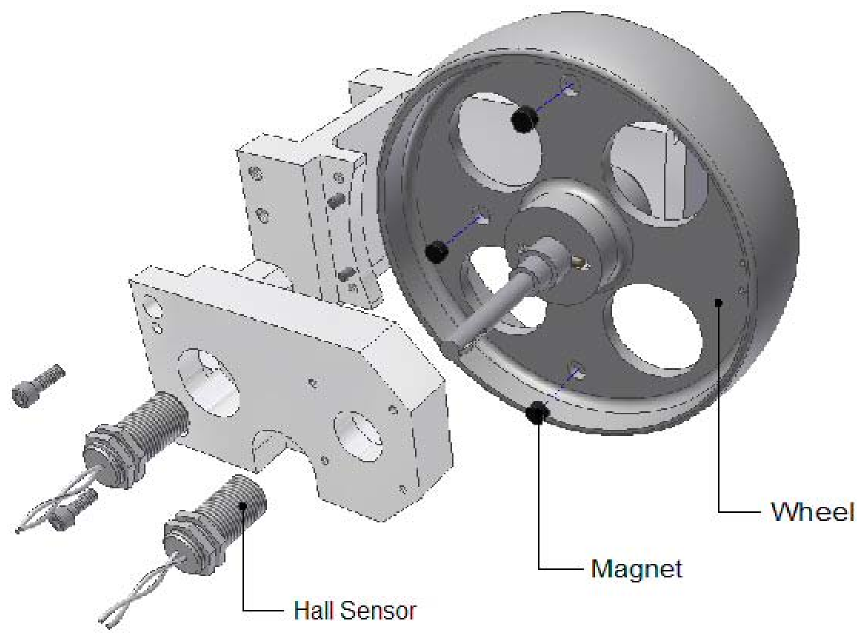


Figure 2-4 Wheel Assembly

2.1.2. Stepper motor assembly

The stepper motor assembly consists of a linear actuator, two limit switches, a bracket for mounting the assembly to the yoke, and a cover with purge air for keeping out dust and moisture.

The linear actuator is a stepper motor with a nut as part of its rotor and a threaded lead screw. The lead screw is locked with two nuts to a trip lever that slides into a channel. The lead screw does not rotate, but advances or retreats with each step. At the top of the lead screw is a gimbaled foot, which seats firmly against the bottom of the wheel head sheet guide when the assembly is inserted. A rubber bellow protects the lead screw from dust and particulates.

The windings of the motor are electrically connected to the stepper motor controller, which is part of the ESS I/O link in the lower main scanner head. This controller is commanded by step and direction signals sent from the ESS control card in the control head. Each step of the motor results in a linear translation of 0.007934mm (0.0003125 inches), resulting in high-precision positioning.

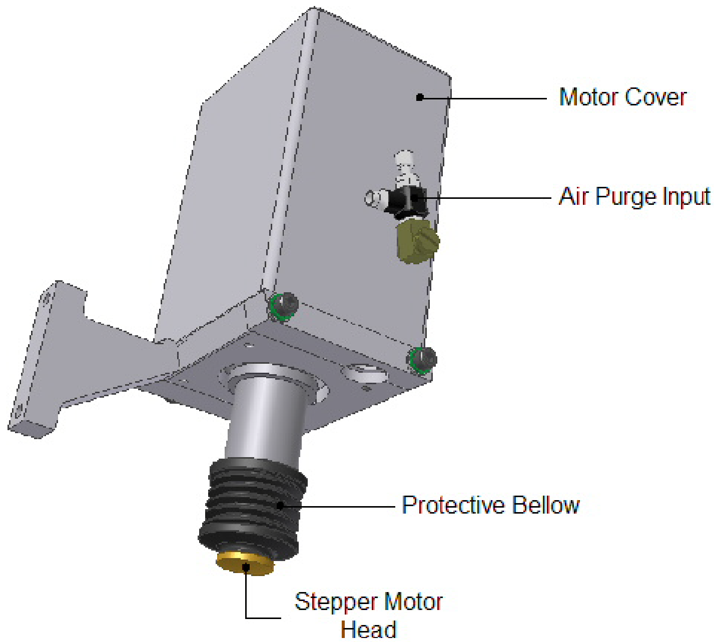


Figure 2-5 Stepper Motor Assembly

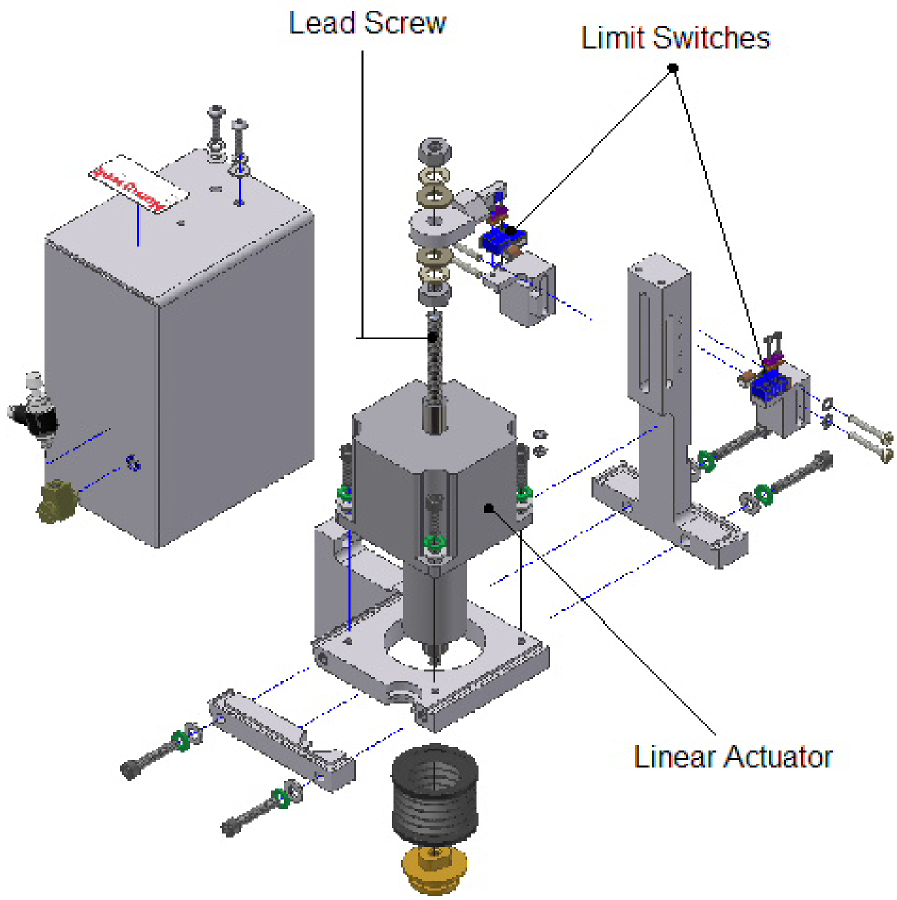


Figure 2-6 Stepper Motor Assembly (Exploded)

The motor limit switches are micro switches mounted on the motor assembly. They are used to stop the motor movement at precise positions and are not only safeguards to ensure the stepper motor does not over-extend itself, but also provides repeatable positioning that can be used by the standardize routine to check that the stepper motor assembly is working properly.

The limit switches are adjustable and normally set up by the manufacturing team prior to installation of the ESS at the mill. In some cases it may be necessary to adjust the limit switches after the sensor has been installed to account for variations in sheet gap. See Section 8.9(steps 12-19) for instructions on how to properly set limit-switch positions in the field.

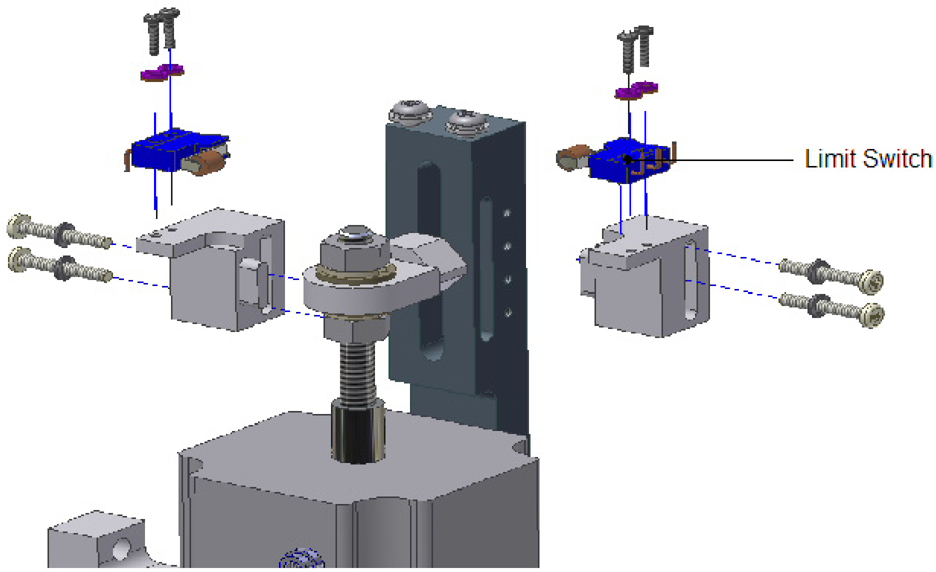


Figure 2-7 Limit Switches

2.1.3. Brake and locate assemblies and solenoids

The brake and locate assemblies with their associated solenoid valves are designed to stop wheel spin and orient the wheel to a specific position during the ESS standardize routine. Braking is required because the wheel is spinning near sheet speed as the scanner comes offsheet. The locate function rotates the wheel to its normal position so that Z-sensor readings during all phases of standardize are repeatable. If locate was not used, the wobble in the wheel would lead to variable Z-sensor results.

The locate assembly is mounted to the yoke and coupling to the wheel shaft is made secure by a pin. The locate function is provided by a cam on the wheel shaft that is rotated by an air piston. The solenoid valve that controls the locate function is mounted to a manifold on a mounting plate bolted to the wheel head sheet guide and is activated by the control card in the control head. The second solenoid on this manifold does not have functionality in this version of the ESS and can be used as a backup in case of failure of the locate solenoid.

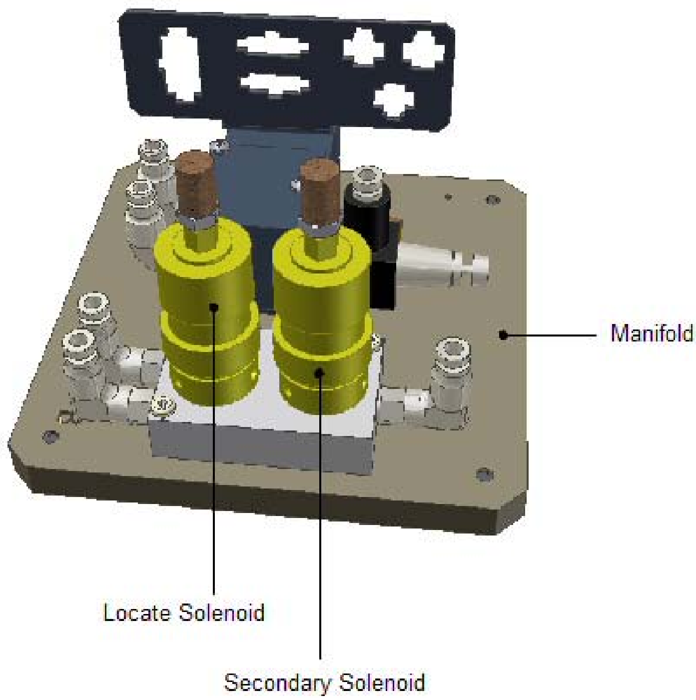


Figure 2-8 Manifold, locate solenoid, and secondary solenoid

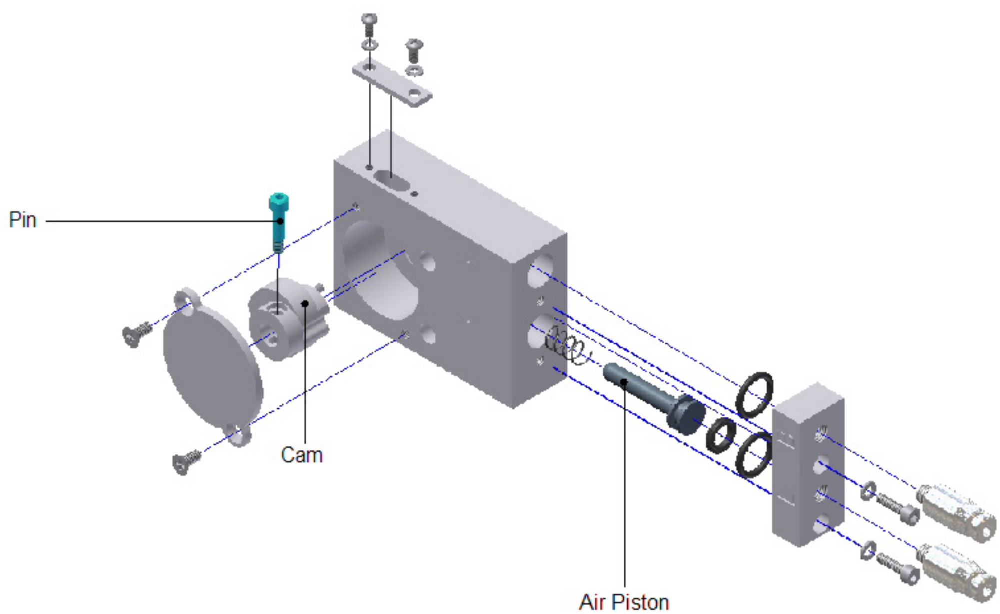


Figure 2-9 Locate Assembly

The brake assembly is friction based and has an internal solenoid that is activated by the control card in the control head. The assembly has a plastic cover to protect it from dirt present in the wheel head. There are set screws where the wheel shaft enters the brake assembly. In addition to the four mounting screws, these set screws must also be loosened to remove the brake assembly.

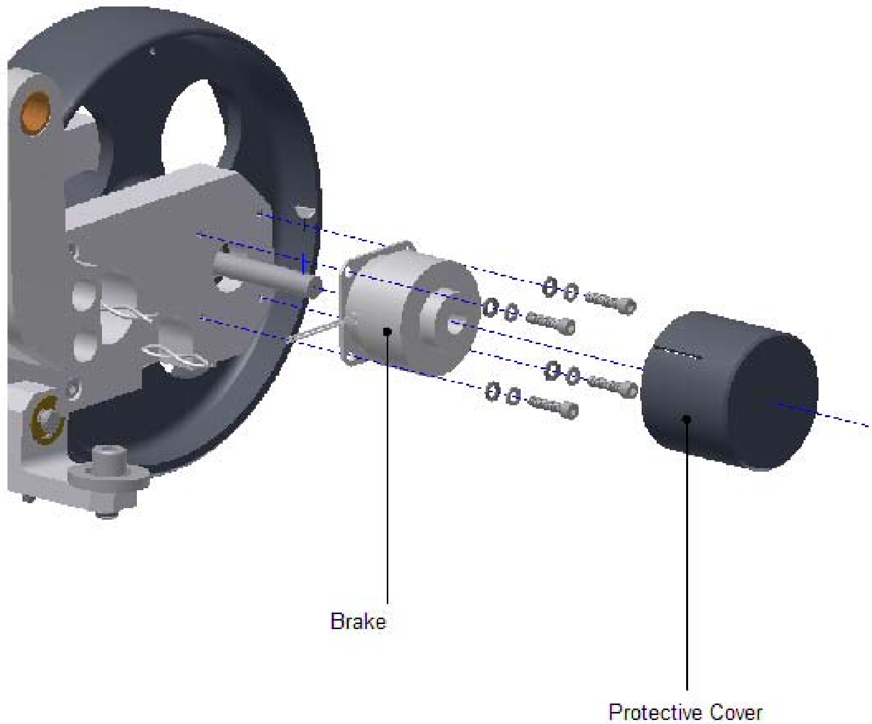


Figure 2-10 Brake Assembly

2.1.4. Electrical and air

Air to the wheel head is provided through a quick-disconnect fixture. To guarantee adequate air pressure, plumb the air to the line going to the caliper and basis weight sensor rather than the line used for the air-wipes. Normally 40 psi air is used.

Electrical connections to the main scanner head are made through a round 19-pin military style connector.

2.2. Control Head

The control head houses the sensor's intelligence. It has a control card PCB for coordination of all electro mechanical functions and signal measurements within the sensor. It also houses a transducer cavity that provides direct physical measurement of force and sheet stretch.

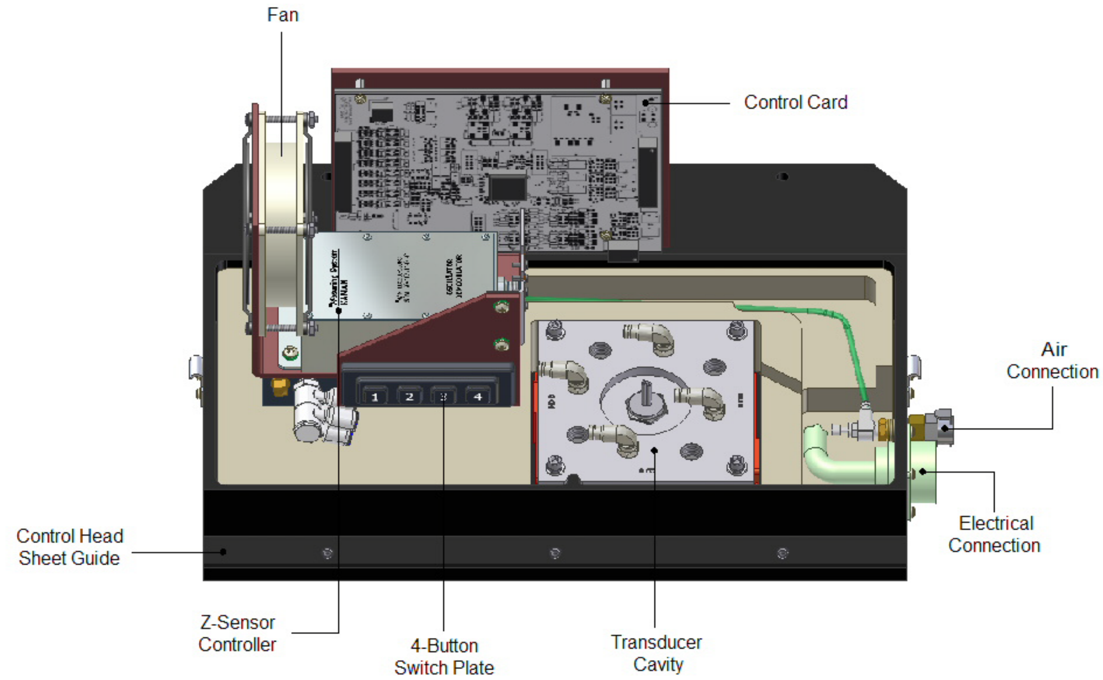


Figure 2-11 ESS Control Head (View 1)

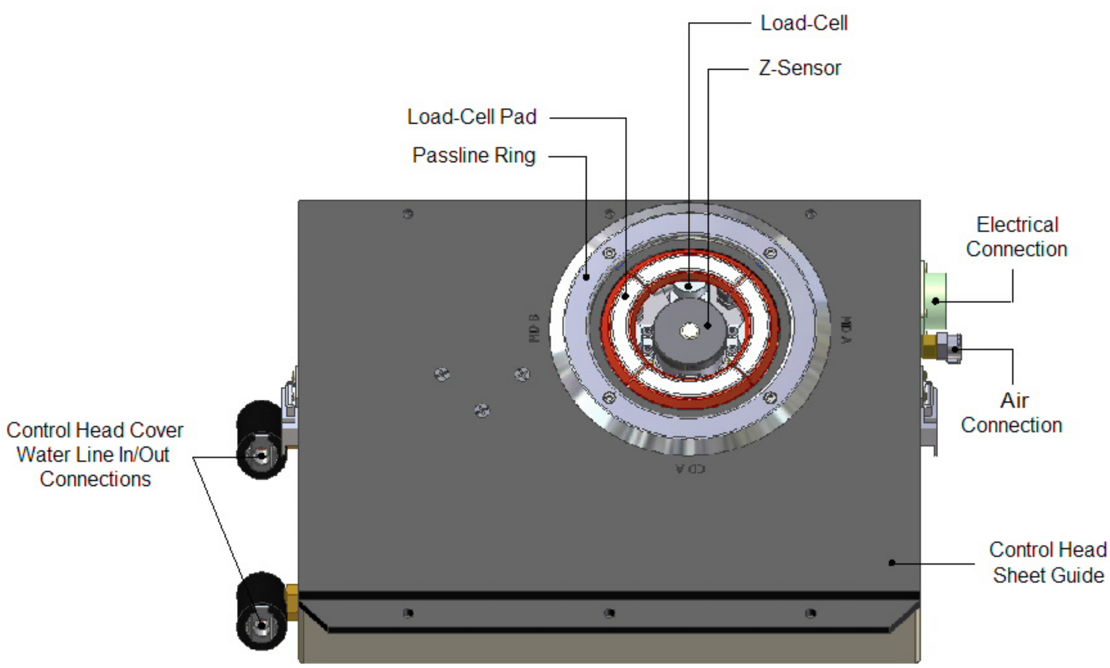


Figure 2-12 ESS Control Head (View 2)

2.2.1. Transducer cavity

The transducer cavity is the sensing unit of the ESS control head. It consists of four load cells and a Z-sensor. The four load cells measure resistance to sheet deflection and the Z-sensor measures wheel position and relates this to sheet stretch. A small amount of purge air is used inside the cavity to ensure the sheet does not create a vacuum that could lead to additional forces on the load cells unrelated to extensional stiffness.

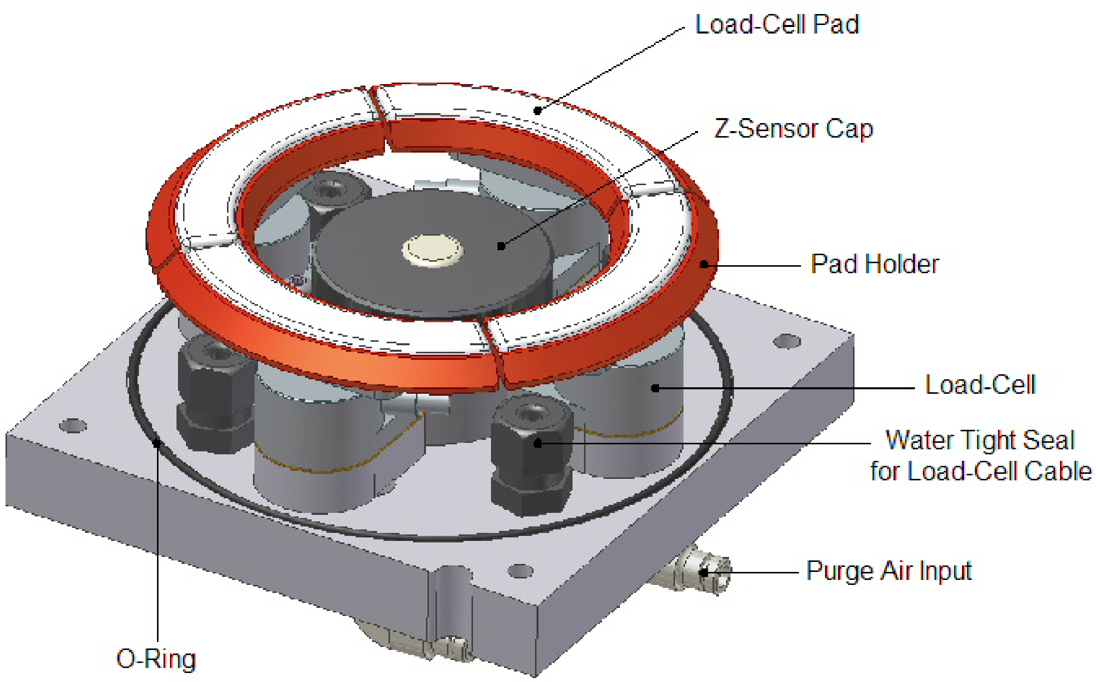


Figure 2-13 Transducer Cavity

2.2.1.1. Load cell assembly

Within the transducer cavity is a segmented ring of load-cell assemblies. These load-cell assemblies are used to measure the sheet's resistance to elastic stretch. Two load-cell assemblies are used for MD measurement and two for CD measurement.

Each load-cell assembly is made up of:

- Load cell
- Pad holder

- Pad (a high density material resistant to abrasion and build up)
- Shims for height adjustment

The electrical cabling for each load cell passes through a water tight seal in the transducer cavity and connects to the ESS control card.

The load-cell assemblies sit on brass shims that are used to adjust the assemblies' height with respect to the pass line ring. This adjustment is done during ESS assembly in the factory. The CD load-cell assemblies are adjusted so that the load-cell pads are the same height as the pass line ring. The MD load-cell assemblies are typically recessed 0.25mm (0.010 inches). This recession enhances the forces on the CD load cells where sheet tension is lower. If load cells are replaced in the field, they need to be adjusted for proper height. See Section 8.7.

The load cells are susceptible to damage when subjected to forces greater than 4.5kg (10 lbs). Such forces can cause micro-yields in the frame that change the zero-force reading. Fortunately, this offset effect is corrected during sensor standardization. However, the application of a large enough force will permanently damage the load cell.

2.2.1.2. Z-Sensor

The Z-sensor probe is located in the middle of the transducer cavity and measures the distance between itself and a conductive target. It functions by inducing Eddy currents in the target and measuring the response. The power to the Z-sensor probe is provided by a controller box that is also located in the ESS control head (see Figure 2-2).

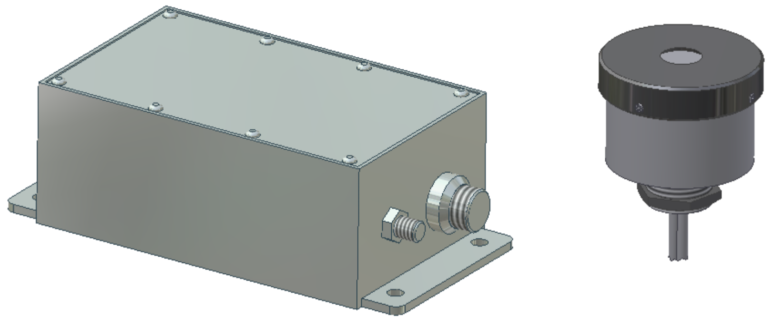


Figure 2-14 Z-Sensor and Driver

The Z-sensor controller box outputs a voltage to the ESS control card that is linearly proportional to the distance between the Z-sensor probe and the conductive target. The farther the target is away from the probe, the higher the voltage. This measurement system is designed for industrial environments and is not influenced by non-conductive materials that exist between the probe and the target such as the moving sheet, moisture, or dirt.

In the case of the ESS, the conductive target is the wheel located in the wheel head of the sensor. If the system knows the distance from the top of the CD load-cell pads to the button on the Z-sensor cap (ZDEL) one can determine the amount of sheet deflection caused by the wheel. This idea can be expressed mathematically by the formula:

Sheet Deflection = ZDEL – Z

where Z is the distance reading (to the wheel) made by the Z-sensor. Assuming absolute tension in the sheet, sheet deflection can be translated into elastic sheet stretch which is an input parameter for determining extensional stiffness.

The Z-sensor probe is covered by a protective cap that prevents the probe from being damaged as the wheel physically pushes against this cap during Phase four of standardize.

ATTENTION

The Z-sensor is similar in appearance and function to the Z-sensor used in the main scanner head, but they are not interchangeable. The ESS Z-sensor is calibrated to minimize temperature sensitivity and optimize linearity for the ESS wheel target. The probe and PCB are a matched pair and should always be replaced as a pair.

2.2.2. Control card

The control card is the brain of the ESS. Without it, the sensor could not function. Functions include:

- Wheel targeting
- Activation of electro-mechanical functions
- Communication of information to and from the scanner MSS
- Communication of information to and from the ESS wheel head through the ESS I/O Link installed in the lower main scanner head.

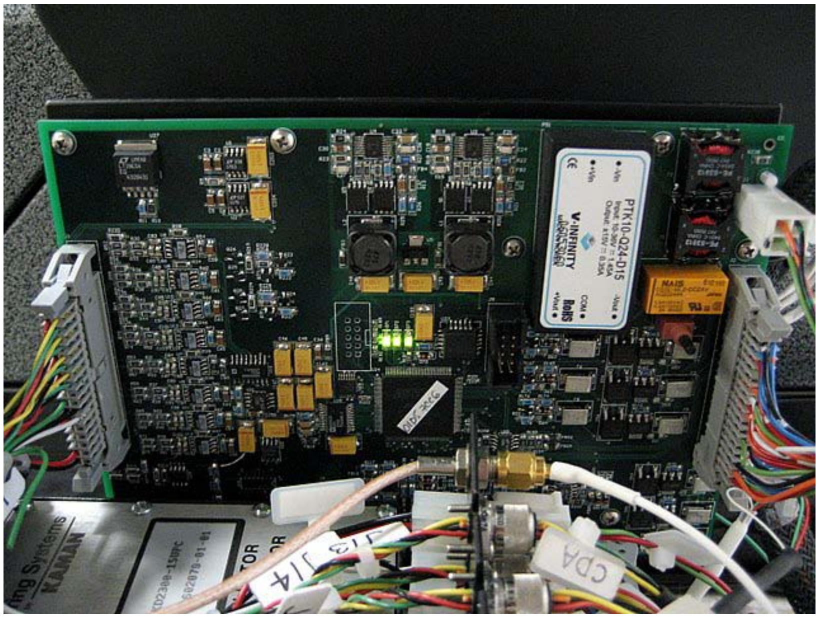


Figure 2-15 ESS Control Card

2.2.2.1. Wheel targeting

The ESS control card sends **step** and **direction** commands to the stepper motor in the wheel head through the power track. Each step command moves the motor's lead screw by 0.0079mm (0.0003125 inches). The direction command dictates the direction of lead screw motion.

Control of the stepper motor translates to control of the wheel position and degree of stretch in the sheet. Too little stretch results in inadequate load-cell signal. Too much stretch could permanently damage the sheet or cause a sheet break.

The control card, in conjunction with the stepper motor and Z-sensor, is used to position the wheel inside the transducer cavity and ensure sheet stretch is kept constant and to the desired amount. Define the degree of sheet stretch at the operator station and the software converts this into a target voltage for comparison with the Z-sensor output. The stepper motor is then fine tuned through the control card so that the Z-sensor voltage output equals the user's target value.

The wheel is kept at target during the scan using a targeting algorithm issued by the ESS control card. This algorithm will compensate for scanner misalignment or other mechanical perturbations that could shift the vertical position of the upper head relative to the lower.

When the error between desired and actual Z-sensor signal is within a certain range called the deadband, the control card inhibits stepper motor motion. This feature is used to preserve the life of the motor and limit hunting when negligible errors are found between the target and Z-sensor signal.

2.2.2.2. Electro mechanical functions

In addition to performing load-cell and Z-sensor measurements, the ESS control card is responsible for coordinating all of the electro mechanical functions within the sensor. Communication between the control card and wheel head is done through the scanner power track and ESS I/O link in the lower main scanner head.

In the control head, the control card provides:

- Power to the Z-sensor controller
- Power to the fan
- Power and control of the solenoid for the transducer cavity air purge.
- Head and Z-sensor temperature measurements

In the wheel head, the control card provides:

- Control of the BRAKE solenoid
- Control of the LOCATE solenoid

- Control of the INSERT solenoid
- Control of the stepper motor controller (Power to the stepper motor itself is provided by +24V in the lower main scanner head due to high current requirements).

2.2.2.3. Communication with the EDAQ

Prior to Experion MX, the ESS communicated with the MSS using the PCI-PCDAQ card in the scanner's end-bell. With the introduction of Experion MX, the communication with the ESS is done through an EDAQ card in the upper head of the main scanner. This way, even though the ESS is mounted outboard, it requires one sensor slot in the main upper scanner head in order to function.

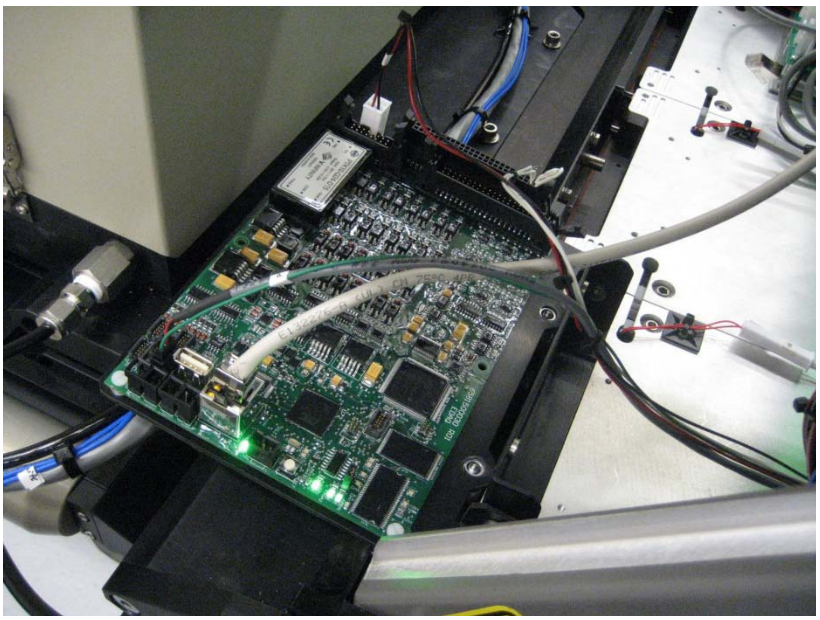


Figure 2-16 EDAQ in main scanner head (upper)

2.2.2.4. Communication with the ESS I/O link

The ESS control card communicates commands and receives signals from the ESS wheel head through an ESS I/O link that is installed in the lower main scanner head. This unit multiplexes all of the communication signals onto three loop back power track wires. The I/O link requires one sensor bay in the lower main scanner head as shown in Figure 2-17.

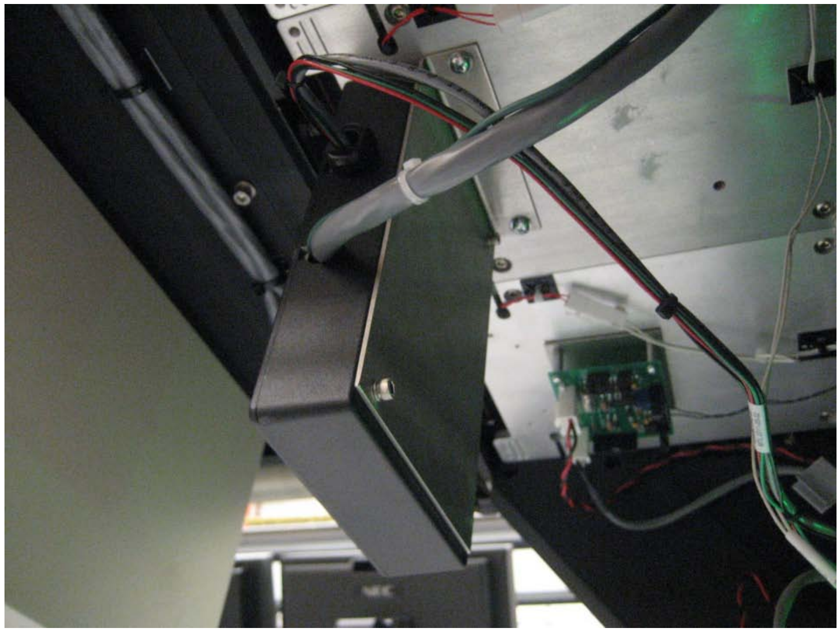


Figure 2-17 EDAQ in main scanner head (upper)

2.2.3. Electrical, air, and water

Air to the control head is provided through a quick-disconnect fixture. To guarantee adequate air pressure, the air should be plumbed to the line going to the caliper and basis weight sensor rather than the line used for the air wipes.

Electrical connections to the main scanner head are made through a round 55-pin military style connector.

3. EDAQ

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

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

The board is based on an ARM CPU running the Linux Operating System and an FPGA that controls real-time data acquisition. [1]

The EDAQ board contains a large number of input output systems, including

- Analog Inputs (16 inputs of 12 bits @ 4KHz and 8 inputs of 10 bits @ 1 Hz),
- Analog Outputs (2 @ 12 bits),
- Digital Inputs (16 @ 24V logic),
- Digital Output (16 @ 24 V logic),
- Frequency input (400 Hz -500 KHz),
- Three serial ports,
- USB (presently unused) and
- Ethernet.

Except for a few dedicated signals such as the Green Light (radiation safety), all sensor signals connect through the EDAQ to the new Experion MX MSS by Ethernet.

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

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

3.1. Physical Layout

Figure 3-1 and Figure 3-2 show the EDAQ PCBA (p/n 6581500030) as it is mounted next to a sensor. To the left are the Digital and Analog I/O, which connect directly to a sensor. Below these two large connectors is a 16 pin expansion connector that is only used when the EDAQ is attached to the frame controller expansion board (p/n 6581500032).

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

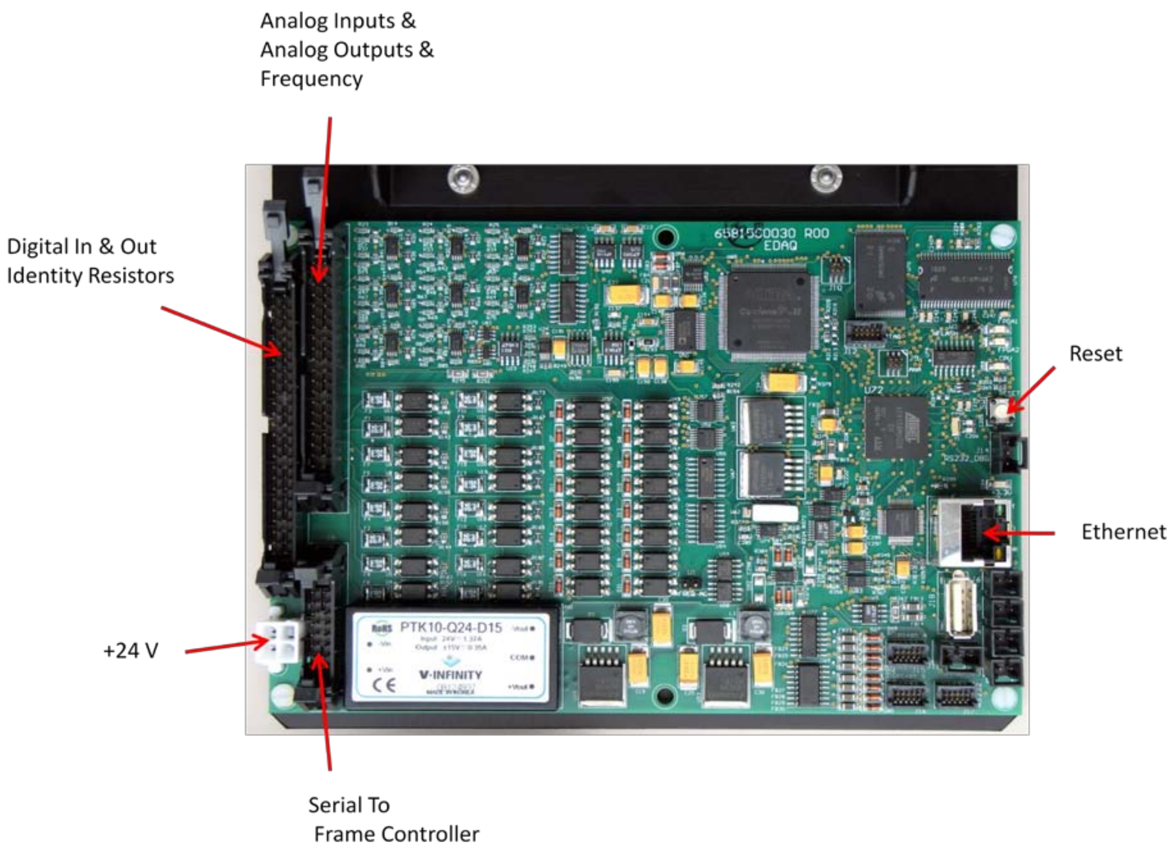


Figure 3-1 Top view of EDAQ board

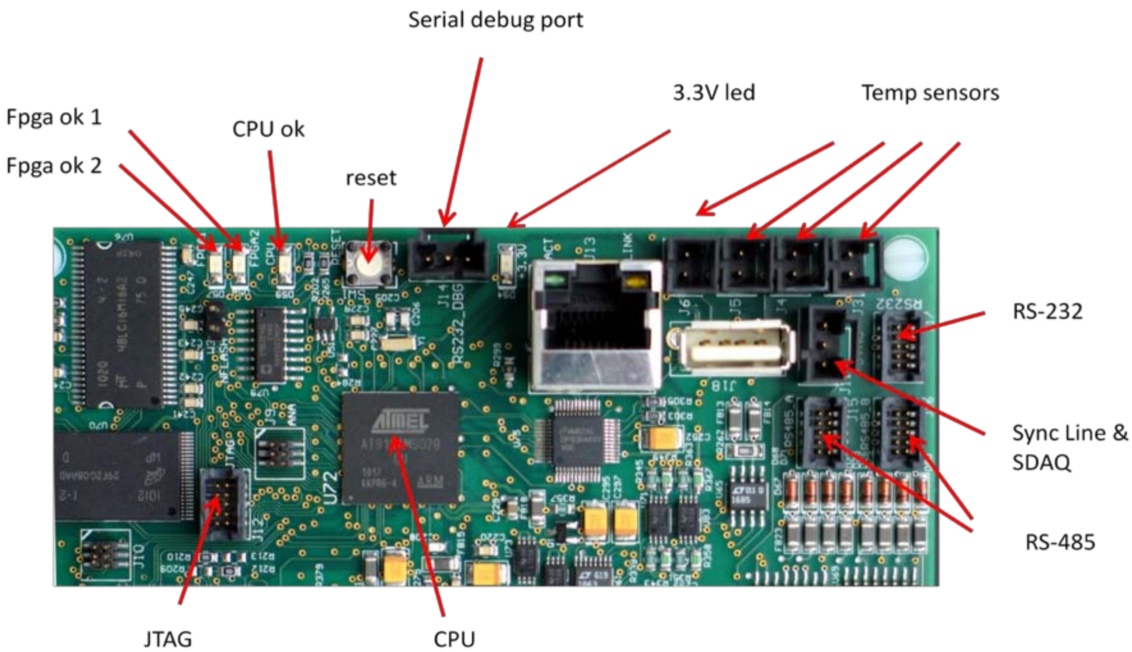


Figure 3-2 Enlarged view of the top right corner of the EDAQ to show LEDs and I/O connectors

3.2. Hardware Status Information

There are four diagnostic LEDs on the EDAQ. See Figure 3-2.

- 3.3 V LED. When lit, this indicates that all power supplies on board are functional. The signal is derived from the 3.3 V power supply, which in turn is derived from the 15 V power supply, which is derived from the +24V input.
- CPU OK LED. This LED is under control of the central ARM CPU. It will be lit when the main sensor application (edaqapp) is running on the CPU
- Fpga ok 1 (not used at present)
- Fpga ok 2. This LED will blink if the FPGA is loaded and running code

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

3.3. EDAQ reset

A soft reset of the EDAQ may be performed through a Web interface running on the scanner MSS. This interface may be accessed from a RAE station.

A hardware reset can be performed by pressing the white button next to the debug cable. This resets both the CPU and FPGA and is equivalent to a power on/off.

3.4. EDAQ Sensor Identification and IP addressing

All EDAQs, assuming their firmware (flash code) is the same, are identical. EDAQs can be freely interchanged between sensors and the scanner end bell.

Each EDAQ contains all the code for all supported sensors and loads the appropriate software depending on the identification ID code read at boot time. Two resistors are used to uniquely identify the EDAQ.

For sensor-connected EDAQs, there is a sensor model resistor embedded in the cable harness connecting the sensor to the EDAQ. This resistor determines the Function Code. Function Codes are unique for each sensor model to the extent that the EDAQ needs to differentiate the models (for example, all Source 9 Basis Weight Measurement Sensors presently have the same Function Code, regardless of radioactive isotope).

In addition, the head power distribution board has a resistor for each EDAQ platform connector. This determines the position of the EDAQ in the head. The EDAQ can self-identify both its position and function.

Refer to the Scanner System Manual to troubleshoot if the EDAQ does not identify itself properly or how to find the correct resistor values.

Every EDAQ has a unique IP address on the scanner network. If the EDAQ can identify its position, it will set its IP address to 192.168.0.XYZ (where XYZ is the position number in the head. The Frame Controller EDAQ (FC-EDAQ) always sets itself to IP number 192.168.0.2. The MSS is always 192.168.0.1 on the scanner network and usually 192.168.10.(n+100) (where n is the number of MSSs on the same MX Experion network) on the Experion MX LAN. The MSS is assigned 192.168.10.101 at the factory, but this can be set to any IP address by using the MSS web page. Refer to the MSS chapter in your Scanner manual.

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

3.5. Obtaining Status Information

3.5.1. Experion MX Platform

An overall status page is available from a RAE Station under the MSS Setup Diagnostics tab. Choose the MSS Summary Page.

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

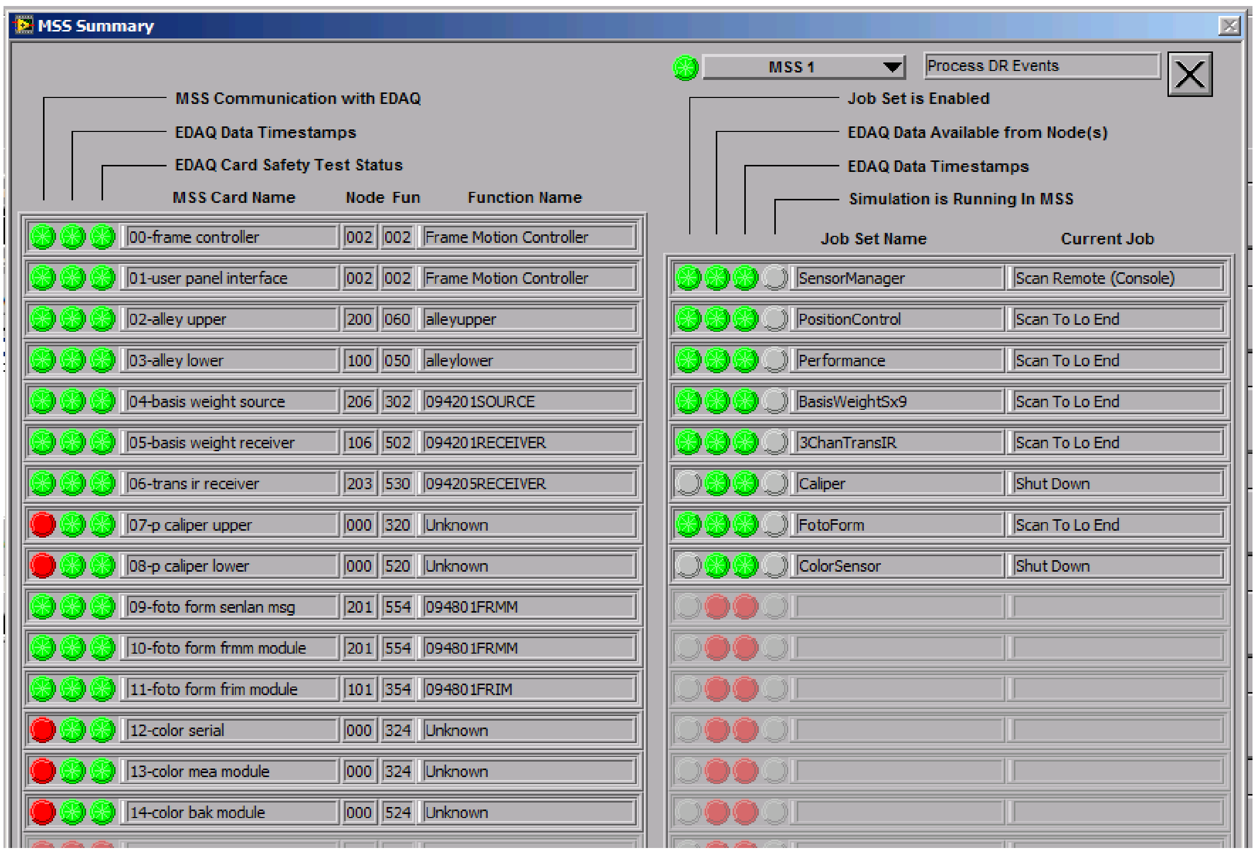


Figure 3-3 MSS Diagnostic page displaying EDAQ status

Table 3-1 MSS Summary Display Status Indicators and their meanings

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

Sensors that are part of the RAE database but are not enabled on the scanner show the left most column indicator as red (caliper in the above example).

3.6. MSS and EDAQ Web Pages

Much more detail is available on the MSS and the EDAQs, which all run web-servers and can display server pages containing information on the state of the system. As a general rule, consult the MSS web pages first. They are accessible in three different ways:

- From RAE by going to the MSS Diagnostic tab, clicking on MSS Monitor, choosing the appropriate MSS and clicking on MSS web page
- By opening a browser on any computer connected to the Experion MX level network and using the address *http://192.168.10.101/mss.php* (the first MSS on the LAN) or the address set up for the MSS in the Experion MX system
- By opening a browser on any computer connected to the scanner LAN switch and using the address *http://192.168.0.1/mss.php* or *http://192.168.10.101* (for the 1st MSS on the system)

Figure 3-4 is the main MSS web page.

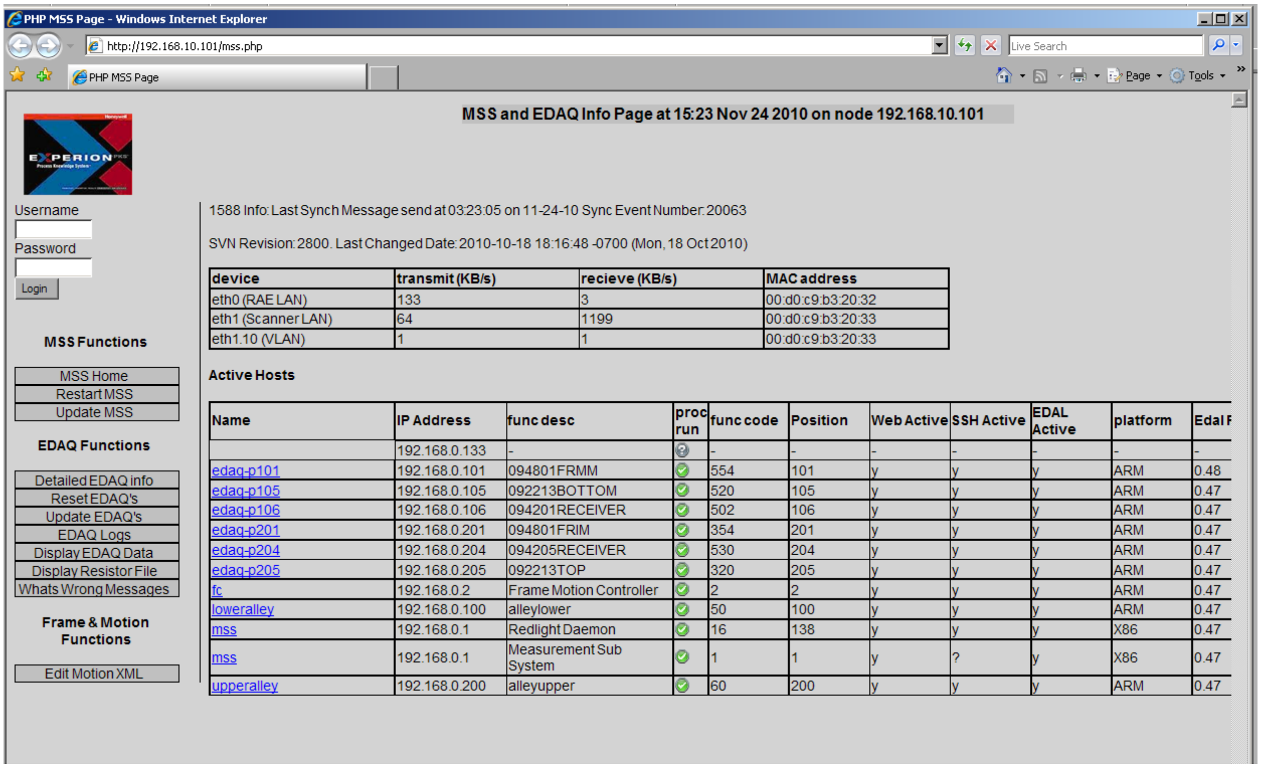


Figure 3-4 Main MSS web page

The left panel shows a column of options divided into:

- MSS functions
- EDAQ functions
- Frame and Motion Functions

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

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

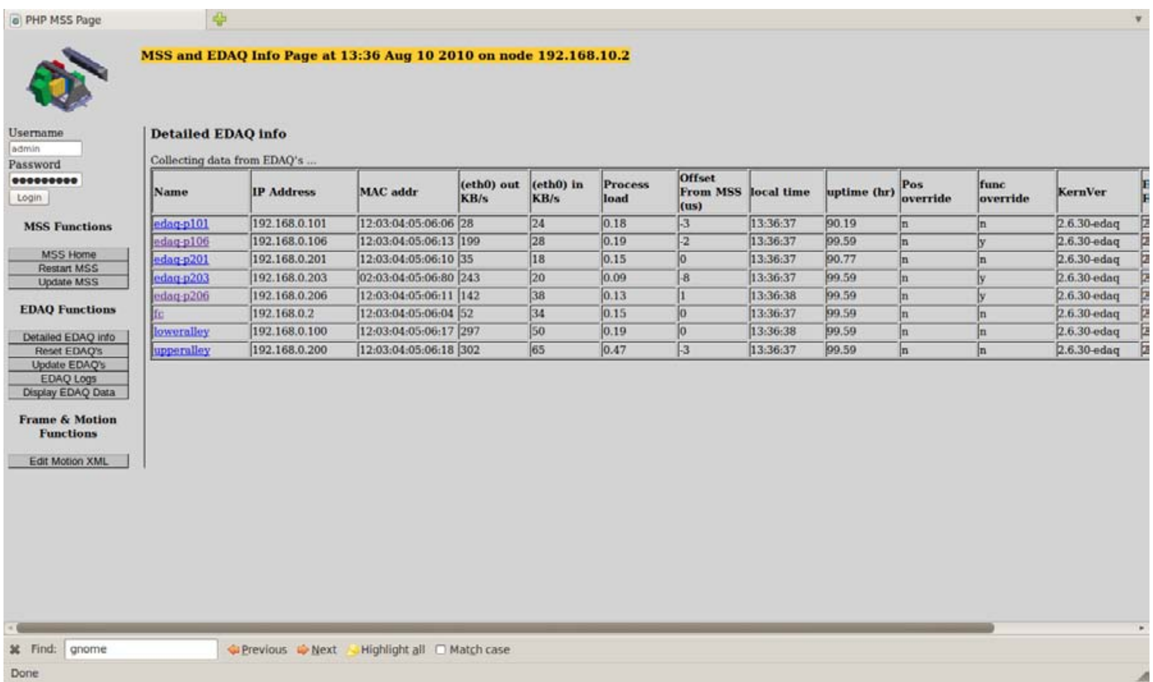
The second table lists all EDAQs discovered on the Scanner LAN, their IP numbers, a brief description (related to model number), a program status column, the associated Function Code, Position Code and whether the communication protocols are running (http, ssh and Edal, the proprietary sensor data transmission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

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

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

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

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



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

Figure 3-5 Partial display of EDAQ detailed information

4. Installation

4.1. Parts list

The following subassemblies are included with the ESS:

- ESS Control Head
- ESS Wheel Head
- I/O Link Box
- Mounting Bars, Upper and Lower
- Sheet stabilization rollers, Lower only
- Dummy sheet-guides
- Electrical Harnesses of the Control Head and Wheel Head
- Calibration Kit
- User Manual

4.2. Mounting the sensor

CAUTION	When working on scanner heads, beware of static electricity. Wear wrist straps.

CAUTION	The load cells can only accept 10 pounds of force before damage will occur. Make sure to handle the control head with utmost care and use spacer bars to protect them until installation on the scanner.

4.2.1. Mounting

The ESS heads are mounted to main scanner head as shown in next two figures. The roller mounts attached to the ESS lower head on the upstream and downstream side should be aligned so they are flush with the main ESS sheetguide.

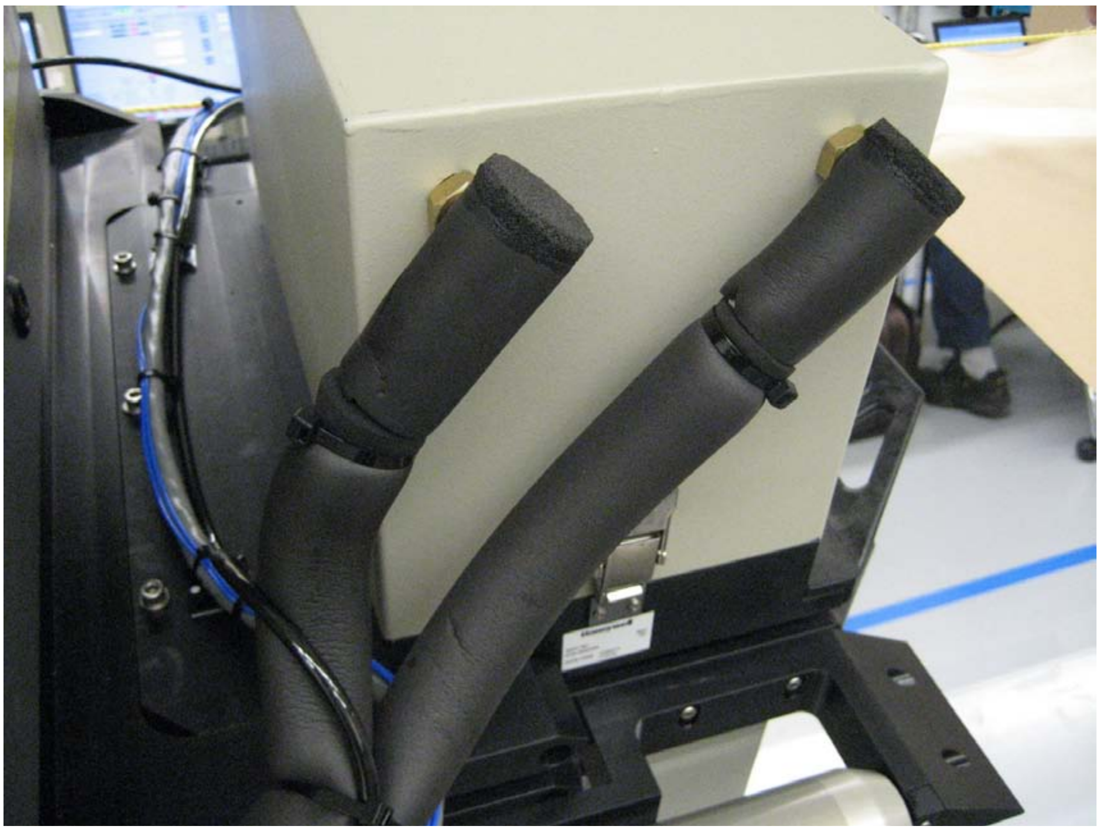


Figure 4-1 ESS Mounting

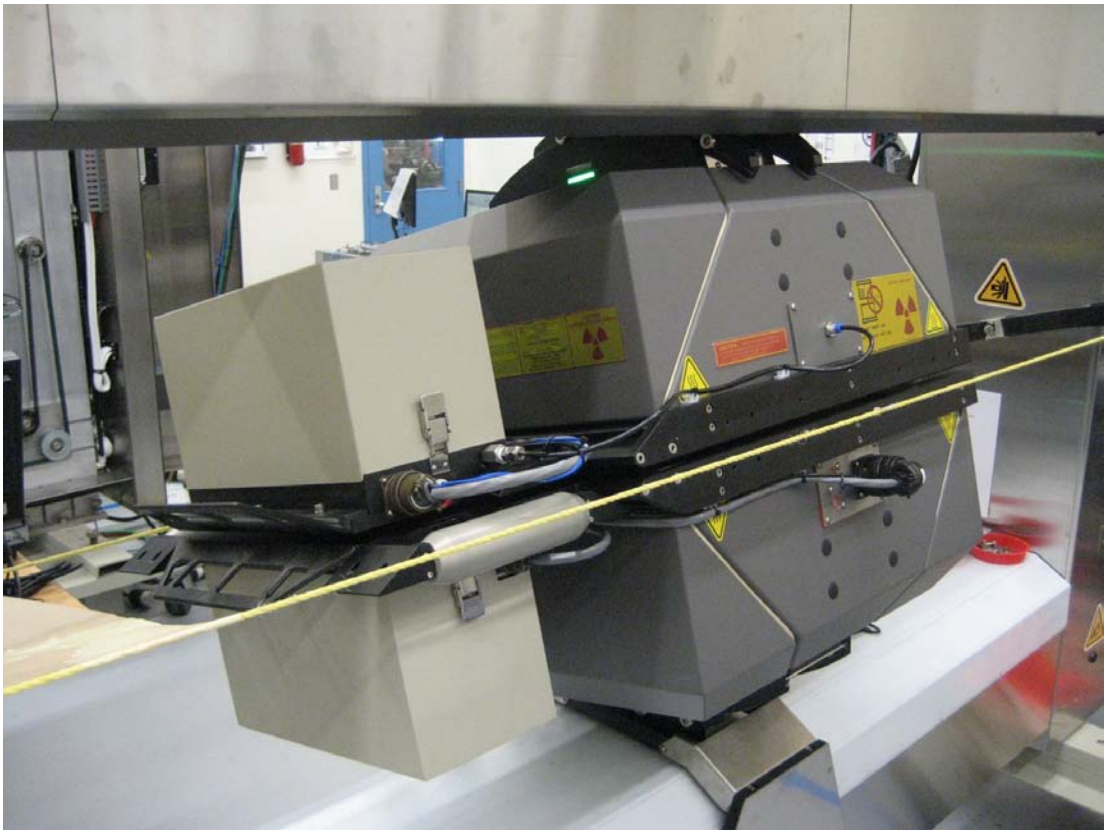


Figure 4-2 ESS Mounting

4.3. Electrical connections

4.3.1. Wiring harnesses

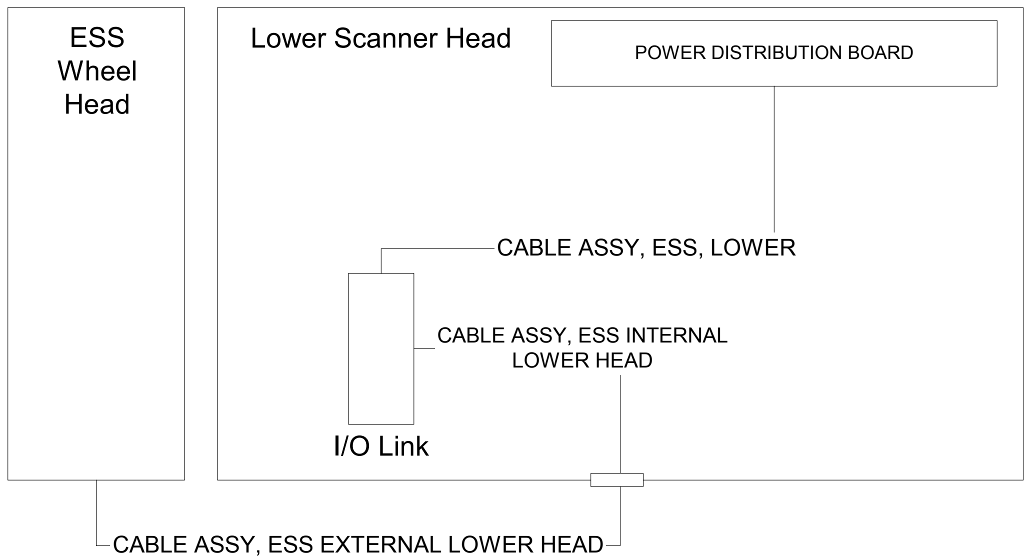


Figure 4-3 Wheel-Head Wiring Schematic

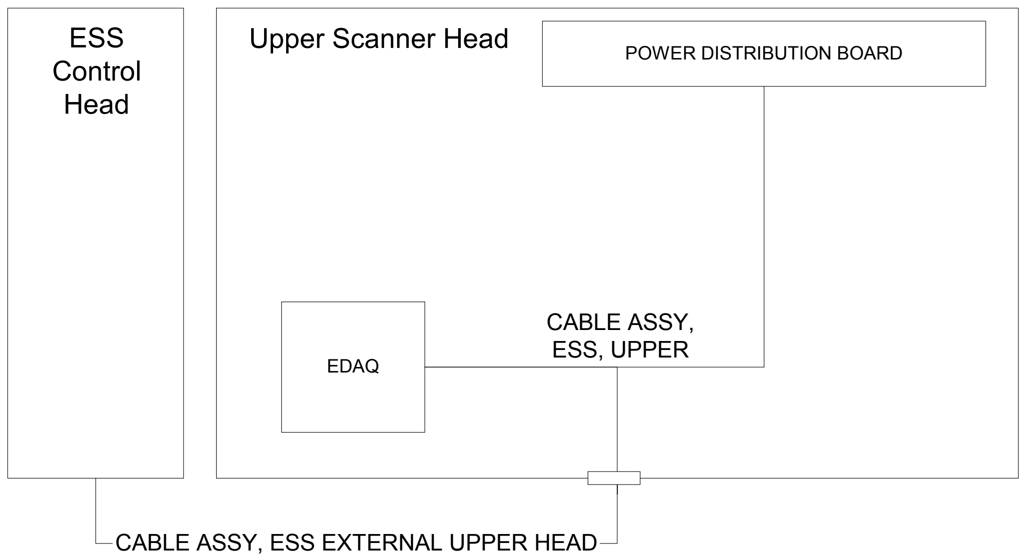


Figure 4-4 Control Head Wiring Schematic

The control and wheel head wiring harnesses (CABLE ASSY, ESS EXTERNAL UPPER HEAD and CABLE ASSY, ESS EXTERNAL LOWER HEAD, respectively) connect to the round 55-pin and 19-

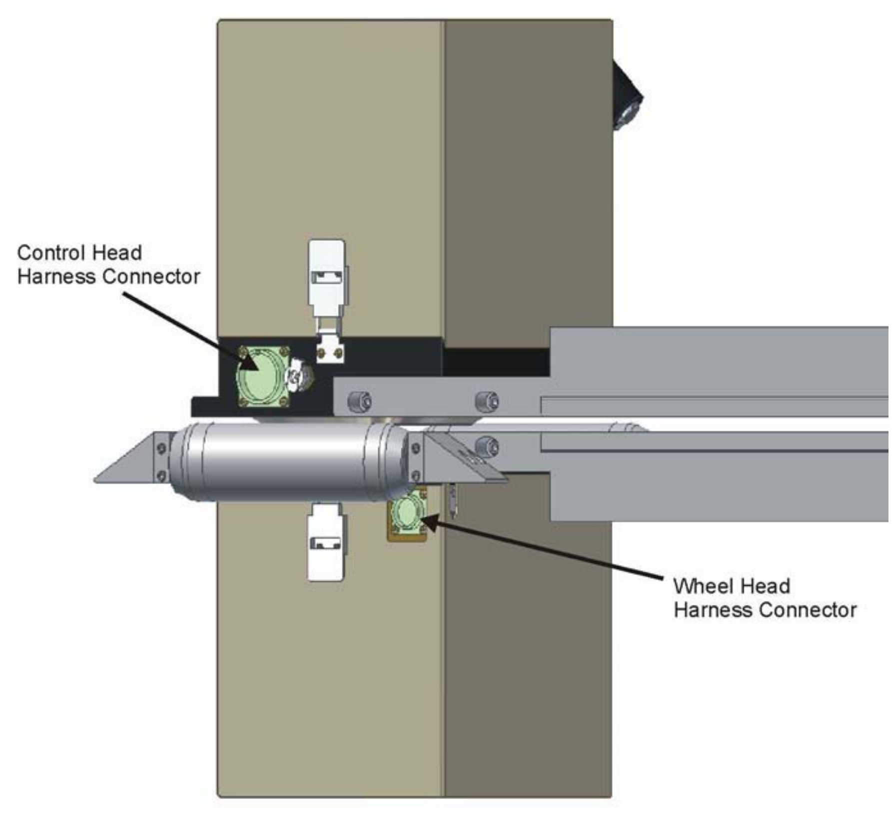


Figure 4-5 ESS Electrical Connections

1. Connect (CABLE ASSY, ESS UPPER) to the upper main scanner head EDAQ and power distribution board. Remember that since this is an external sensor the 18-pin molex connector attaches to the inner part of the power distribution board.

ATTENTION

NOTE:	Make sure the P-8 connectors that you choose to use have the loop-back connection attached at the end bell, as these wires are used to directly communicate information from the upper ESS control card to the lower-head I/O link PCB.

2. Connect the non-military end of (CABLE ASSY, ESS INTERNAL LOWER HEAD) to the PCB inside the I/O link PCB in the lower main scanner head. You will need to remove the cover of the I/O link box to accomplish this. Additionally, connect (CABLE ASSY, ESS LOWER) to the I/O link box as well. The two harnesses that enter this box both have a grounding wire. Connect them together and attach to one of the screws used to mount the heat

sink. Once connections have been made, put the cover back on the box. Do not use the Heyco cable-strain fittings for these harnesses as they are cumbersome to install and remove.

3. Secure the cables inside the heads with tie wraps as necessary.

4. Mount the I/O Link box to a sensor bay in the main lower scanner head.

5. Ensure all grounding wires are properly connected.

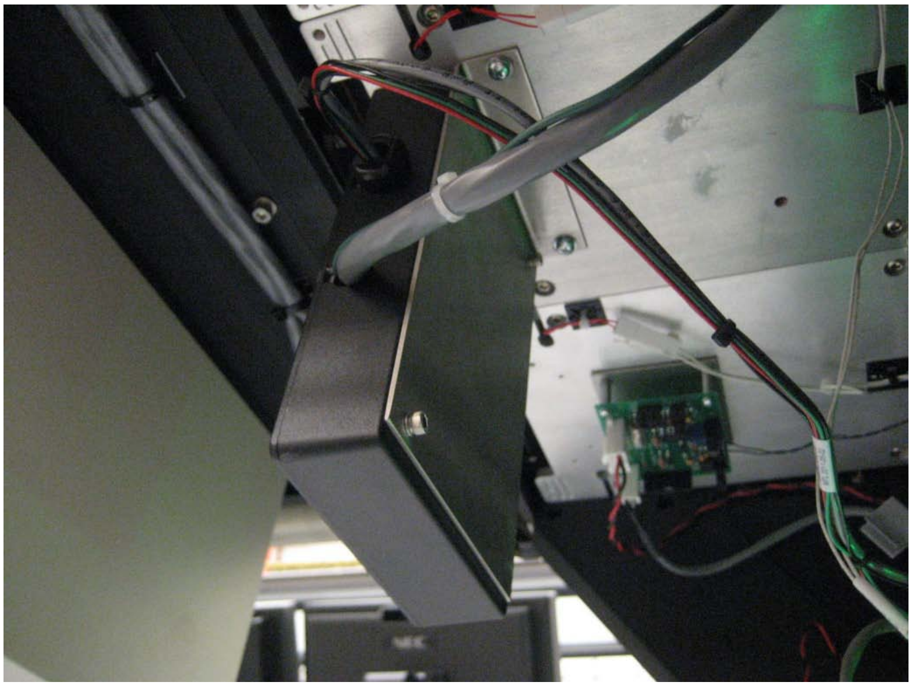


Figure 4-6 I/O Link Box mounted to Sensor Plate

4.4. Service connections

4.4.1. Water connections

1. The ESS requires that scanner water be flowing through the control head cover at all times. There is no solenoid control of the water flow.

2. Connect water to the control head through the quick disconnect fittings on the control head cover (See Figure 4-1). The direction of flow does not matter, but the temperature should be approximately 25 °C, otherwise condensation may occur inside the head, resulting in sensor failure.

3. Manage the water flow so that the flow through the control head of the ESS is not interrupted or controlled by flow through other sensors.

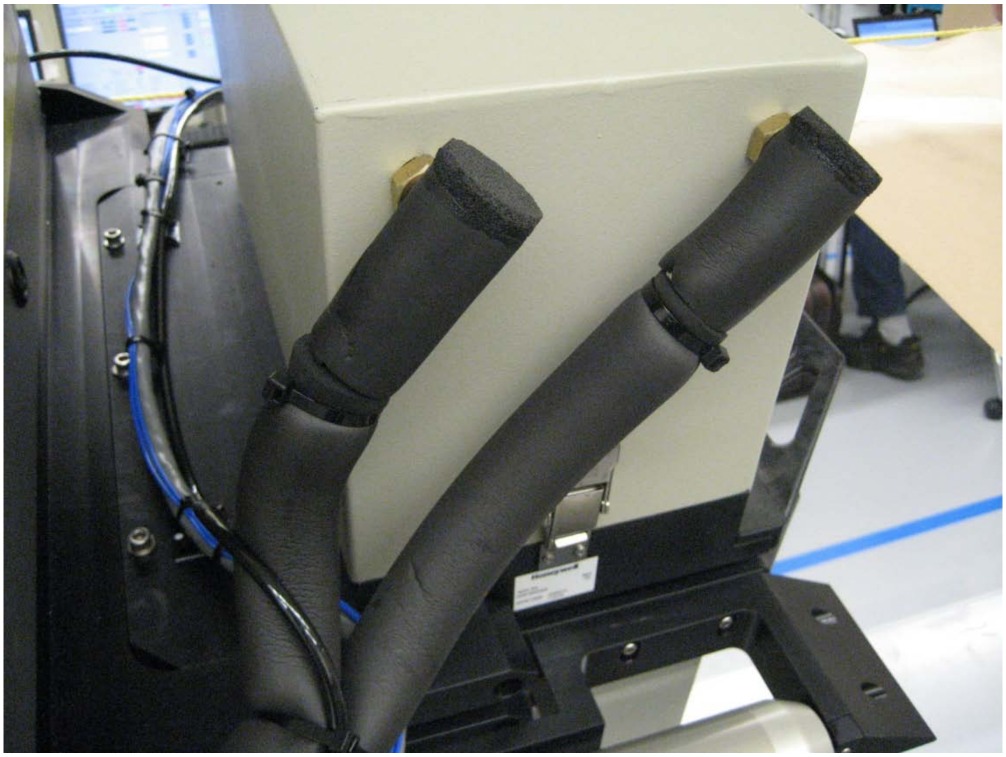


Figure 4-7 ESS Coolant Connections

WARNING

Do not leave the control head cover on a powered ESS without cooling water flowing. The control head sheet guide has heaters that run constantly and the head components will overheat without cooling. It is safe to leave the control head powered as long as the cover is off.

4.4.2. Air connections

1. Both the ESS control head and wheel head require filtered compressed air to operate. Ensure that the air supply at the entrance to the control and wheel heads is 40 psi. Regulate if necessary.

2. The control head air connection is a quick-disconnect fitting mounted onto the sheet guide next to the control head wiring harness connector.

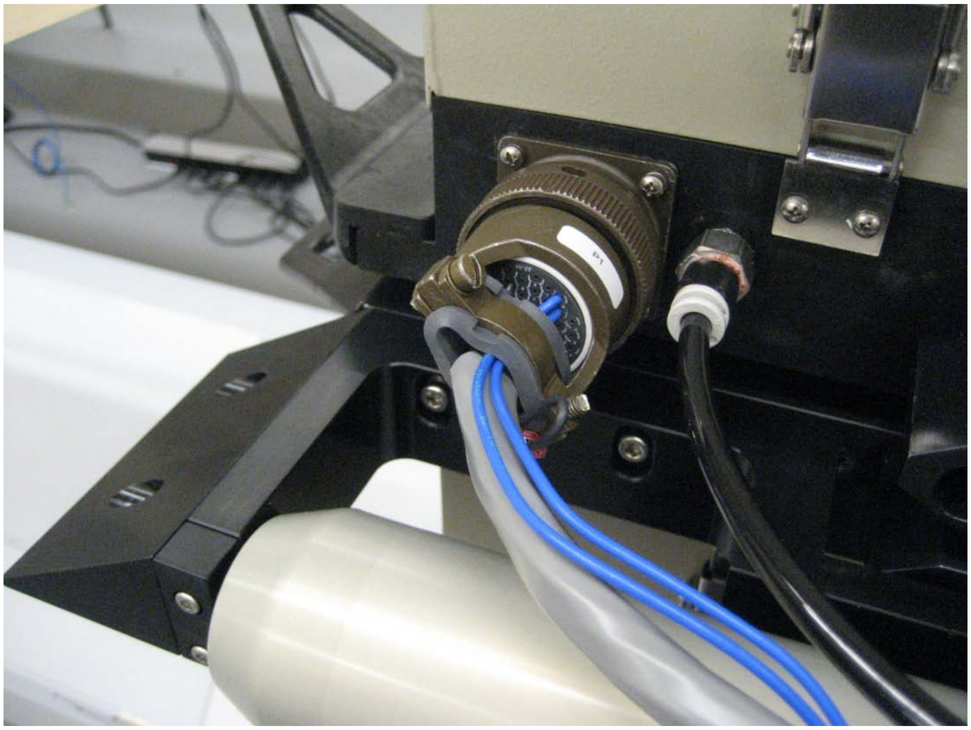


Figure 4-8 ESS Control Head Air Connection

3. The wheel head air supply is connected to main scanner air supply by tubing that extends out of the ESS wheel head cover.

4.5. Software setup

4.5.1. Sensor orientation

The wheel relies on magnets embedded within the assembly and adjacent Hall sensors to determine when to make measurements during the wheel's rotation. To ensure the data is parsed correctly, the direction of wheel rotation must be setup during software configuration through the selection of the correct template in the Configuration Browser. This in turn should set the database flag correctly.

Standing on the same side of the scanner as the ESS is mounted, determine whether the sheet will make the wheel rotate clockwise or counter clockwise. Set this configuration accordingly.

The path to the flag is:

/SCANNER 1/MSS/SS1 ESS/SETUP/WHEEL SPIN IS CW/CCW

4.5.2. Validity checks

The ESS needs to collect onsheet data for a couple of weeks in order to dynamically calibrate. To avoid any BAD EOS errors during this time, disable validity checks for all ESS processors in the **Measurement Setup** page.

4.5.3. Calibration certificate

When you receive your ESS sensor, a calibration certificate will be included. Within this certificate are calibration constants for the Z-sensor, load cells, as well as time-zero standardize results.

ATTENTION

Enter these factory calibration numbers using maintenance screen and the different ESS processors.

4.5.4. Sheet deflection default

To set the sheet deflection default:

1. Go to Measurement Setup display.
2. Select the measurement drop-down tab to show Sheet Deflect AVG.
3. Change the nominal and set point values to 3.0mm. Make sure you check your units.
4. ENSURE THAT THIS TARGET VALUE IS THE SAME FOR ALL GRADES!

4.6. System check

This procedure checks communication and all of the electro mechanical functions of the sensor.

4.6.1. Communication

The control card has three lights that show the communication status of the sensor.

- The leftmost light indicates power to the control card.
- The middle light indicates communication with the EDAQ.
- The rightmost light indicates communication with the I/O link in the lower main scanner head.

All three lights must be ON for the ESS to work properly. See Figure 4-8.

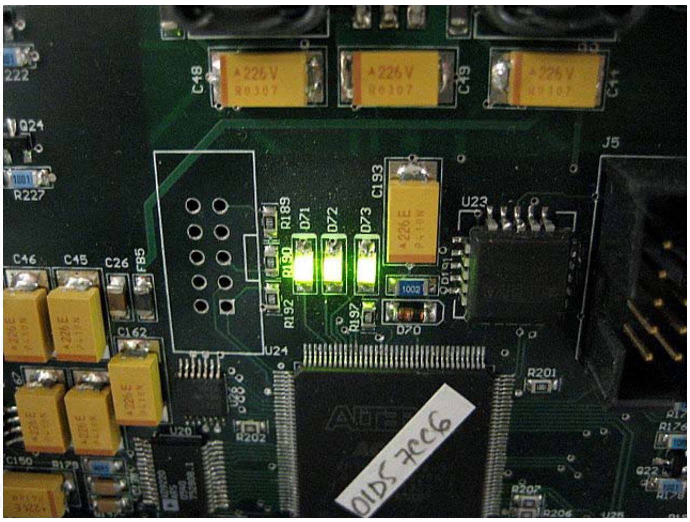


Figure 4-9 Control Card lights

4.6.2. Manual mode testing

The quickest way to determine if all electro-mechanical functions are working properly is to put the ESS into manual mode.

1. Remove the ESS control head cover.
2. Disable the ESS sensor set.
3. Go to **Sensor Maintenance → MSS Setup Diagnostics → MSS I/O Point Monitor**.
   a. Choose your MSS
   b. Card: ESS Control Head
   c. I/O Type: Digital Outputs
4. Turn off Remote Mode by de-selecting this button in the **New Digital** column (last row and showing ON in Figure 4-9 example). Make sure the

button in the **Now Digital** column in the Remote Mode row turns off, indicating the sensor has successfully received the command.

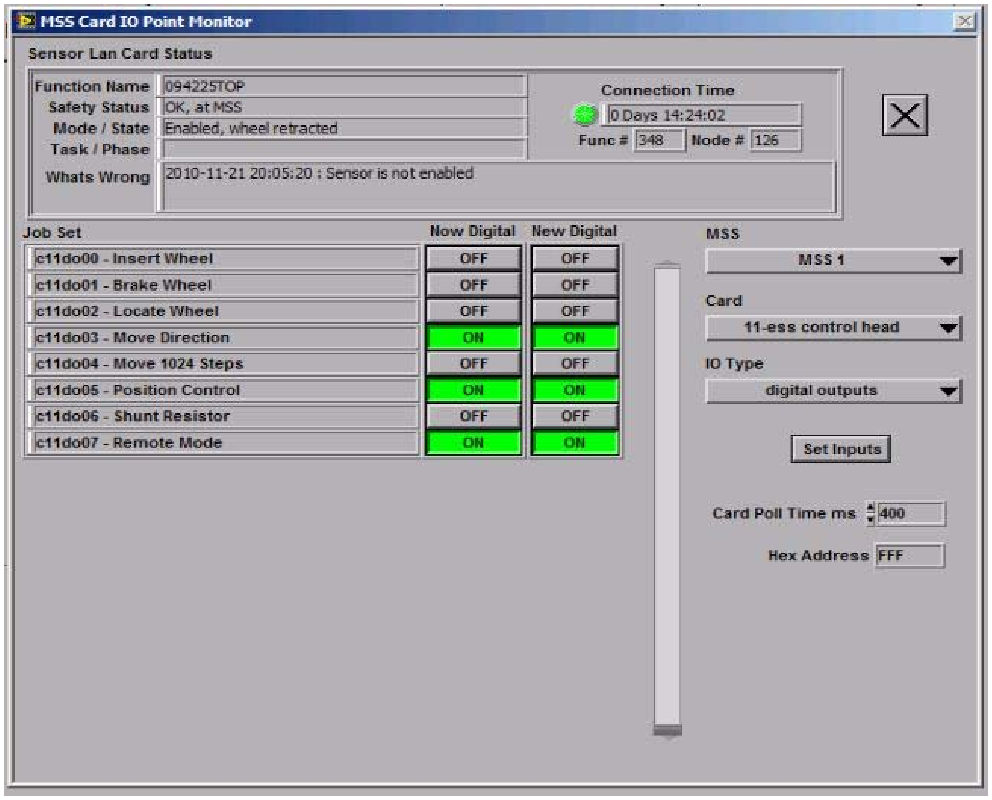


Figure 4-10 Turning off Remote Mode

5. Table 4-1 indicates how each function is controlled by the 4 push buttons. Note that the INSERT function is latched.

Table 4-1 Push Buttons

Push Button 1	Push Button 2	Push Button 3	Push Button 4	Action Taken by ESS Control Card
Pressed	Pressed			Insert Wheel (latched)
Pressed		Pressed		Brake Wheel
Pressed			Pressed	Locate Wheel
	Pressed	Pressed		Move stepper motor forward
	Pressed		Pressed	Move stepper motor backward
		Pressed	Pressed	Activate calibration resistors

6. Test all electro-mechanical functions of the sensor.

- Test the insert. It is a latched function and remains inserted until you engage it again using the push buttons.
- To test the brake, spin the wheel and engage the brake function and ensure the wheel stops spinning.
- Engage the locate function and ensure the wheel positions itself so that the counterbalance block on the wheel is at the lowest position.
- With the wheel inserted and located, move the wheel using the stepper motor control so that it positions itself to the upper most point and hits the insert limit switch. At this position, the wheel should be touching the Z-sensor cap in the upper head and will deflect the upper head slightly. If this does not occur, contact Honeywell Engineering for further instructions.
- You do not need to check the calibration resistors.

7. To return to remote mode, which is required for normal operation of the ESS:
    - Re-enable the ESS sensor set.
    - Turn on remote mode using the MSS I/O Point Monitor screen.
    - Clear safety faults.

4.7. Remote mode testing

1. Actuate the ESS functions remotely using the MSS I/O point monitor digital outputs. This is most easily done by connecting your laptop to the Experion scanner MSS and remote interfacing to the server.
2. Bring up the ESS analog inputs on the **MSS IO Point Monitor** page.
    - All load-cell voltages (MDA Normal/Tension, MDB Normal/Tension, CDA Normal/Tensions, CDB Normal/Tension) should be between 0 and 1V.
    - If the wheel is retracted, the Z-sensor voltage should be close to 10V. The voltage of the Z-sensor decreases if you insert the wheel and move it closer.

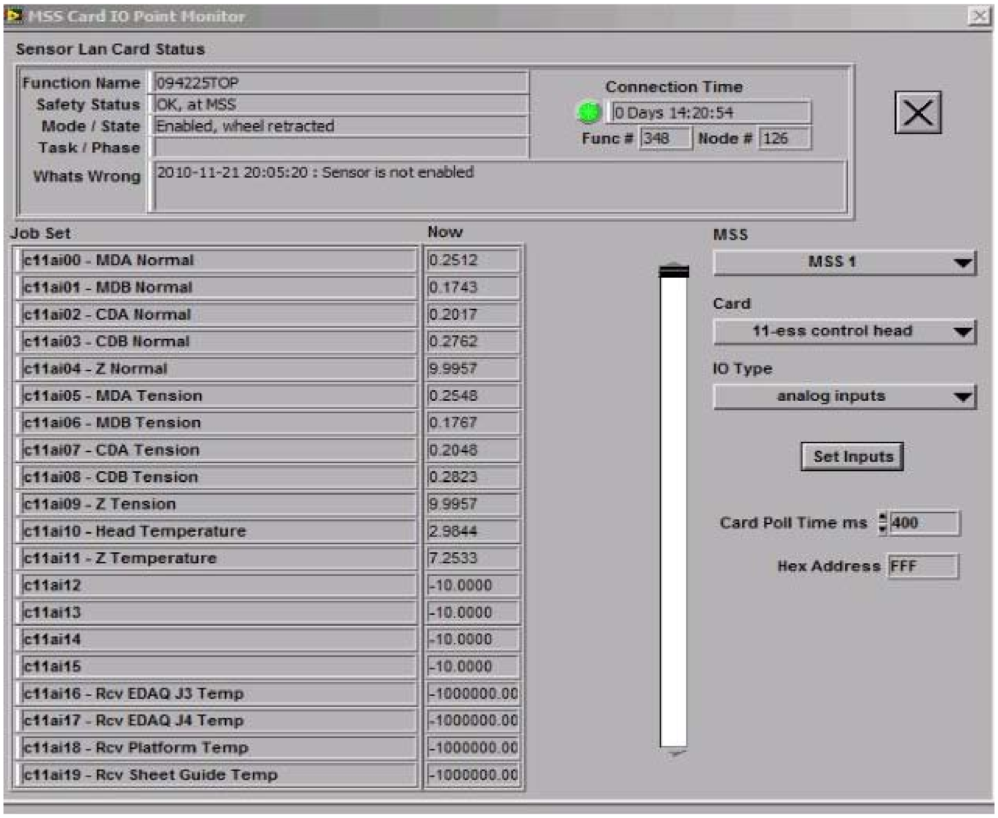


Figure 4-11 MSS Diagnostics for ESS

4.8. Auto Z calibration

Perform a Z-calibration. See Section 8.3.

4.9. Wheel spin test

This test ensures that the targeting algorithm and all supporting electro-mechanics are working properly.

1. Remove the wheel head cover.

2. With the sensor in remote mode set the following contact outputs using the MSS I/O point monitor:

Digital outputs

Insert: HIGH

Brake: LOW

Locate: LOW

Direction: LOW

Move 1024: LOW

Position Control: HIGH

Shunt Resistors: LOW

Mode: HIGH

Analog outputs

Analog Output: 6V

3. Spin the wheel using your hand to make sure the wheel is free of obstructions.
4. Using an air-jet, spin the wheel in the direction it would go as per the mill's sheet motion. The wheel should be spun to high speed (for example, more than 10 rotations per second).
5. Check that the analog input voltage is the same as the analog output. Keep the wheel spinning for the remainder of the test.
6. Squeeze the ESS sheet guides and watch to see that the wheel position compensates for this gap change immediately and tries to keep the distance between the wheel and the Z-sensor the same. The response should be real-time and not a slow step motion. This ensures the hall sensors are tracking wheel motion correctly.
7. Change the analog output to 5V and check that the wheel moves to the new target accordingly.
8. Retract the wheel when the test is complete. Clear safety faults if needed.

4.10. Getting Ready to Scan

This section describes the setup procedures for getting ready to scan the ESS onsheet.

4.10.1. Wheel Spin

1. Put the ESS onsheet. If running on light paper, your initial Z deflection value of 3.0mm may not be large enough to cause the wheel to spin (by friction against the sheet).

2. The sensor does not operate properly if the wheel is not spinning. Remove the ESS wheel head cover and then put the scanner into scan mode and do a visual check.

   Leaving the wheel cover off for a couple of hours will not damage the sensor.

3. Continue to increase the Sheet Deflection Avg (nominal and setpoint) from the **Measurement Setup** display, as shown in Figure 4-15, until wheel spin occurs (do not exceed 4.5mm), then continue to the next step.

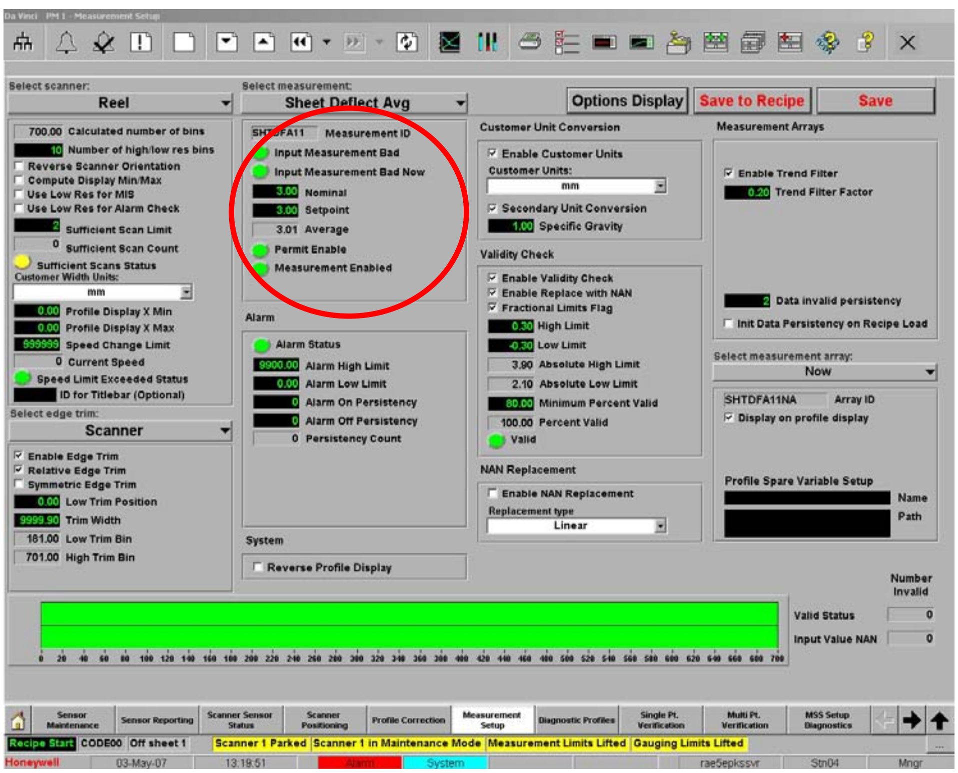


Figure 4-12 **Changing the ESS Deflection Target Values**

4.10.2. Insert / retract points and settling time

You want to insert the wheel once the ESS transducer cavity is fully onsheet and retract before the transducer cavity reaches the opposite edge going offsheet. The spot size of the transducer cavity is 127mm and is the minimum distance the sensor can reach, which respect to sheet edge, before wheel retraction/insertion needs to occur.

1. ESS insertion points relative to sheet edge are configured at: **Sensor Maintenance → Sheet Deflection Processor → Configuration Parameters → Positional Setup**.

2. Start with the default value of 300mm and work outwards towards sheet edge until a comfortable position is reached. The ESS must always retract before leaving the sheet. The spot size of the gauge is 127mm and represents the minimum insert/retract position relative to the sheet edge.

3. Measurements of extensional stiffness cannot be made until the wheel target position has been achieved. The settling time is defined by the variable Z TGT IO Time in units of ms and by default is set to 3000.

   This means that the system will wait three seconds after the wheel has been inserted before taking usable measurements. The targeting speed depends on the speed of the sheet.

4. Adjust the settling time accordingly, being careful not to lower this too much, otherwise you start taking measurement before wheel targeting has been completed and obtain erroneous values near the edges.

5. Z TGT IO time can be modified at: **Sensor Maintenance → Sheet Deflection Processor → Configuration Parameters → Time Periods→Z TG IO Time**.

   The best way to define a minimum Z TGT IO time is to look at the raw voltages from the Z-sensor and determine the position where it flat-lines and modify Z TGT IO accordingly.

6. The ESS will not insert onsheet until the sheet edges have been defined. This will take a full forward and backward scan. Furthermore, the ESS profiles are a stitching of a forward and backward scan due to the settling time mentioned previously. Thus, the first profile scan will look only partially complete.

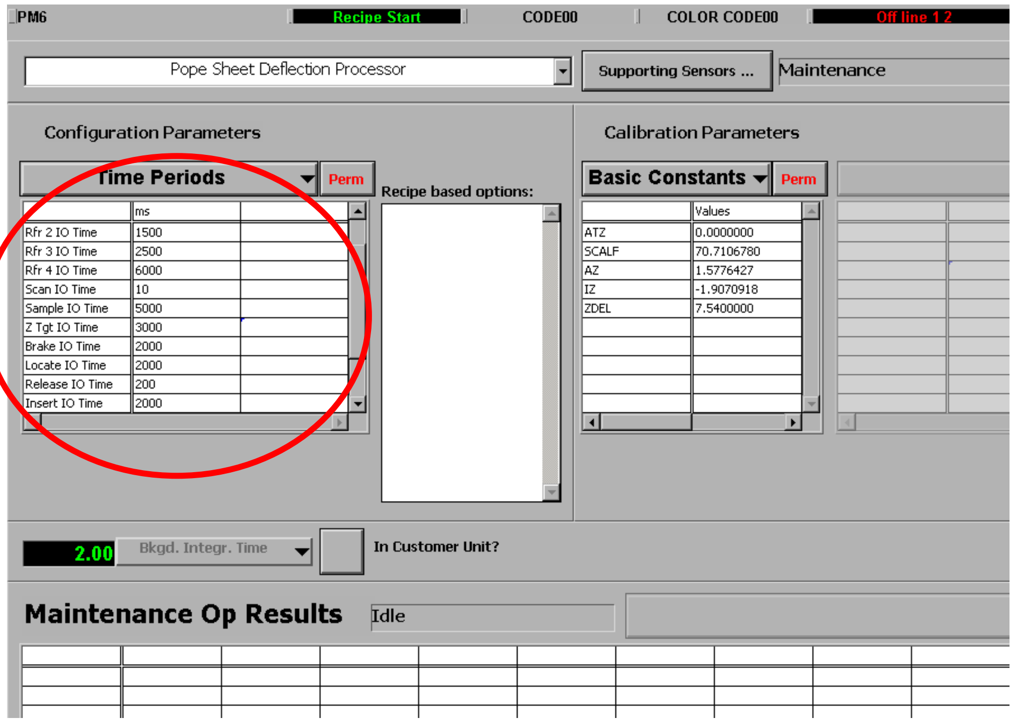


Figure 4-13 Modifying Settling Time

4.10.3. Sheet Deflection Calibration

Define the amount of deflection you wish to impose on the sheet. Too little deflection will not provide enough force on the load cells to ensure a usable measurement. Too much deflection could risk damaging the sheet and put undue wear on the load cells.

The purpose of this calibration procedure is to choose an appropriate value for the wheel's Z-target.

1. Perform this test on the lightest grade of product your machine produces. This ensures that adequate load-cell force will be present on all heavier grades.

2. Go to the MSS scan voltages page and display the ESS CDA Tension analog voltage input. This is the weakest of all the signals. With the ESS scanning and wheel inserting into the sheet, ensure that this load-cell signal is reading at least 0.2V above the noise floor. If it is less, increase the Sheet Deflection AVG value (nominal and setpoint) in 0.25mm increments until this occurs.

ATTENTION

It will take one full scan before the new deflection values take effect. Confirm by looking at the sheet deflection profile.

ATTENTION

Do not go past a sheet deflection setting of 4.5mm as this may damage the sheet. If you are unable to get adequate signal on the CDA Tension reading at this point, consult Honeywell Engineering for further instructions.

3. Make sure that the Z-target value you settle on is the same for all grades, otherwise, this target changes when a grade change occurs.

In some rare instances the Z-target calculated during this calibration procedure may be too high for the heaviest grades and could mark the sheet. In this case, define two z-targets, one for light grades and one for heavy grades. Follow the same procedure for the heavy grades of paper and generate a second set of calibration constants accordingly.

4.11. Wear in Period

Let the ESS wear in for one week. This will allow any wear patterns on the load-cell pads to be defined and avoid component signal drift during the dynamic calibration stage.

4.12. Dynamic Calibration

Once the ESS has completed its wear-in period, you can start dynamic calibration of the sensor. See Chapter 6.

5. Operations

The ESS control card has integrated SDAQ capability that allows it to communicate information to and from the scanner endbell through EDAQ. This chapter discusses the details of this bi-directional communication.

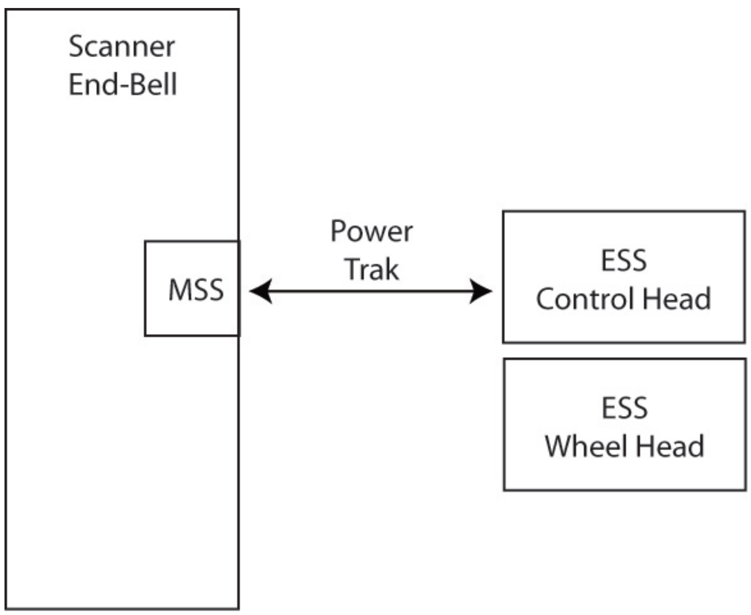


Figure 5-1 ESS Communication with Scanner

5.1. ESS Control Card to MSS signals

Table 5-1 lists the signals that are sent from the ESS to the MSS through the EDAQ. These signals come from the ESS control card and quantify the state of the load cells, Z-sensor, and temperature probes. Once these values are received, calibration constants are applied to convert the raw voltages into real physical values necessary for the calculation of extensional stiffness.

- **Channels 1 to 4**: Voltages from the four load cells when the wheel is in normal (peak) position. Using Experion MX calibration constants and offset data acquired during standardize, these voltage can be translated into real force values.

- **Channel 5**: Z-sensor voltage when the wheel is in normal (peak) position. Using Experion MX calibration constants and offset data acquired during standardize, this voltage can be translated into a real distance between Z-sensor and wheel. From this, the actual sheet deflection can be determined.

- **Channels 6 to 9**: Voltages from the four load cells when the wheel is in tension (lowest) position. Using Experion MX calibration constants and offset data acquired during standardize, these voltage can be translated into real force values.

- **Channel 10**: Z-sensor voltage when the wheel is in tension (lowest) position. Using Experion MX calibration constants and offset data acquired during standardize, this voltage can be translated into a real distance between Z-sensor and wheel. From this, the actual sheet deflection can be determined.

- **Channels 11 and 12**: Control card and Z-sensor temperature sensor voltages. Using Experion MX calibration constants, temperatures can be determined. The head temperature is used to monitor temperature of the upper head. An alarm will go off if this signal exceeds a user-defined limit. The Z-temperature signal is not currently used on this version of the sensor.

Table 5-1 Signals sent from ESS to MSS

Bit	Channel	Description
16 Bits	1	Load-Cell MD(A) : Normal
16 Bits	2	Load-Cell MD(B) : Normal
16 Bits	3	Load-Cell CD(A) : Normal
16 Bits	4	Load-Cell CD(B) : Normal
16 Bits	5	Z-Sensor : Normal
16 Bits	6	Load-Cell MD(A) : Tension
16 Bits	7	Load-Cell MD(B) : Tension
16 Bits	8	Load-Cell CD(A) : Tension
16 Bits	9	Load-Cell CD(B) : Tension
16 Bits	10	Z-Sensor : Tension
16 Bits	11	Control Card Temperature
16 Bits	12	Z-Sensor Temperature (not used)

5.2. MSS to ESS Control Card signals

Table 5-2 lists the digital signals that are sent from the MSS to the ESS through EDAQ. These signals are all binary *on* or *off* states transmitted to the ESS control card through an 8-bit word. These states are received by the ESS control card and then relayed to the various electro mechanical functions of the ESS.

- **Bit 0** controls the insert cylinder. When this bit is HIGH, the insert cylinder is activated using the INSERT solenoid and pushes the end stop of the stepper motor against the wheel head sheet guide. With the wheel inserted, changes in stepper motor motion will results in a corresponding change in the vertical position of the wheel. This function is available if bit 7 is HIGH.

- **Bit 1** brakes the wheel. The brake action is achieved using the BRAKE solenoid. When this bit is HIGH, the solenoid is activated and applies friction braking to the wheel shaft. This stops the wheel from spinning which is necessary when sensor begins standardization. This function is available if bit 7 is HIGH.

- **Bit 2** locates the wheel. When bit 2 is HIGH, the LOCATE solenoid is activated and the locate piston pushes against a cam in the locate/brake assembly. This piston will force the cam, and wheel, in a specific angular position. Locating the wheel ensures that standardization of the sensor is repeatable in terms of Z-sensor readings during Phases 2, 3, and 4. This function is available if bit 7 is HIGH.

- **Bit 3** is used to control the direction of the stepper motor movement. When this bit is HIGH, the stepper motor will cause the wheel to move away from the Z-sensor. When the bit is low the stepper motor will cause the wheel to move towards the Z-sensor. This assumes that the wheel has been inserted and that the motor stop is pressed against the sheet guide. This function is available if bit 7 is HIGH.

- **Bit 4** activates a command whereby the ESS control card sends 1024 step commands to the stepper motor driver in the lower main scanner head I/O link. This is used in Phase 3 of the standardize routine to test the stepper motor and Z-sensor. If the change in Z-sensor signal is not within an expected range during this defined movement, then a limit error is generated. This will help identify if there is a problem with the stepper motor. This function is available if bit 7 is HIGH.

- **Bit 5** enables the wheel targeting algorithm. When the bit is HIGH, the algorithm is activated. This function is available if bit 7 is HIGH.

- **Bit 6** enables the shunt resistor relays on the ESS Sensor control card. When the bit is HIGH the shunt resistors are connected to the load-cell circuit. This provides a check of the load-cell gain electronics and is used during Phase 4 of the standardize routine. If the results are outside a certain range, an error in standardize will be reported. This function is available if bit 7 is HIGH.

- **Bit 4+6** is a combination mode that is similar to the Move 1024 function, but in this case the stepper is limited to 500 steps. It is used during the auto calibration of the Z-sensor.

- **Bit 7** changes the mode of operation of the sensor from Manual (LOW) to Remote (HIGH). In remote mode all of the above commands are available for normal operation of the sensor. When the sensor is in manual mode, you can manually control each electro mechanical function listed by using push buttons located in the control head.

Table 5-2 Digital Signals sent from MSS to ESS

Bit	Function	Description
0	INSERT	Insert the Wheel
1	BRAKE	Brake the Wheel
2	LOCATE	Locate the Wheel
3	DIRECTION	Set direction of stepper motor motion
4	MOVE 1024	Move the stepper motor 1024 steps
5	POSITION CONTROL	Enable wheel-targeting algorithm
6	SHUNT RESISTORS	Enable shunt-resistor relays
4+6	MOVE 500	Move the stepper motor 500 steps
7	MODE	Change mode of operation.

There is one additional digital output from the MSS to ESS. The sensor maintains a constant sheet deflection value (through the wheel) while scanning. The amount of sheet deflection is initially defined at the operator station in units of distance.

Using the Z-sensor calibration constants, this user-defined distance is converted into an equivalent voltage the Z-sensor can understand and use for comparison. The stepper motor is adjusted to keep the desired and actual Z-sensor voltages the same within a small dead-band.

The target Z-sensor voltage is communicated to the ESS control card through a 16-bit word.

Bit	Function	Description
15…0	Z-target	Specifies the required target voltage on the Z-sensor.

5.3. Modes of operation

Table 5-3 summarizes the settings for the ESS during its different modes of operation. Specifically, it shows the states of the electro mechanical functions along with Z-targeting.

Table 5-3 Modes of Operation

Operation	Insert	Brake	Locate	Direction	Move 1024	Position Control	Shunt Resistors	Mode	Z Target
Bit	**0**	**1**	**2**	**3**	**4(*)**	**5**	**6**	**7**	**---**
Offsheet	LOW	LOW	LOW	LOW (*)	LOW (*)	HIGH	LOW	HIGH	+10V
Onsheet, off of sheet	LOW	LOW	LOW	LOW (*)	LOW (*)	HIGH	LOW	HIGH	+10V
Onsheet, over sheet	HIGH	LOW	LOW	LOW (*)	LOW (*)	HIGH	LOW	HIGH	Target
Sample	LOW	LOW	LOW	LOW (*)	LOW (*)	LOW	LOW	LOW	Target
Standardize Phase 1	HIGH	HIGH	LOW	HIGH (*)	LOW (*)	HIGH	LOW	HIGH	+10V
Standardize Phase 2	HIGH	LOW	HIGH	HIGH (*)	LOW (*)	HIGH	LOW	HIGH	+10V
Standardize Phase 3	HIGH	LOW	HIGH	LOW	HIGH	LOW	LOW	HIGH	+10V
Standardize Phase 4	HIGH	LOW	HIGH	HIGH (*)	LOW (*)	HIGH	HIGH	HIGH	0V

(*) When POSITION CONTROL is HIGH, contact outputs DIRECTION and MOVE 1024 are ignored and not relayed to the wheel head. The control card sends direction and move commands to the stepper motor as per the targeting algorithm

5.4. Standardize Operations

A four-phase standardize routine is used for the ESS. This routine checks all functions of the sensor with the exception of the Hall sensors in the wheel head.

Measurements made during standardize are saved and used to correct online Z-sensor and load cell offsets to ensure accurate stiffness measurements.

5.4.1. Wheel positions

Table 5-4 Wheel Positions during Standardize

Phases	Wheel Positions
Phases 1 and 2	Full Retraction – typically 7.6mm (0.30 in) below the Z-sensor cap and level with the control head pass line ring.
Phase 3	Insertion – typically 4.6mm (0.18 in) below the Z-sensor cap and 3.0mm (0.12 in) above the control head pass line ring
Phase 4	Full insertion – fully inserted against the Z-sensor cap.

ATTENTION

NOTE: No background operation is required for the ESS.

5.4.2. Phases of standardize

This section details system operation during each phase of standardize.

5.4.2.1. Phase 1

In Phase 1, the system prepares for standardize:

- System sets the INSERT contact output to lift the wheel to the approximate level of the pass line ring.
- System sets the BRAKE contact output to stop the spinning wheel.
- INSERT remains on throughout standardize.

5.4.2.2. Phase 2

In Phase 2, the system uses the Z-sensor to read the wheel position:

- System turns off the BRAKE contact output.

- System sets the LOCATE contact output to rotate the wheel to Normal Mode position (high point of the wheel) for a repeatable Standardize.
- System reads and stores the Z-sensor signal
- System reads and stores the Z-sensor and head temperatures.

LOCATE remains on throughout the remainder of standardize.

5.4.2.3. Phase 3

In Phase 3, the system moves the wheel to an intermediate position closer to the Z-sensor cap. The system uses the Z-sensor to read the wheel position. The load-cell signals are read with no force applied.

- System sends the stepper motor 1024 pulses to move the wheel towards the Z-sensor. This will move the wheel up approximately 3.15mm (0.124 in).
- The system reads and stores the Z-sensor signal.
    - This value is compared to the time-zero reading (that is, point of installation) and if it differs by more than a user-defined limit an alarm is generated.
    - If the difference in Z-sensor readings between Phase 2 and 3 of standardize – compared to that from time-zero – differs by more than a user-defined limit an alarm is generated.
- The system reads and stores all four zero-force load-cell signals. These signals are compared to those from time-zero and if they differ by a certain magnitude an alarm is generated.
    - Zero-force readings takes during Phase 3 of standardize will be subtracted from onsheet readings. This compensates for offset drift in the load cells.

5.4.2.4. Phase 4

In Phase 4, the wheel is moved towards the Z-sensor until it is touching the Z-sensor cap. The system reads the Z-sensor signal. The system reads all four load-cell signals with shunt resistors applied.

- System moves the stepper motor until it hits the INSERT limit switch. At this point, the wheel should be touching the Z-sensor cap. The control head sheet guide shifts upwards slightly when this operation occurs.

- The system reads and stores the Z-sensor signal in this position. All subsequent Z-sensor readings measured onsheet will have this value subtracted off, compensating for offset drift.
- System applies shunt resistors across each load cell's Wheatsone bridge and reads the signals. This is used to monitor the stability of the gain electronics in the ESS control card. Limits are applied and alarms generated if this drift exceeds a user-defined limit.
- System reads and stores the Z-sensor and head temperatures.

5.4.3. Calculations

The measurements obtained in the four phases of standardize are used to calculate the correction factors for scan measurement values.

5.4.3.1. Z-Sensor correction

During Phase 4 of standardize the wheel is pushed up against the Z-sensor cap. This measurement is used to correct for offset drifts that have occurred in the Z-sensor driver (due to temperature or other factors) or physical wear of the Z-sensor cap from the point the ESS was installed.

The correction factor is called DZST and is defined as

DZST = ZSTD4 – ZST40

Where ZSTD4 = Z-Sensor voltage at Phase 4 of standardize

ZSTD40 = Z-Sensor voltage at time-zero Phase 4 of standardize (that is, initial calibration reading at installation of the sensor)

All scanning Z-sensor measurements are corrected by subtracting the correction factor DZST from the current reading. This correction factor is updated during each standardize routine.

Z-Sensor Voltage (corrected) = Z-Sensor Voltage (now) – DZST

5.4.3.2. Z-Sensor limits

Using the corrected Z-sensor signal along with the intercept (IZ) and slope (AZ) of the Z-sensor calibration performed at time-zero, you can determine the physical position of the wheel at each phase of standardize.

ZD2 = IZ + AZ * ZTEM2	(Wheel position Phase 2)
ZD3 = IZ + AZ * ZTEM3	(Wheel position Phase 3)
DZ4 = AZ * DZST	(Wheel position shift Phase 4)
ZD23 = ZD2 – ZD3	(Wheel travel between Phase 2 and Phase 3)
Z3 = ZDEL – ZD3	(Wheel insertion at Standardize Phase 3)

where ZTEMX=corrected Z-sensor voltage during phase X of standardize.

If the wheel is not in the expected position within a certain limit, an alarm appears indicating a problem. This helps identify issues related to the stepper motor or Z-sensor and prevents the sensor from going onsheet when not working properly.

These limits are:

- If ABS (Z3-Z30) > Z3LIM
- If ABS (DZ4) > DZ4LIM
- If ABS (ZD23 – ZD230) > ZDLIM

The values for these limits can be modified in SENSOR MAINTENANCE (see Figure 5-2).

1. Choose **Sheet Deflection Processor**.
2. Choose **Limits** under calibration parameters
3. Modify the appropriate limit and click **Perm**.

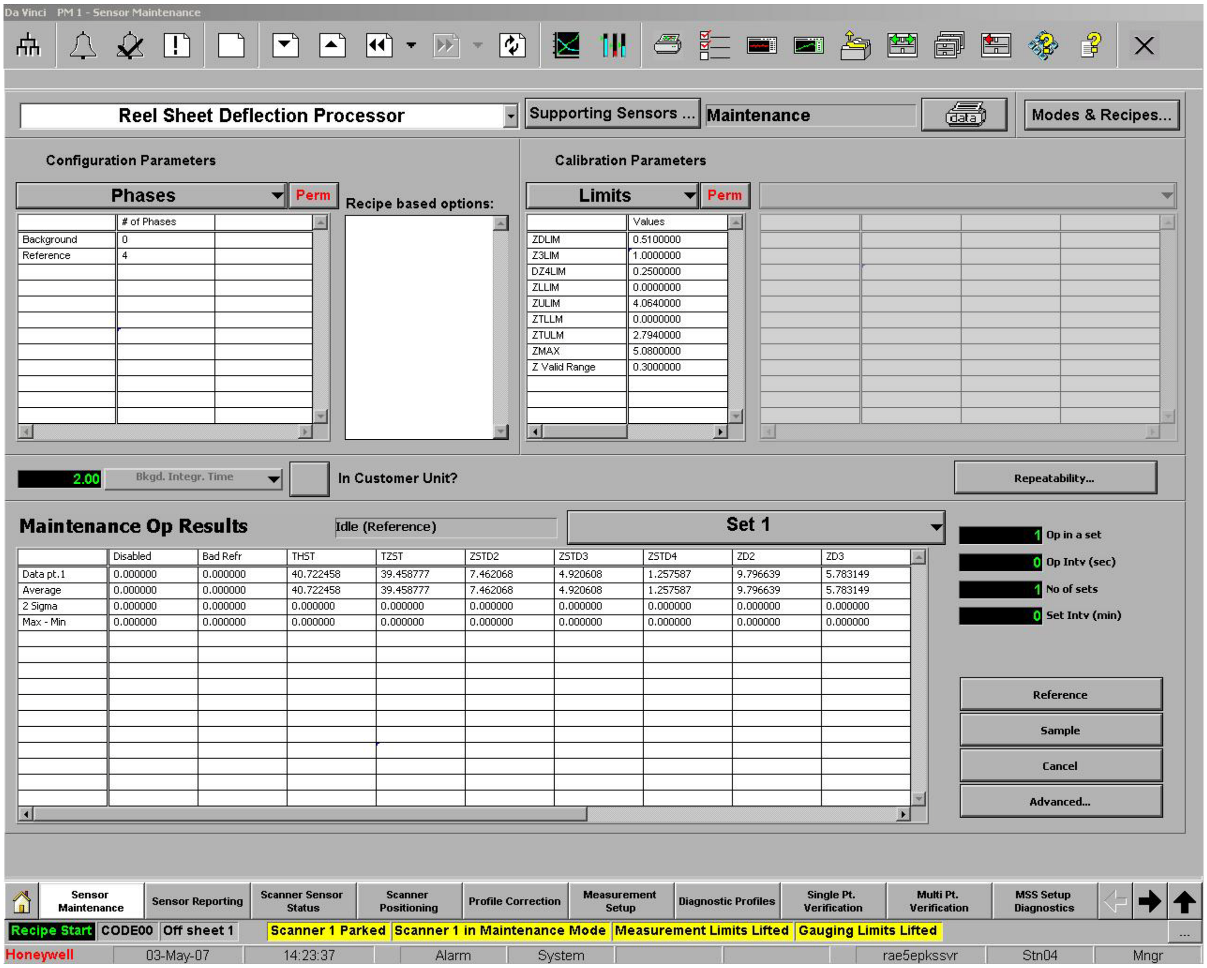


Figure 5-2 Sensor Maintenance, Sheet Deflection Processor

5.4.3.3. Load-Cell correction

Like the Z-sensor, the load cells must also be corrected for offset drift. The zero-load output voltage naturally drifts over time due to mechanical wear in the housing and internal strain gauges. It also varies slightly with temperature.

The correction factor for load cells is simply the zero-force signal measured during Phase 3 of standardize.

For example, consider the MDA load cell (that is, one of the load cells in the MD direction):

MDA Load-Cell Voltage (corrected) = MDA Load-Cell Voltage (current) – MDAST3

Where MDAST3 = zero-force load-cell signal measured on MDA during Phase 3 of standardize.

In addition to the above offset correction, there are also sensitivity corrections applied which compare the difference in load cell signal obtained in Phase 3 (no load) and Phase 4 (shunt resistor) to the corresponding difference that was measured at time-zero.

The shunt resistors quantify any drift in the control card gain electronics associated with the load-cell measurement. The following ratios calculate the fractional change in gain compared to installation.

$RLMDA = [\ MDAST_4 – MDAST_3\ ] / [\ MDAST40 – MDAST30\ ]$

$RLMDB = [\ MDBST_4 – MDBST_3\ ] / [\ MDBST40 – MDBST30\ ]$

$RLCDA = [\ CDAST_4 – CDAST_3\ ] / [\ CDAST40 – CDAST30\ ]$

$RLCDB = [\ CDBST_4 – CDBST_3\ ] / [\ CDBST40 – CDBST30\ ]$

MDAST40, MDBST40, CDAST40, CDBST40 are the signals for the MD forces during Phase 4 of standardize (taken at time-zero). MDAST30, MDBST30, CDAST30, CDBST30 are the signals for the MD forces during Phase 3 of standardize (taken at time-zero). MDXST, CDXST (where X = A or B) are the current values at standardize.

5.4.3.4. Load-Cell limits

The following limit checks are applied to the load-cell signals during standardize.

- If ABS (RLMDA -1) > MRSALIM
- If ABS (RLMDB – 1) > MRSBLIM
- If ABS (RLCDA – 1) > CRSALIM
- If ABS (RLCDB – 1) > CRSBLIM
- If ABS [MDAST3 – MDAST30] / [MDAST30] > MDALIM
- If ABS [MDBST3 – MDBST30] / [MDBST30] > MDBLIM
- If ABS [CDAST3 – CDAST30] / [CDAST30] > CDALIM
- If ABS [CDBST3 – CDBST30] / [CDBST30] > CDBLIM

The values for these limits can be modified in **Sensor Maintenance** (see Figure 5-3).

1. Choose **Reel Stress Processor.**

2. Choose **Limits** under calibration parameters.

3. Modify the appropriate limit.

4. Click **Perm** once the modifications have been made.

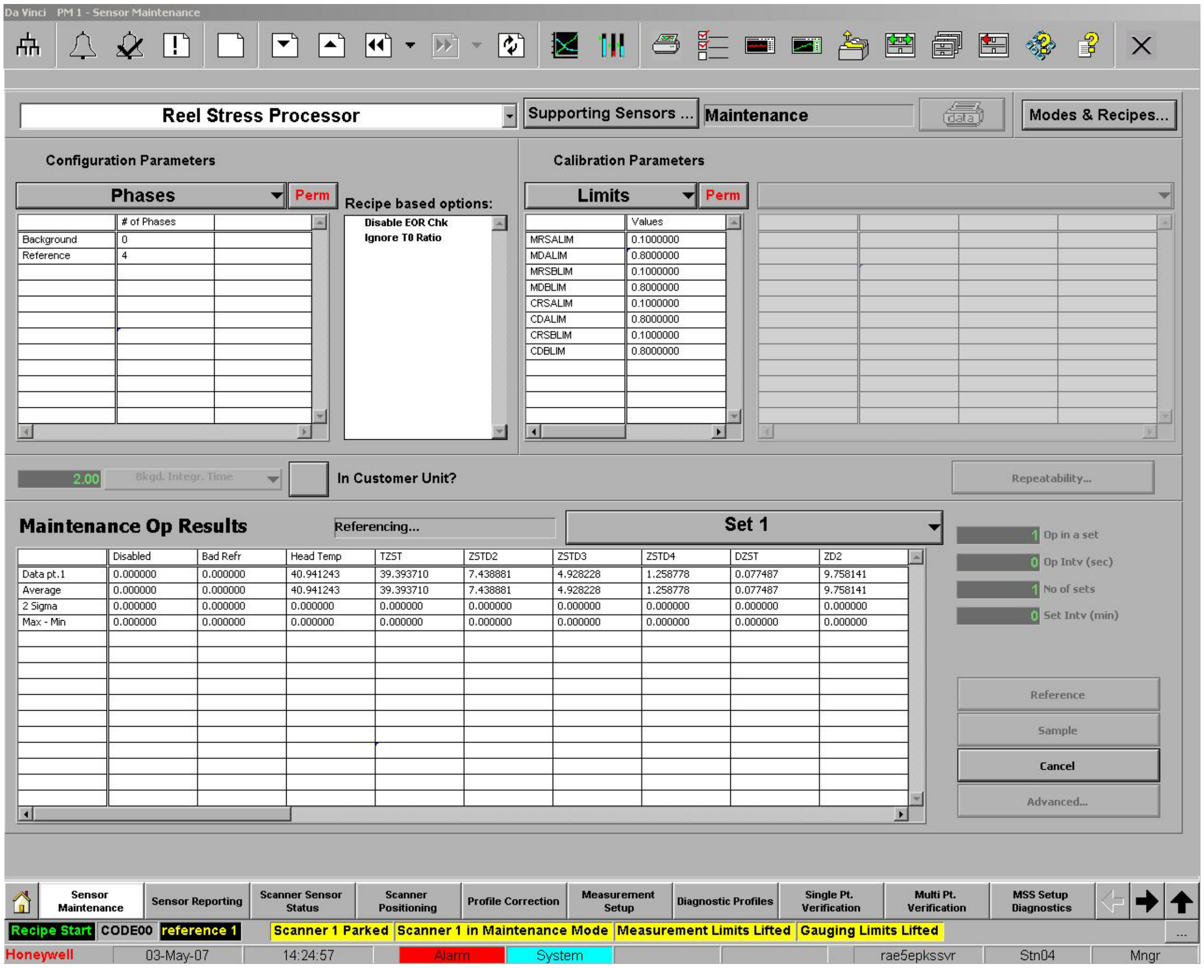


Figure 5-3 Sensor Maintenance, Stress Processor

5.5. Scanning Operations

During a scan, the twelve analog input channels from the ESS are read and stored in Now profile arrays. At the end of the scan, this data is combined with the moisture measurement to generate extensional stiffness and squareness measurements.

When Scan mode is initiated after Standardize, the following operations occur:

- Sensor is placed in onsheet mode so it is ready for scanning. This mode moves the stepper motor to the retract limit switch, forcing the wheel as far away from the Z-sensor as possible. The insert cylinder is not activated
- Scanner goes onsheet. The insert cylinder is activated which inserts the wheel. The ESS control card begins position control of the stepper to reach the user-defined target deflection.
- The twelve input channels are read for each bin. (This occurs after a settling time when the sensor is first inserted onsheet to ensure the targeting position has been reached)
- The system calculates, for each bin (i), the average readings and temperatures.
- After the sensor completes the scan the cycle repeats.
- The system stores the Normal and Tension mode physical profiles.

For each scan, the sensor performs these limit checks.

- Deflection limit check

If Zi > ZMAX then the sensor is disabled and the scanner is sent offsheet in order to avoid breaking the sheet. This check is made every bin during the scan.

- Scan average limit checks (performed at end of scan)

Scan averages are checked against limit values. If *any* of the limit values are exceeded, then a warning alarm is displayed and printed.

5.6. Calculations for stiffness

The twelve input channels of the ESS are read for each bin (i), and the calculated now readings are

- $ZNOW_i$ (Z-sensor normal)
- $MDANOW_i$ (MDA load cell normal)
- $MDBNOW_i$ (MDB load cell normal)
- $CDANOW_i$ (CDA load cell normal)

- $CDBNOW_i$ (CDB load cell normal)
- $ZTNW_i$ (Z-sensor tension)
- $MDATNW_i$ (MDA load cell tension)
- $MDBTNW_i$ (MDB load cell tension)
- $CDATNW_i$ (CDA load cell tension)
- $CDBTNW_i$ (CDB load cell tension)
- $TZS_i = IZT + AZT * TEMPZ$ (Z-sensor temperature)(no longer used)
- $THS_i = IHT + AHT * TEMPH$ (Head temperature)

5.6.1. MD and CD Profile Calculations

5.6.1.1. Normal mode

The normal mode (wheel at peak) bin data from the ESS is given unique variable names for the purpose of calculation.

$ZS = ZNOW_i$ Z-reading [V]

$MDAS = MDANOW_i$ MDA Load-Cell Reading [V]

$MDBS = MDBNOW_i$ MDB Load-Cell Reading [V]

$CDAS = CDANOW_i$ CDA Load-Cell Reading [V]

$CDBS = CDBNOW_i$ CDB Load-Cell Reading [V]

$ZTEM = ZS – DZST$ Z-Reading offset corrected [V]

$ZD = IZ + AZ * ZTEM$ Z-reading converted to distance [user*]

$Z_i = ZDEL – ZD$ Deflection of paper [user*]

* distance unit is user-defined

MDASGL = MDAS – MDAST3	MDA Load-Cell reading offset corrected
MDBSGL = MDBS – MDBST3	MDB Load-Cell reading offset corrected
CDASGL = CDAS – CDAST3	CDA Load-Cell reading offset corrected
CDBSGL = CDBS – CDBST3	CDB Load-Cell reading offset corrected

FMDA = ALMDA * MDASGL / RLMDA	MDA Converted Force [N]
FMDB = ALMDB * MDBSGL / RLMDB	MDB Converted Force [N]
FCDA = ALCDA * CDASGL / RLCDA	CDA Converted Force [N]
FCDB = ALCDB * CDBSGL /. RLCDB	CDB Converted Force [N]

FMD = FMDA + FMDB	Total MD Force [N]
FCD = FCDA + FCDB	Total CD Force [N]
$LMDC_i = FMD / Z_i$	MD Stress [N/m]
$LCDC_i = FCD / (Z_i – CDDEL)$	CD Stress [N/m]

5.6.1.2. Tension mode

$ZTS = ZTNW_i$	Z-reading [V]
$TMDAS = MDATNW_i$	MDA Load-Cell Reading [V]
$TMDBS = MDBTNW_i$	MDB Load-Cell Reading [V]
$TCDAS = CDATNW_i$	CDA Load-Cell Reading [V]
$TCDBS = CDBTNW_i$	CDB Load-Cell Reading [V]

ZTTM = ZTS – DZST	Z-Reading offset corrected [V]
ZDT = IZ + AZ * ZTTM	Z-reading converted to distance [user*]
$ZT_i = ZDEL – ZDT$	Deflection of paper [user*]

* distance unit is user-defined

$MDATSL = TMDAS - MDAST3$	MDA Load-Cell reading offset corrected
$MDBTSL = TMDBS - MDBST3$	MDB Load-Cell reading offset corrected
$CDATSL = TCDAS - CDAST3$	CDA Load-Cell reading offset corrected
$CDBTSL = TCDBS - CDBST3$	CDB Load-Cell reading offset corrected

$FMDAT = ALMDA * MDATSL / RLMDA$	MDA Converted Force [N]
$FMDBT = ALMDB * MDBTSL / RLMDB$	MDB Converted Force [N]
$FCDAT = ALCDA * CDATSL / RLCDA$	CDA Converted Force [N]
$FDCBT = ALCDB * CDBTSL / RLCDB$	CDB Converted Force [N]

$FMDT = FMDAT + FMDBT$	Total MD Force [N]
$FCDT = FCDAT + FCDBT$	Total CD Force [N]
$TMD_i = FMDT / ZT_i$	MD Stress [N/m]
$TCD_i = FCDT / (ZT_i - CDDEL)$	CD Stress [N/m]

5.6.1.3. Process

1. Store the Normal mode physical profiles Z_i, LMDC, $LCDC_i$ and the Tension Mode profile ZT_i , TMD_i, and TCD_i.
2. Use the above variables to calculate MD and CD extensional stiffness profiles.
3. Periodic limit check: if $Z_i > ZMAX_i$ then disable the sensor and send the scanner off sheet in order to avoid breaking the sheet. Scanning of the head is allowed when the **Extensional Stiffness Sensor Disable** switch is set.

5.6.1.4. Extensional stiffness

MD extensional stiffness

MD extensional stiffness is made up two factors. The true extensional stiffness profile and a squash correction that squashes the profile about its' mean. The variable C4 is the squash correction factor. A value smaller than 1 will squash the profile, a value larger than one will amplify it.

$\mathrm{MD\ STIFFNESS}_i = \mathrm{MD\_DFACT}_i + \mathrm{MD\_SQUASH}_i$ where

$\mathrm{MD\_SQUASH}_i = C4 * (\langle \mathrm{MD\_DFACT}_i \rangle - \mathrm{MD\_DFACT}_i)$, and

$\mathrm{MD\_DFACT}_i =$

$$\{1 + B1 \cdot (MOI_i - C1)\} \cdot \left\{ BDYN + B2 + B3 \cdot BW_i^{C2} + \frac{B4 \cdot TMD_i}{Z_i^{C3} - ZT_i^{C3}} + \frac{B5 \cdot LMDC_i}{Z_i^{C3} - ZT_i^{C3}} \right\}$$

where:

B1 = Coefficient of scan-average dependence on moisture

BDYN = Grade-dependent dynamic correction constant (offset) for scan-average customer measurement.

B2 = Grade-independent scan-average offset

B3 = Coefficient of scan-average dependence on basis weight (normally 0)

B4 = Coefficient of scan-average dependence on MD Tension Mode term

B5 = Coefficient of scan-average dependence on MD Normal Mode term.

C1 = Nominal Moisture (normally 7.5%)

C2 = Exponent of basis weight in scan-average customer measurement calculation

C3 = Exponent of Z in scan-average MD customer measurement calculation

CD extensional stiffness

$\mathrm{CD\_STIFFNESS}_i = \mathrm{CD\_DFACT}_i + \mathrm{CD\_SQUASH}_i$, where

$\mathrm{CD\_SQUASH}_i = C4 * (\langle \mathrm{CD\_DFACT}_i \rangle - \mathrm{CD\_DFACT}_i)$, and

$CD\_DFACT_i =$

$$\{1 + B1 \cdot (MOI_i - C1)\} \cdot \left\{ \begin{array}{l} BDYN + B2 + B3 \cdot BW_i^{C2} \\ + \dfrac{B4 \cdot TCD_i}{(Z_i - CDDEL)^{C3} - (ZT_i - CDDEL)^{C3}} \\ + \dfrac{B5 \cdot LCDC_i}{(Z_i - CDDEL)^{C3} - (ZT_i - CDDEL)^{C3}} \end{array} \right\}$$

where:

B1 = Coefficient of scan-average dependence on moisture

BDYN = *Grade-dependent* dynamic correction constant (offset) for scan-average customer measurement.

B2 = *Grade-independent* scan-average offset

B3 = Coefficient of scan-average dependence on basis weight (normally 0)

B4 = Coefficient of scan-average dependence on CD Tension Mode term

B5 = Coefficient of scan-average dependence on CD Normal Mode term.

C1 = Nominal Moisture (normally 7.5%)

C2 = Exponent of basis weight in scan-average customer measurement calculation

C3 = Exponent of Z in scan-average CD customer measurement calculation

CDDEL = CD Load-Cell pad height relative to MD load-cells pads. The MD load-cell pads are normally recessed by 0.254mm relative to the CD pads. Therefore, CDDEL is -0.254mm.

5.6.1.5. TSI calculation

Another way of expressing paper stiffness is using the Tensile Stiffness Index (TSI) which is defined as

TSI = Extensional Stiffness / BW

- TSI_MD = MD EXT STIFFNESS / BW
- TSI_CD = CD EXT STIFFNESS / BW

5.6.1.6. Squareness calculation

Two squareness (anisotropy or geometric mean) measurements can be output by the sensor:

- Extensional Stiffness Ratio = MD EXT STIFFNESS / CD EXT STIFFNESS
- Extensional Stiffness Geometric Mean = SQRT (MD EXT STIFFNESS * CD EXT STIFFNESS)

6. Dynamic Calibration

The ESS is a dynamic sensor. It can only obtain measurements on a moving sheet. Unlike other traditional sensors where you can calibrate static samples, the ESS requires a comparison of ESS results to lab data while the machine is running.

This section outlines the steps for performing dynamic calibration of the ESS. Its purpose is to relate online ESS measurements to lab results for all grades of paper produced at the mill. Since each mill's process and lab setup is different, calibration is mill specific. By collecting and cross-referencing sensor and lab data, calibration constants are generated that best represent this relationship.

The data of interest for dynamic calibration is the end-of-reel average. From the sensor side, you collect MIS report information. From the lab side, you collect the average of the profile taken from the end-of-reel test strip.

Calibration requires testing of each representative grade with at least 10 to 20 reels per grade.

6.1. Tags

The following tags should be setup in the customer's data collection system to grab the data for the ESS dynamic calibration process. Note that depending on your system and software configuration, there could be variations in the names.

6.1.1. General Tags

- Reel Code
- Reel Grade
- Timestamp

6.1.2. ESS Tags

- Sheet Deflection Average

./Application packages/Mis/Home/Winder 1/Shtdfa11 average/Data/Float result last

- Sheet Deflection Normal Average

./Application packages/Mis/Home/Winder 1/Shtdfn11 average/Data/Float result last

- Sheet Deflection Tension Average

./Application packages/Mis/Home/Winder 1/Shtdft11 average/Data/Float result last

- MD Stress Tension Average

./Application packages/Mis/Home/Winder 1/Mdst11 average/Data/Float result last

- MD Stress Normal Average

./Application packages/Mis/Home/Winder 1/Mdsn11 average/Data/Float result last

- CD Stress Tension Average

./Application packages/Mis/Home/Winder 1/Cdst11 average/Data/Float result last

- CD Stress Normal Average

./Application packages/Mis/Home/Winder 1/Cdsn11 average/Data/Float result last

- MD Extensional Stiffness Average

./Application packages/Mis/Home/Winder 1/Mdes11 average/Data/Float result last

- CD Extensional Stiffness Average

./Application packages/Mis/Home/Winder 1/Cdes11 average/Data/Float result last

- Basis Weight Average

./Application packages/Mis/Home/Winder 1/Bw11 average/Data/Float result last

- Moisture Average

./Application packages/Mis/Home/Winder 1/Ms11 average/Data/Float result last

Depending on your interest, you may also want to tag ESS TSI values. Of course, TSI is just extensional stiffness divided by basis weight and can be calculated later if necessary.

6.1.3. Lab Tags

Tags from the lab should be:

- MD Extensional Stiffness
- CD Extensional Stiffness
- Basis Weight Average
- Moisture Average

ATTENTION

If your lab only collects TSI results, generate extensional stiffness data from the simple relationship:

ES = TSI * BW [kN/m]

6.2. Lab data collection methodology

ESS dynamic calibration is dependent on high quality lab results. The more accurate and repeatable the lab data the better the ESS calibration and results. It is desirable to have ultrasonic Extensional Stiffness lab testing as the standard method because it is easily implemented, it can be integrated into an automated system, and it is subject to smaller fluctuations than destructive methods.

Discuss with the lab supervisory personnel their standard testing procedures. Work out an agreement for testing that uses standard testing whenever it is adequate and includes as much of the following criteria as is practical:

- Perform 10 to 25 lab extenstional stiffness measurements in both MD and CD direction spread evenly across the strip that represent the profile over which the ESS measures. Exclude the edge data where ESS does not measure if possible.
- For each strip, determine the average extensional stiffness in both MD and CD directions recorded for that particular reel ID.
- Collect end-of-reel average lab Moisture and Basis Weight.

- Collect at least 10 to 20 reels per grade for a representative set of grades.
- Ensure consistent moisture conditioning before doing lab measurements.
- Ensure data collection procedures that are complete and repeatable from operator to operator.

Error from a lab stiffness gauge is typically between 5 and 15% depending on the lab gauge and procedures being used. Because the ESS is being calibrated using lab results, the more repeatable the lab measurements the better the ESS results and future comparisons.

ATTENTION

The ESS calibration is only as good as the consistency of the lab data.

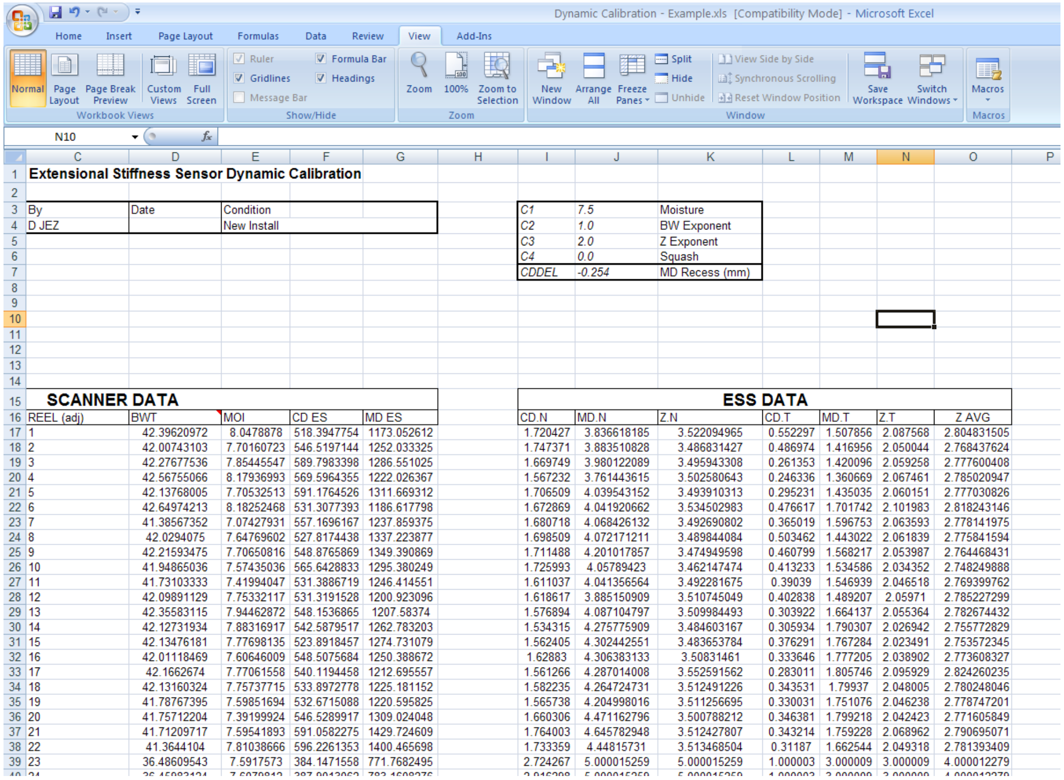
6.3. Dynamic Calibration spreadsheet

The ESS calibration spreadsheet is a tool for determining the dynamic calibration coefficients of the sensor. It uses both ESS online data and lab data to complete the fit. The actual process is quite simple, the most difficult part is collecting the data. If you can configure your data collection tool so it reports information in this order/format, it is simple to copy this data to the ESS spreadsheet for analysis.

ATTENTION

Obtain the spreadsheet from Honeywell Engineering.

Figure 6-1 shows the portion of the spreadsheet with scanner data copied. There is general information such as reel code, timestamp, BW, and MOI. After that, ESS data is entered according to the tags mentioned earlier in this chapter.



Extensional Stiffness Sensor Dynamic Calibration

By	Date	Condition
D JEZ		New Install

C1	7.5	Moisture
C2	1.0	BW Exponent
C3	2.0	Z Exponent
C4	0.0	Squash
CDDEL	-0.254	MD Recess (mm)

SCANNER DATA					ESS DATA						
REEL (adj)	BWT	MOI	CD ES	MD ES	CD.N	MD.N	Z.N	CD.T	MD.T	Z.T	Z AVG
1	42.39620972	8.0478878	518.3947754	1173.052612	1.720427	3.836618185	3.522094965	0.552297	1.507856	2.087568	2.804831505
2	42.00743103	7.70160723	546.5197144	1252.033325	1.747371	3.883510828	3.486831427	0.486974	1.416956	2.050044	2.768437624
3	42.27677536	7.85445547	589.7983398	1286.551025	1.669749	3.980122089	3.495943308	0.261353	1.420096	2.059258	2.777600408
4	42.56755066	8.17936993	569.5964355	1222.026367	1.567232	3.761443615	3.502580643	0.246336	1.360669	2.067461	2.785020947
5	42.13768005	7.70532513	591.1764526	1311.669312	1.706509	4.039543152	3.493910313	0.295231	1.435035	2.060151	2.777030826
6	42.64974213	8.18252468	531.3077393	1186.617798	1.672869	4.041920662	3.534502983	0.476617	1.701742	2.101983	2.818243146
7	41.38567352	7.07427931	557.1696167	1237.859375	1.680718	4.068426132	3.492690802	0.365019	1.596753	2.063593	2.778141975
8	42.0294075	7.64769602	527.8174438	1337.223877	1.698509	4.072171211	3.489844084	0.503462	1.443022	2.061839	2.775841594
9	42.21593475	7.70650816	548.8765869	1349.390869	1.711488	4.201017857	3.474949598	0.460799	1.568217	2.053987	2.764468431
10	41.94865036	7.57435036	565.6428833	1295.380249	1.725993	4.05789423	3.462147474	0.413233	1.534586	2.034352	2.748249888
11	41.73103333	7.41994047	531.3886719	1246.414551	1.611037	4.041356564	3.492281675	0.39039	1.546939	2.046518	2.769399762
12	42.09891129	7.75332117	531.3191528	1200.923096	1.618617	3.885150909	3.510745049	0.402838	1.489207	2.05971	2.785227299
13	42.35583115	7.94462872	548.1536865	1207.58374	1.576894	4.087104797	3.509984493	0.303922	1.664137	2.055364	2.782674432
14	42.12731934	7.88316917	542.5879517	1262.783203	1.534315	4.275775909	3.484603167	0.305934	1.790307	2.026942	2.755772829
15	42.13476181	7.77698135	523.8918457	1274.731079	1.562405	4.302442551	3.483653784	0.376291	1.767284	2.023491	2.753572345
16	42.01118469	7.60646009	548.5075684	1250.388672	1.62883	4.306383133	3.50831461	0.333646	1.777205	2.038902	2.773608327
17	42.1662674	7.77061558	540.1194458	1212.695557	1.561266	4.287014008	3.552591562	0.283011	1.805746	2.095929	2.824260235
18	42.13160324	7.75737715	533.8972778	1225.181152	1.582235	4.264724731	3.512491226	0.343531	1.79937	2.048005	2.780248046
19	41.78767395	7.59851694	532.6715088	1220.595825	1.565738	4.204998016	3.511256695	0.330031	1.751076	2.046238	2.778747201
20	41.75712204	7.39199924	546.5289917	1309.024048	1.660306	4.471162796	3.500788212	0.346381	1.799218	2.042423	2.771605849
21	41.71209717	7.59541893	591.0582275	1429.724609	1.764003	4.645782948	3.512427807	0.343214	1.759228	2.068962	2.790695071
22	41.3644104	7.81038666	596.2261353	1400.465698	1.733359	4.44815731	3.513468504	0.31187	1.662544	2.049318	2.781393409
23	36.48609543	7.5917573	384.1471558	771.7682495	2.724267	5.000015259	5.000015259	1.000003	3.000009	3.000009	4.000012279

Figure 6-1 Scanner Data

Figure 6-2 shows the corresponding lab data. If you collect destructive test data such as STFI or ring-crush, keep this information in the spreadsheet also, in case you wish to develop correlations in the future.

To the right of the lab data in Figure 6-2 are some calculations that do not require user intervention.

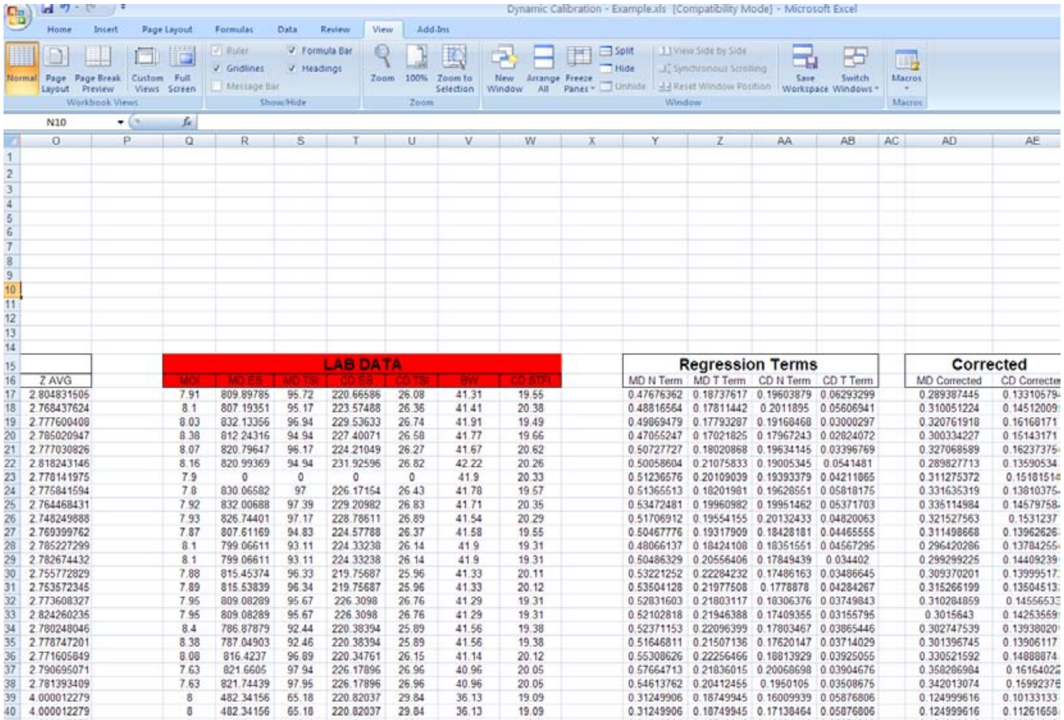


Figure 6-2 Lab Data

In Figure 6-3, the specific calibration parameters for either MD or CD measurement are determined. This is based on a X-Y fitting of online extensional stiffness against lab data using the math outlined in Chapter 5. A closeup of this section is provided on Figure 6-4. The calibration parameters are BDYN, B1, B2, B3, B4, and B5.

- BDYN: Grade-dependent offset. Typically zero.
- B1: Moisture correction factor. Typically left at 0.05.
- B2: Grade independent offset.
- B3: Basis weighting factor. Typically zero.
- B4/B5: Dynamic Response factors.

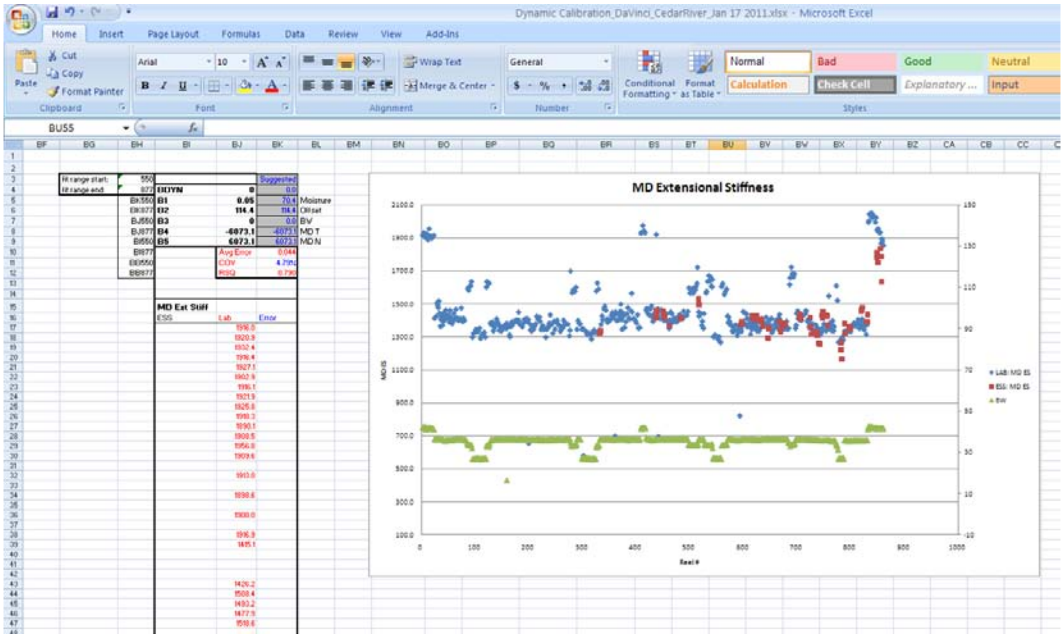


Figure 6-3 Calibration Parameters and plot of lab versus ESS extensional stiffness

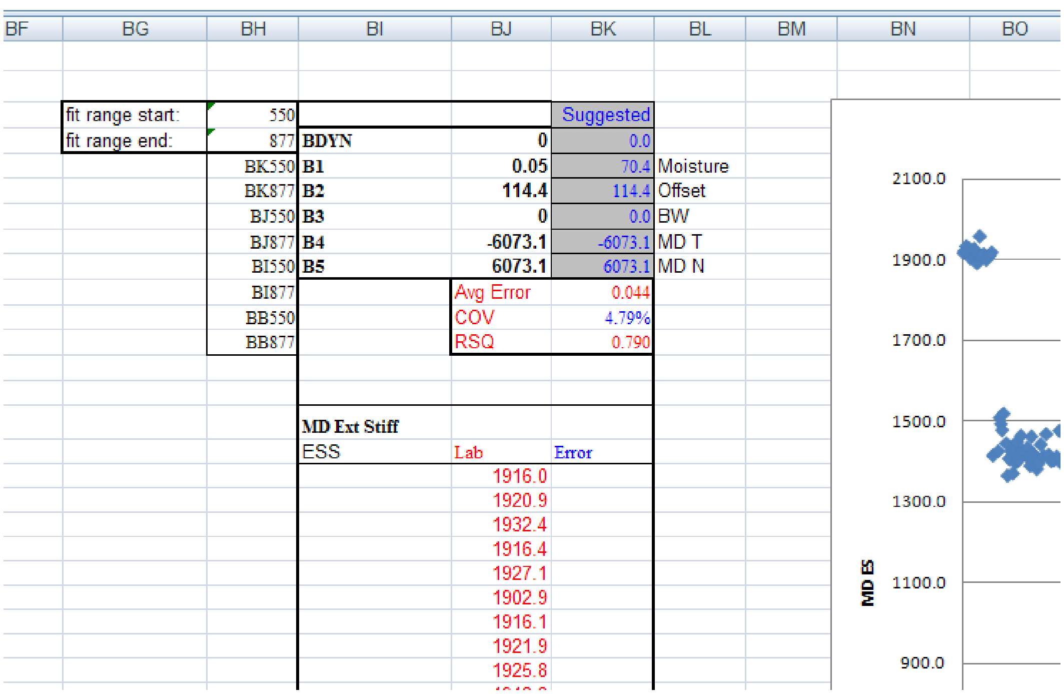


Figure 6-4 Modifying Calibration Parameters

Figure 6-4shows a close-up of the calculation area. The standard methodology is:

1. Set B5 to the suggested value in the gray cell
2. Set B4 to equal the negative of B5.
3. Set B2 to the suggested value in the gray cell
4. Iterate.

Follow this procedure for both the MD and CD data. Additional parameters include the moisture correction factor and the basis factor. Their influence on the extensional stiffness results can be determined by looking at the mathematical relationship outlined in Chapter 5.

Examine the comparison between ESS and lab data to determine quality of the calibration. If there are differences between the two at the lowest grade range, try setting the deflection target higher.

6.4. Entering Calibration Coefficients

The calibration coefficients for both MD and CD direction can be entered on the Maintenance Screen under the stiffness processor.

6.5. Tension Issues

6.5.1.1. End-of-Reel limits checks

The ESS may be adversely affected by extreme changes in sheet tension around reel turn-up. In order to prevent this distorted reading from being reported to the end user, limits on the MD and CD readings are imposed at turn-up time.

6.5.1.2. Limit check period

The End of Reel Limit check function detects slackness in the sheet after a reel turn-up that causes the ESS stiffness readings to drop. The test keeps a running average of the four stress values during reel buildup. When the end of a reel is detected, on the next scan the average value of the four stress values calculated for the scan are compared to the averages for the previous reel. If the values are off by the specified limit for either stress value, the Out Of Limit flag is set. In this case the actual stiffness values calculated for the scan are replaced by the trended average from the last reel to prevent the filter from becoming contaminated with the out of range values.

Limit Check parameters are available in the top leftmost listbox of the Sensor Maintenance display when the Stress Processor is selected. They can be changed when in Maintenance mode. There is a separate upper and lower limit for each stress value and they are percent values around the trended average. A lower limit of .3 means that the stress value can be as low as 70% of the trended average and pass the test. You can also set the number of scans to check and whether or not you want the end-of-reel check enabled or disabled.

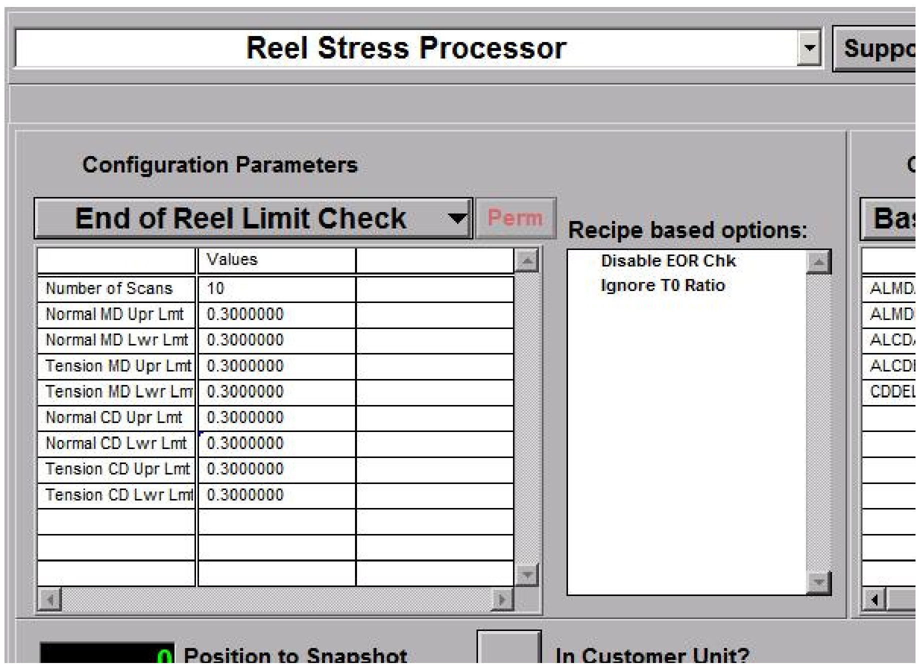


Figure 6-5 End of reel limit check parameters in Sensor Maintenance

7. Maintenance

7.1. Preventive Maintenance

Preventive maintenance procedures are minimal. The frequency of preventive maintenance procedures is often defined by the operating environment.

Table 7-1 Preventive Maintenance Internal checklist

Procedure	Daily	Weekly	Months		Years			Task Details
			1	6	1	3	5	
Remove Buildup	X							See Section 8.1
Inspect for Wear		X						See Section 8.2
Check Z-calibration			X					See Section 8.3
Inspect the Locate Piston				X				See Section 8.4
Check all Electro-Mechanical functions				X				See Section 8.5
Replace the Brake					X			See Section 8.6
Replace Load Cells/Pads						X		See Section 8.7
Load Cell Calibration					X			See Section 8.8
Replace the Wheel						X		See Section 8.9
Replace the Stepper Motor Assembly							X	See Section 8.10

8. Tasks

This chapter contains procedures for maintaining optimal ESS function and troubleshooting issues with the sensor.

Due to the electro mechanical nature of this sensor, it will be necessary to replace parts from time to time. This section outlines the procedures recommended for replacing the more complex assemblies. Items like solenoids are not discussed.

8.1. Remove Buildup

Remove buildup on the ESS load-cell pads on a regular basis. Unlike the caliper sensor where even a small amount of buildup can cause significant issues with the measurement, the ESS is much more forgiving but should still be kept relatively clean.

More importantly, remove any debris buildup between the load-cell pads, otherwise cross-coupling can occur between load cells and could compromise the ESS measurement.

Activity Number:	Q4225-60-ACT-001	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Operator
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 day
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
	Part Number	Quantity	Lead Time

Required Parts:	
Required Tools:	Kerosene or isopropyl alcohol Clean cloth Knife

1. Take the sensor offsheet.
2. Release the clutch on the scanner and split the heads to allow access to the transducer cavity in the control head.
3. Carefully scrape the waxy pitch buildup from the top of the four load-cell pads and from the pass line ring. Apply kerosene or isopropyl alcohol to a clean cloth and wipe the pads and rings.

CAUTION

Be careful not to hit or press on the load-cell pads with more than 10 pounds of force. Damage to the load cells may result.

4. Use a thin knife to remove any debris between the load-cell pads.
5. Using the same technique as step 3, clean the contacting surface of the wheel.
6. Using an available air supply, carefully blow out debris from the transducer cavity.
7. Inspect the opening around the wheel to look for material that may have fallen into the lower head. Remove the lower head cover and remove debris as required.
8. If dirt build-up is low/high on a daily basis, adjust the cleaning schedule accordingly.

If the MD or CD signals show a step change in reading after completing this procedure, clean more frequently.

8.2. Inspect for Wear

Due to the contacting nature of the sensor's load-cell pads and wheel, it is important to inspect the sensor on a regular basis for wear and possible replacement of these contacting components.

Activity Number:	Q4225-60-ACT-002	**Applicable Models:**	All
Type of procedure:	Inspect	**Expertise Level:**	Technician,
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 day
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
	Part Number	Quantity	Lead Time
Required Parts:			
Required Tools:			

1. Take the sensor offsheet.
2. Release the clutch on the scanner and split the heads to allow access to the transducer cavity in the control head.
3. Carefully inspect the load-cell pads for wear. If the pad material is worn so the paper is now sliding across the pad holder, consider replacement (See Section 8.7). Look for possible movement of the load-cell pad within the holder. If this occurs, contact Honeywell Engineering for further instructions.

CAUTION

CAUTION:	Be careful not to hit or press on the load-cell pads with more than 10 pounds of force. Damage to the load-cells may result.

4. Rotate the wheel and look for signs of wear. This will manifest as a flat portion typically located at the wheel's highest point of rotation. Significant wear on the wheel indicates that it should be replaced.

8.3. Check Z-Calibration

A Z-calibration should be performed during installation and once a month to ensure that the calibration constants of the sensor have not drifted. Drift of these values would lead to a drift in the target position and the overall measurement.

Activity Number:	Q4225-60-ACT-003	**Applicable Models:**	All
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
	Part Number	Quantity	Lead Time
Required Parts:			
Required Tools:	Kerosene, knife		

This section outlines the steps for performing a calibration of the ESS Z-sensor. This procedure determines the slope and intercept of the Z-sensor voltage output as a function of distance between the Z-sensor probe and the wheel. This is used to convert raw Z-sensor voltages to physical distance values. It will also record the time-zero values at the different phases of standardize.

1. Enter Frame: **Scanner/Sensor → Sensor Maintenance.**
2. Choose **Sheet Deflection Processor** on the top left of the sensor maintenance screen.

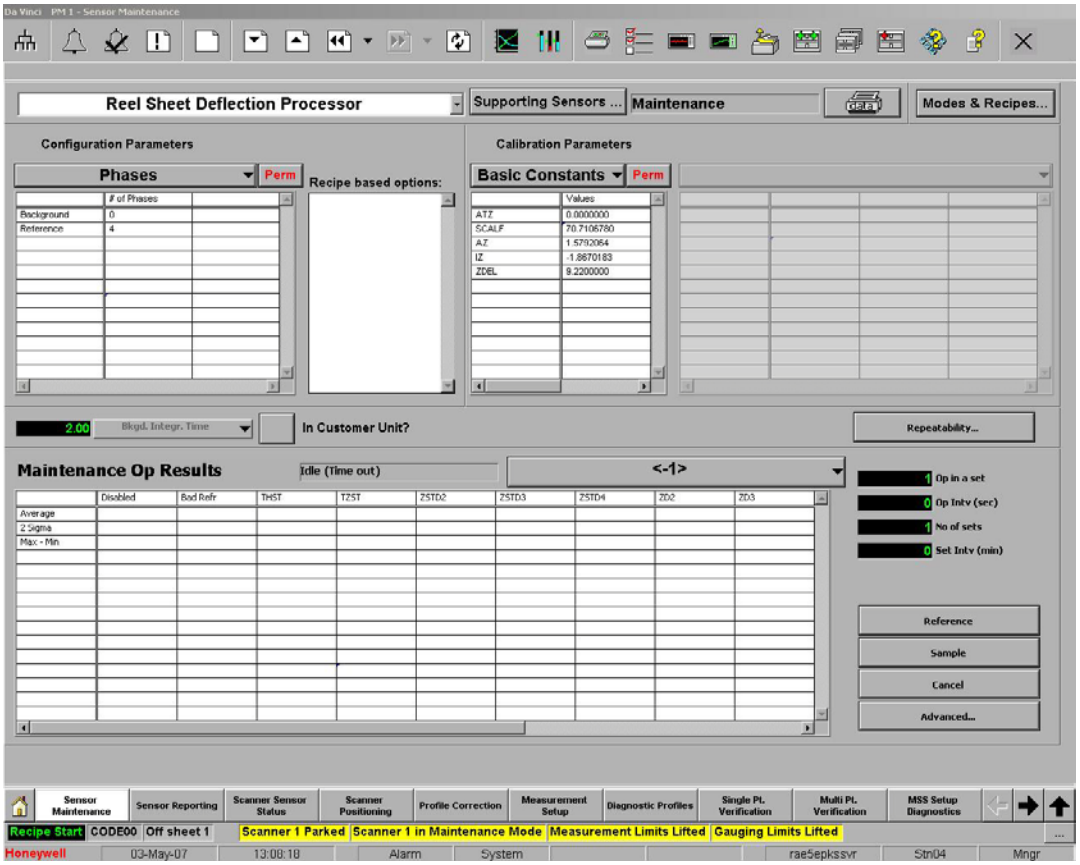


Figure 8-1 Auto-Z Calibration: Choosing Z-Sensor Processor

3. Enter Maintenance Mode through **Modes & Recipes → Retrieve Recipe → Enter Maint**.

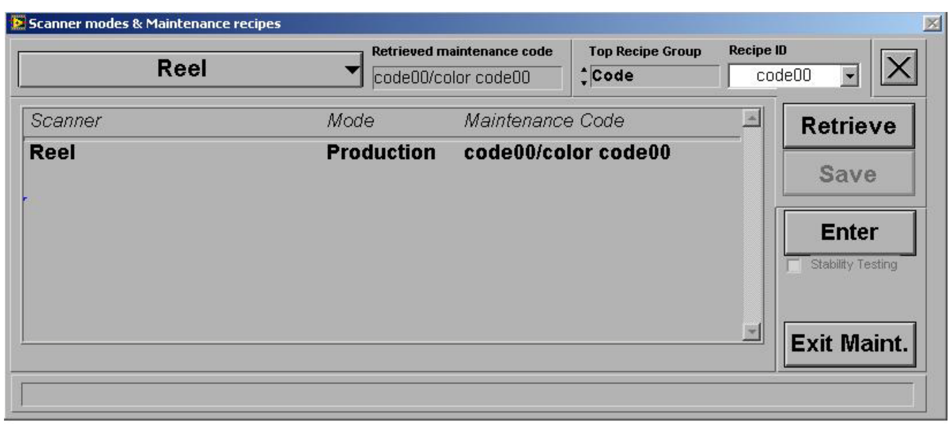


Figure 8-2 Auto-Z Calibration: Retrieve Maintenance Code

4. Choose **Advanced** (bottom right) from the main display to enter into the Z-calibration window.

5. Make sure that **Cold** is selected as the type of calibration.

6. Click **Calibrate**. The sensor performs an initial standardize, then several samples at different wheel positions, followed by a final standardize. When this is completed, a linear fit will be applied to the data (estimated calibration time is five minutes).

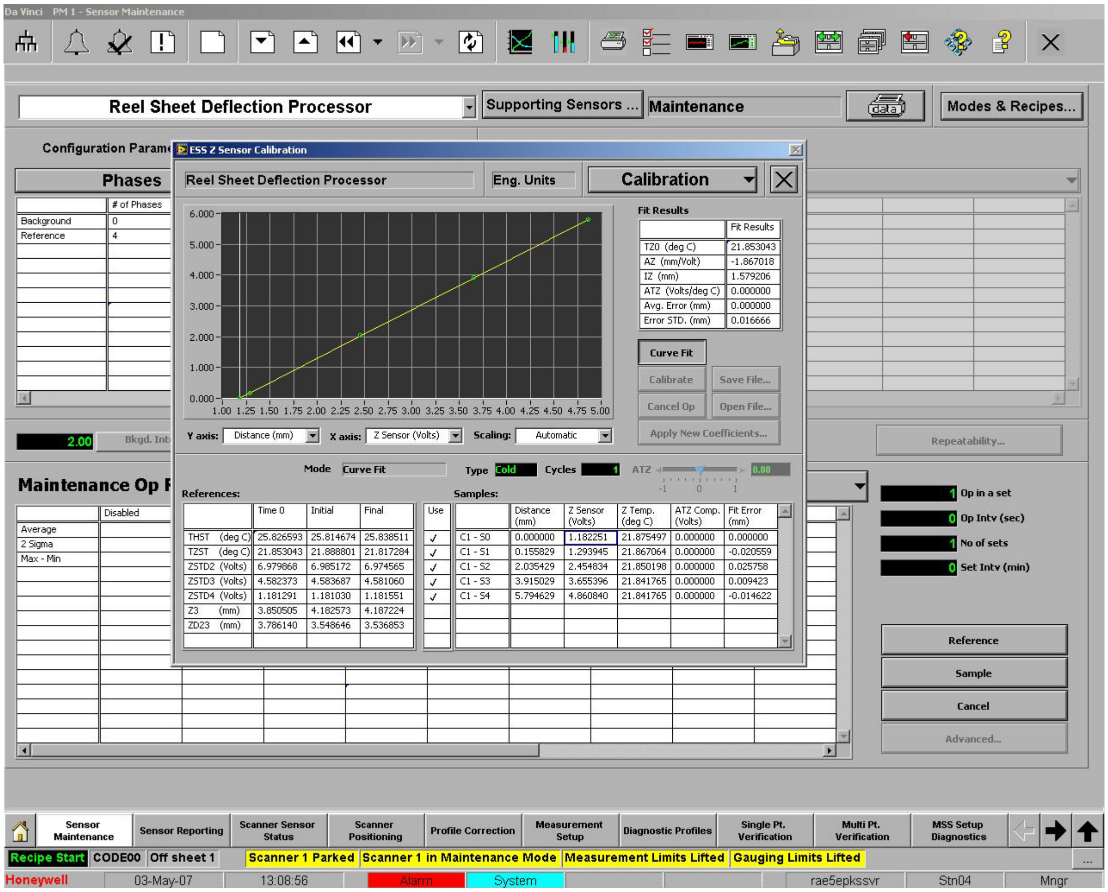


Figure 8-3 Auto-Z Calibration: Calibrate

7. If any of the error values in the **Fit Results** table show up in red on the display, this means the fit is bad. Check that there's no dirt on the wheel or Z-sensor cap that could affect the calibration. Run the calibration again. If the error values are not red, then click off **Curve Fit**.

8. To apply the new coefficients, click **Apply New Coefficients**. A new frame appears that shows what is going to be changed in your setup. The left column is the slope, intercept, and ATZ value (temperature compensation variable, not used here). The right column shows all the updated time-zero values for standardize. Leave all the parameters checked.

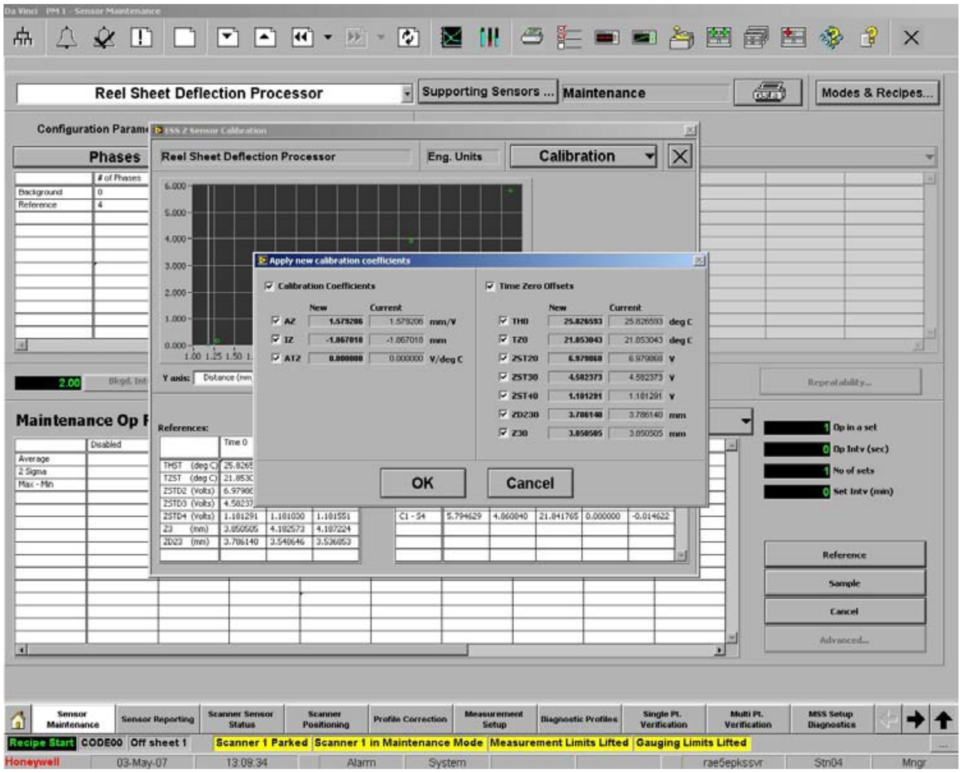


Figure 8-4 Auto Z Calibration: Applying Coefficients

9. Click **OK** to apply the new coefficients.

10. Close the Auto-Z calibration frame.

This completes the Auto Z calibration routine.

1. If a change in IZ is greater than 5%, the gap distance has drifted and it is necessary to update both coefficients. Perform a Z-calibration on a more regular basis to monitor this distance and update accordingly.

2. If a change in the AZ is greater than 5% this indicates the calibration of the Z-sensor itself has varied. Update both coefficients and perform a Z-calibration on a more regular basis. If the Z-sensor continues to drift, it could mean damage to one of the calibration trim-pots and the Z-sensor assembly needs to be replaced. Contact Honeywell Engineering.

8.4. Inspect the Locate Piston

The locate piston ensures that the wheel is rotated to a specific orientation before the standardize routine and ensure consistent results. Lubricate this piston regularly to ensure proper function.

Activity Number:	Q4225-60-ACT-004	**Applicable Models:**	All
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	6 months
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
	Part Number	Quantity	Lead Time
Required Parts:	Lubricant (calibration tool kit)		
Required Tools:	Screwdriver		

1. See Figure 2-14 illustrating how to access and remove the piston.
2. Inspect the piston. If the tip of the piston is getting worn, replace it. If the O-ring or spring is degraded replace it as well.
3. Generously lubricate the piston’s outer circumference where the O-ring is located and re-install. Use a screwdriver to push the piston in and out several times to distribute the lubricant and ensure smooth travel.
4. Close up the assembly and put the wheel head cover back on.

8.5. Check Electro-Mechanical Functions

Confirm that all the electromechanical functions of the sensor are working properly using this procedure. Often certain components will start showing signs of wear leading to potential failure, but still produce a good measurement. This inspection is used to preemptively identify these components and replace them accordingly.

Activity Number:	Q4225-60-ACT-005	**Applicable Models:**	All
Type of procedure:	Maintain	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None

Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	6 months
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
	Part Number	Quantity	Lead Time
Required Parts:	Flat-head screwdriver		
Required Tools:			

1. Put the sensor into manual mode.

2. Spin the wheel. Ensure the wheel spins freely. If not, there could be bearing wear and may need to be replaced. With the wheel spinning, activate the brake using the push buttons. Make sure it stops quickly.

3. Activate the locate function using the push buttons and ensure the wheel rotates so that the counterbalance is at the lowest point.

4. Insert the wheel and ensure the rate of insertion is moderate. If it is too slow or too fast (that is, slams against the sheet guide) there are two trim adjustments on the side of the valve (one for insertion, the other retraction) that can be adjusted for a moderate rate of insertion. The goal is to get the sensor reading onsheet as quickly as possible without putting too much strain on the stepper motor's lead screw. Trial and error is usually needed to get the right speed in each case.

5. With the wheel inserted move the stepper motor to the insert and retract limit switches. The motor motion should be smooth. If it is noisy, there could be dirt on the lead screw or perhaps the leadscrew is starting to wear. Open the stepper motor cover and inspect the leadscrew for wear. If necessary, replace the stepper motor.

6. Spin the rollers attached to the sheet guide. Ensure they spin freely. If not, the bearings may need replacement.

8.6. Replace the Brake

The brake should be replaced yearly. Even though the brake may seem to work properly, if it were to fail while the sensor was running it would damage the locate piston and possibly the Z-sensor and wheel during standardize. Since the brake is relatively low in cost and easy to remove, it is worthwhile to do a pre-emptive replacement.

Activity Number:	Q4225-60-ACT-006	**Applicable Models:**	All
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 year
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
	Part Number	Quantity	Lead Time
Required Parts:	Qty 1: 6581800134		
Required Tools:	Allen keys breakable Loctite®		

Figure 8-5 is a diagram of how to remove the brake.

1. Disconnect the electrical connector attached to the brake.
2. Remove the brake cover.
3. Loosen the small set screw attached to the end of the wheel shaft to remove the output part of the brake.
4. Remove the four screws that attach the brake to the wheel assembly.
5. Install the new brake by reversing the previous steps.

Ensure that you use breakable thread-lock on all screws to ensure vibrations do not loosen them over time.

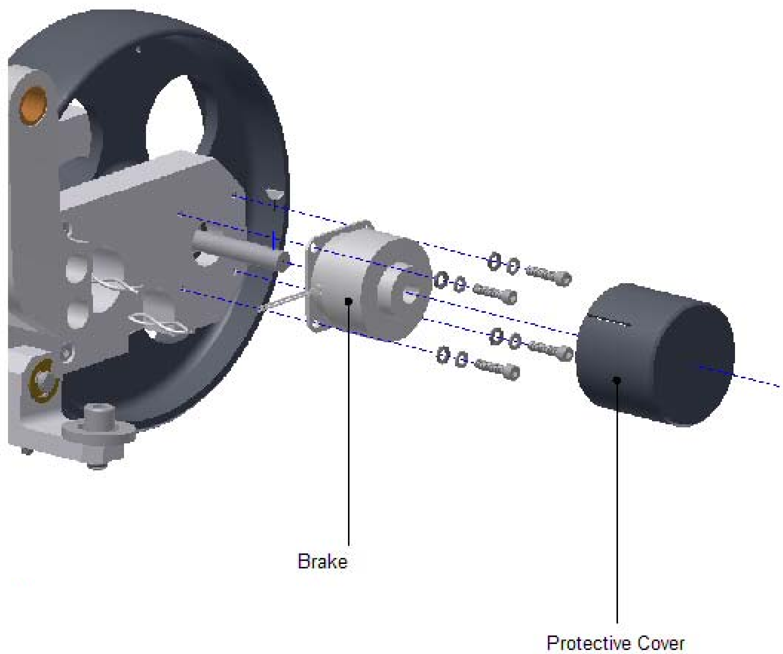


Figure 8-5 Brake Assembly Removal

8.7. Replace Load Cells/Pads

Due to the fact that the load cells are actuated several dozen times per second and run 24 hours a day, seven days a week, the assemblies will need replacement occasionally. Replacement is recommended every three years. However, if you start to notice your ESS measurement getting noisy or drifting, these are indications the load cells are reaching the end of their life.

Lifetime depends on a number of parameters such as the target position of the wheel, type of product, operating temperature, etc., so it may be possible that load cell degradation can occur earlier than the three year replacement schedule.

The load cells and pads should be replaced at the same time, especially if the pads are showing sign of significant wear. If your product isn't abrasive and the pads are not very worn, you can opt to keep the pads you have and just replace the load cells.

Replacement of pads requires a one week wear in period. You can still use the sensor during this time, but there could be drift in the signal until the pads stabilize.

If you are unsure that the load cells need replacement or have been damaged, please contact Vancouver Engineering.

Activity Number:	Q4225-60-ACT-007	**Applicable Models:**	All
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	3 years
Duration (time period):	3 hours	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
	Part Number	Quantity	Lead Time
Required Parts:	Load Cell (6581800092), Load-Cell Pads (6581800194)		
Required Tools:	Allan keys ESS Calibration Kit (6581800154) breakable Loctite Adjustable crescent wrench		

To replace the load cell/pads assembly:

1. Insert spacer bars between the ESS control and wheel head sheet guides to protect the load cells.

2. Uninstall the ESS control head from the main scanner head and turn it upside down on the scanner beam (cover is on). Disconnect the harness from the ESS control head and move the head into a workspace area.

3. Install the upper dummy sheet guide with deflector where the ESS control head used to be if you need to keep the scanner running. During a maintenance shutdown, this step is not required.

4. Using the micrometers provided, measure and record the height of the load-cell pads relative to the pass line ring (see Figure 8-6). **Be sure to zero the micrometers before you use them.**

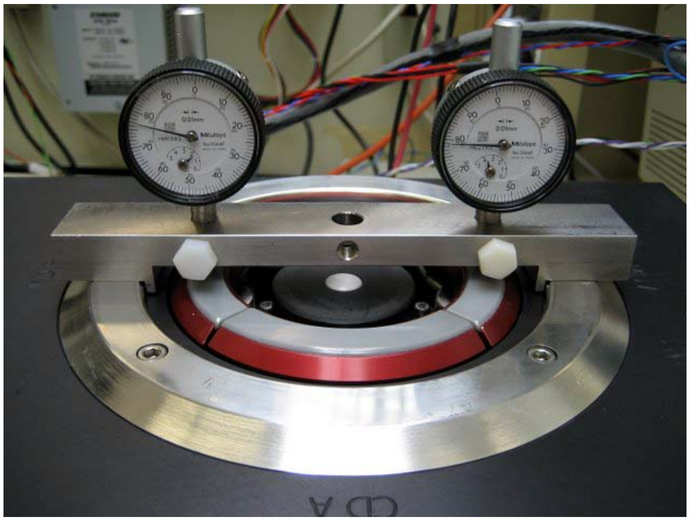


Figure 8-6 Measuring load-cell pad height relative to pass line ring

5. Remove the ESS control head cover and place the head on two spacer bars to protect the load cells.

6. Disconnect the four load cell ITT cannon connectors, the two Z-sensor cables, and four air lines going to the transducer cavity and shown in the following figures.

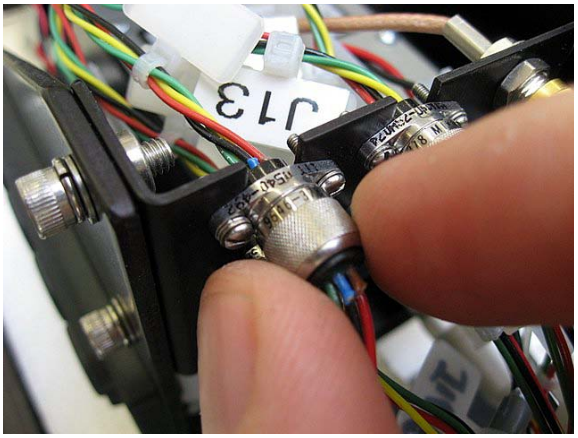


Figure 8-7 Remove ITT Connectors (four in total)

Figure 8-8 Remove SMA Connectors (two in total)

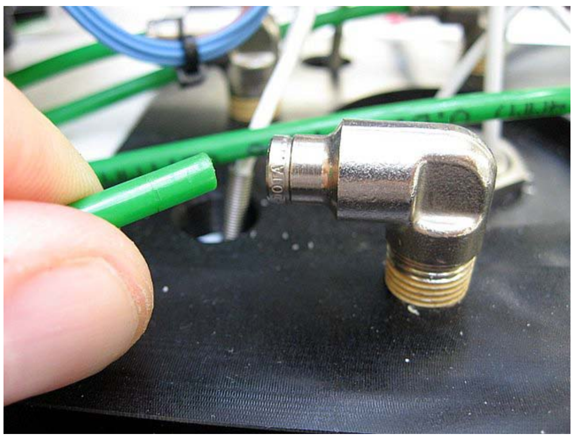


Figure 8-9 Remove air connectors (four in total)

7. Remove the four screws that fasten the transducer cavity to the control head sheet guide and remove the entire assembly from the ESS. Do not lose the O-ring that sits underneath.

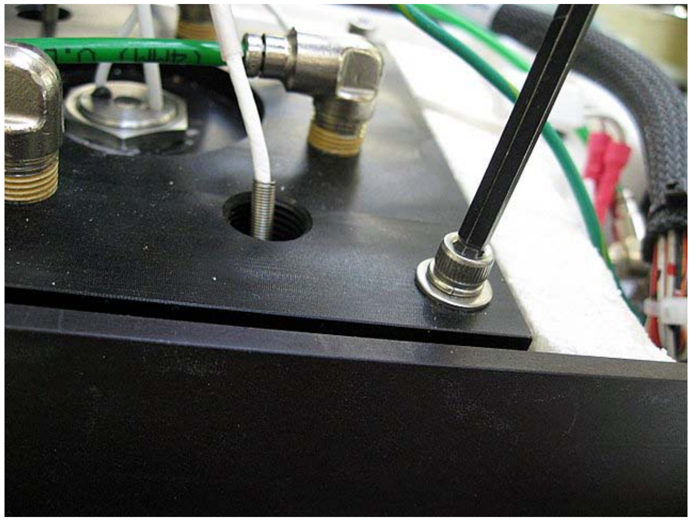


Figure 8-10 Unfastening transducer cavity

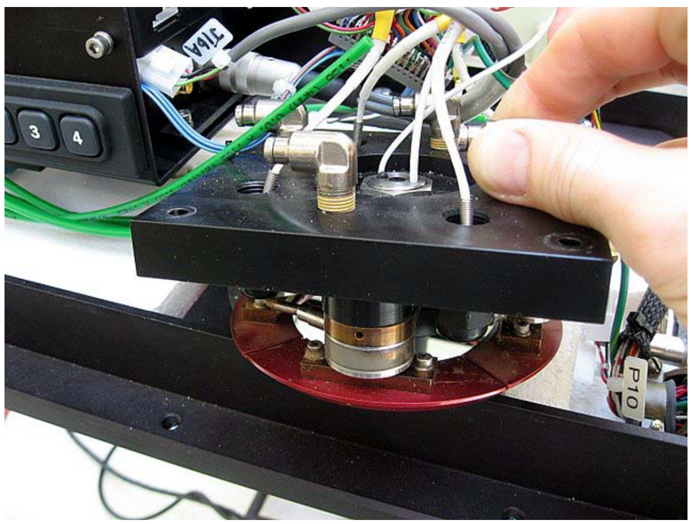


Figure 8-11 Removing transducer cavity

8. Note the position of the load cells and pads relative to the key on the transducer cavity. This is important if you plan on re-using the load cell pads because they have a pre-defined wear pattern and must go back in the same orientation.

9. Being careful not to apply greater than 10 lbs of force on the load cells or to apply a twisting motion to these assemblies, unfasten the two screws for each load cell being replaced, along with their water seal. Cut off the existing label on the wiring in order to feed the cable through the hole in the transducer cavity but re-attach or use tape to re-label if you intend to keep the load cell and just replace the pad. Remove the load cell from the transducer cavity. Be sure to keep the shims that sit underneath together with the load cell removed.

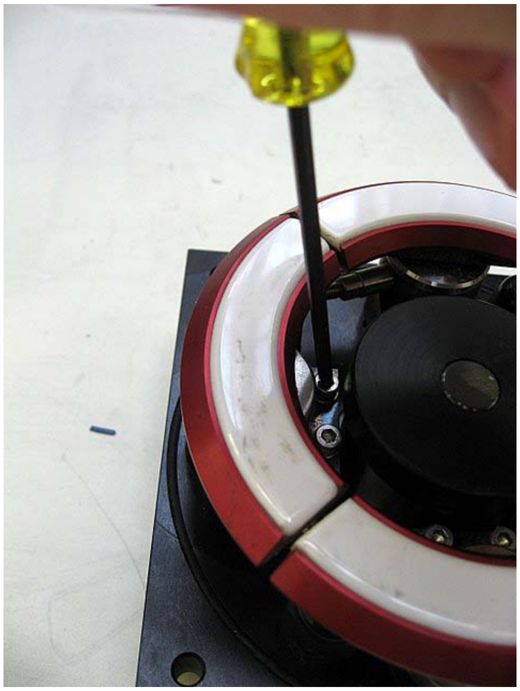


Figure 8-12 Unfastening load cell (two screws)

Figure 8-13 Unfastening water seal

10. If the wear on the existing pads is extreme, then you may wish to replace the pads with new ones, otherwise just use the same pads. Be careful to not apply torque on the load-cell shaft when removing the pads as this may damage the assembly. **When screwing in the new load cells, use breakable Loctite on the fastening screws.**

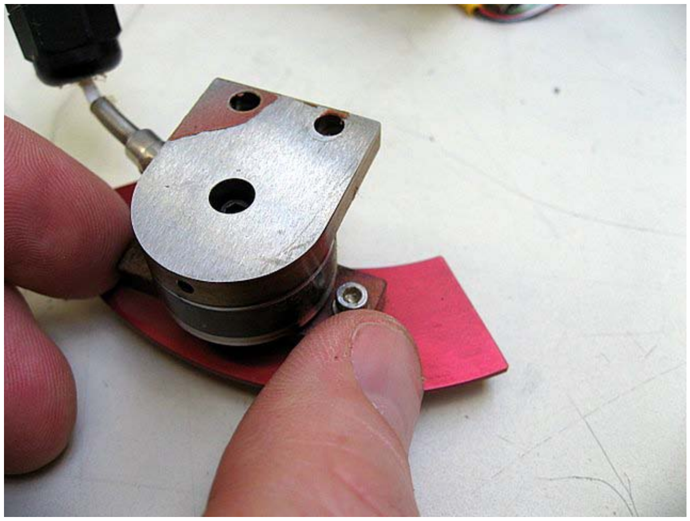


Figure 8-14 Unfastening and fastening the load-cell pad

11. Fasten the new load cells to the transducer cavity without any shims to begin with. You do not need any Loctite at this point because the load cells need additional adjustment in a future step.

12. Fasten the water seals into place making sure that the seal is tightened.

13. Apply a new zap-strap label to the load-cell wiring and copy the old label's description on to the new label.

14. Repeat the above steps 9 to 13 for the other load cells/pads needing replacement.

15. Re-install the transducer cavity and re-connect all of the connectors.

16. Put the ESS control head back into the cover so the load cells are facing upward (towards the ceiling).

17. Check the height of the load-cell pads relative to the pass-line ring.

    Adjust the load-cell heights with shims so they are the same as what was measured in step 4. If you forgot to measure these values or if the load-cell pads were severely worn, it is best to use the default, which is to have the CD load-cell pads level with the pass-line ring and the MD load cells recessed 0.25mm relative to the pass-line ring.

    Be sure to rotate the micrometer assembly from one end of the load-cell pads to the other. If the variation is greater than 0.1mm then try to adjust the angle by cutting a shim in half and raising one side of the load cell up relative to the other.

Being off by +/- 0.05mm is acceptable. If you decide to change the relative height offset of MD to CD load-cell pads, update the variable CDDEL in **Sensor Maintenance→ Sheet Deflection Processor → Basic Constants** accordingly. Remember that the MD load-cell pads are always used as reference, so if the CD pads are higher, CDDEL will have a minus sign in front of it.

18. Once the proper shims have been determined for each of the new load cells, remove the two fastening screws on each load cell, one at a time, and **apply breakable Loctite and re-fasten**. Make sure that the spacing between load-cell pads is even. This can take some time to accomplish.

19. Using the Z-sensor calibration tool, measure the distance from the MD load-cell pads to the Z-sensor cap. Enter this value into the maintenance screen (**Sensor Maintenance→ Sheet Deflection Processor → Basic Constants**) under the variable ZDEL. This value is important because it is used in determination of sheet stretch.

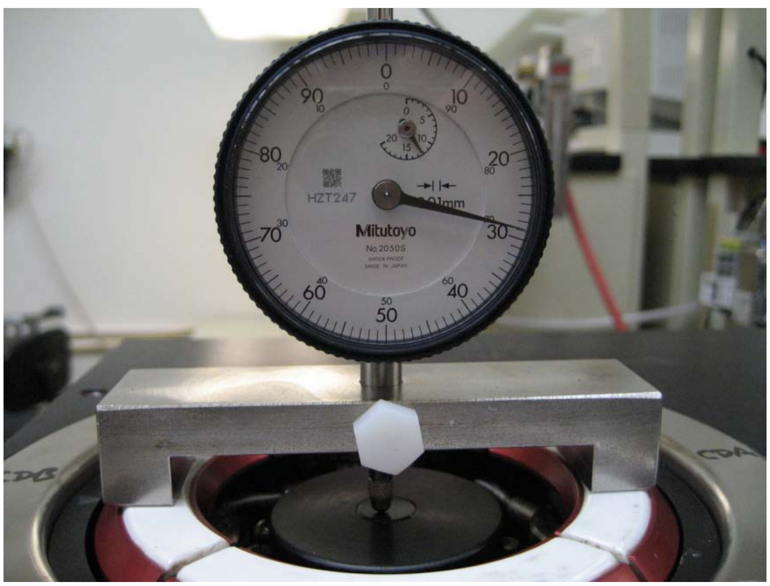


Figure 8-15 Measuring distance between MD load-cell pad and Z-sensor cap

20. Reinstall the ESS control head back onto the scanner using the spacer bars underneath to protect the load cells. Do not connect the control head sheet guide to the mounting bars just yet.

21. Perform a load cell calibration to update the new load-cell calibration coefficients. The load-cell calibration updates all the load-cell constants, including the ones you did not replace.

The routine determines the slope and intercept of each individual load cell as a function of force. Forces are applied to the load cells using three blocks of known weight. They are identified with numbers 1, 2, and 3 marked on their surface.

8.8. Load-cell calibration

It is good practice to check the calibration of the load-cells once a year.

Activity Number:	Q4225-60-ACT-008	**Applicable Models:**	All
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 years
Duration (time period):	3 hours	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
	Part Number	Quantity	Lead Time
Required Parts:			
Required Tools:	ESS Calibration Kit (6581800154)		

1. Change from Operator to Developer Mode.
2. Enter **Display: Scanner/Sensor → Sensor Maintenance.**
3. Choose **Reel Stress Processor** from the drop-down list on the top left of the sensor maintenance screen.

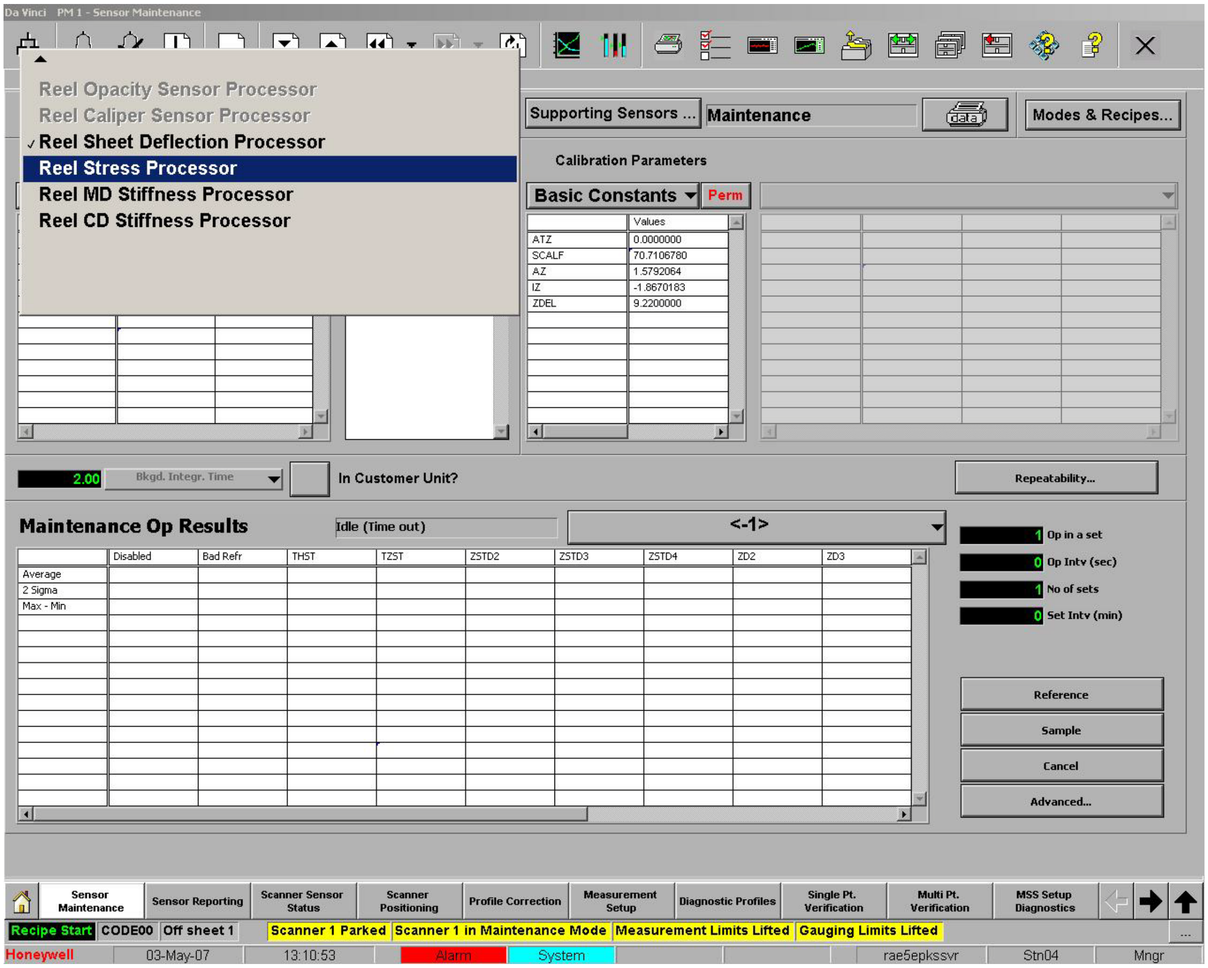


Figure 8-16 Load-Cell Calibration: Choosing Stress Processor

4. Enter Maintenance Mode through **Modes & Recipes → Retrieve Recipe → Enter Maint**.

5. Close the dialog when done.

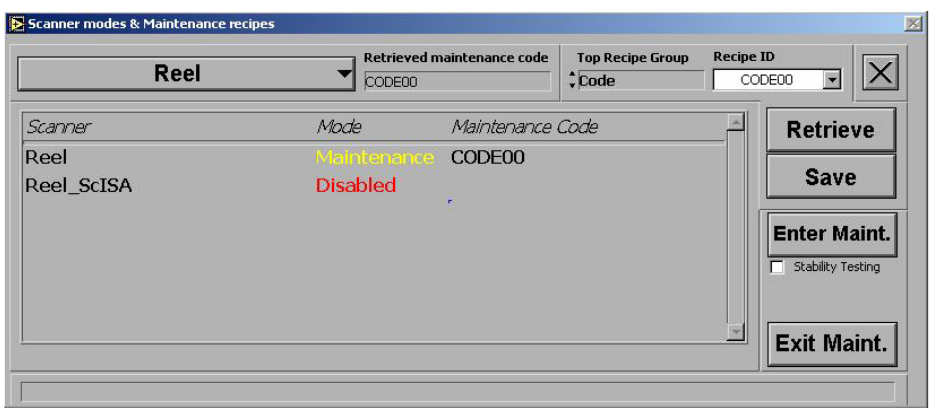
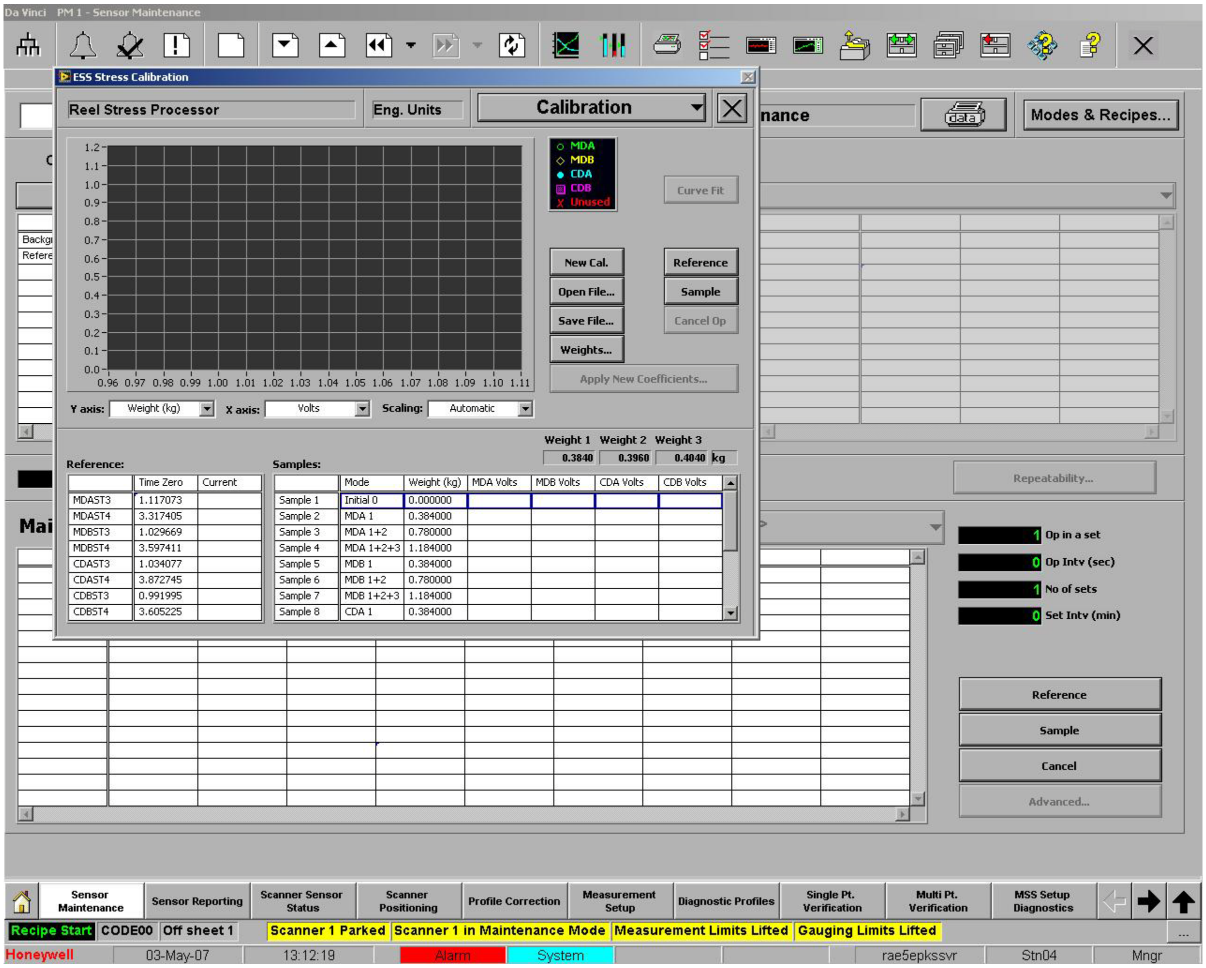


Figure 8-17 Load-Cell Calibration: Retrieve Recipe

6. Choose **Advanced** from the main frame to enter into the load-cell calibration frame.

7. Check that the weights you are using are the same value as the ones entered into the calibration screen. If not, click **Weights…** and modify accordingly.



	Time Zero	Current
MDAST3	1.117073	
MDAST4	3.317405	
MDBST3	1.029669	
MDBST4	3.597411	
CDAST3	1.034077	
CDAST4	3.872745	
CDBST3	0.991995	
CDBST4	3.605225	

	Mode	Weight (kg)	MDA Volts	MDB Volts	CDA Volts	CDB Volts
Sample 1	Initial 0	0.000000				
Sample 2	MDA 1	0.384000				
Sample 3	MDA 1+2	0.780000				
Sample 4	MDA 1+2+3	1.184000				
Sample 5	MDB 1	0.384000				
Sample 6	MDB 1+2	0.780000				
Sample 7	MDB 1+2+3	1.184000				
Sample 8	CDA 1	0.384000				

Figure 8-18 Load-Cell Calibration: Calibration Screen

8. Click **New Cal**. This will populate the bottom right table with 14 entry values. The first and last entries are for no weight on the load cells. The remaining twelve entries represent the three weight configurations for each of the four load cells. There is a specific order to apply the weights:

   a. No weight on the load cells.

   b. Weight 1 on MDA.

   c. Weight 1 + 2 on MDA.

d. Weight 1 + 2 + 3 on MDA.

e. Weight 1 on MDB.

f. Weight 1 + 2 on MDB.

g. Weight 1 + 2 + 3 on MBD.

h. Weight 1 on CDA.

i. Weight 1 + 2 on CDA.

j. Weight 1 + 2 + 3 on CDA.

k. Weight 1 on CDB.

l. Weight 1 + 2 on CDB.

m. Weight 1 + 2 + 3 on CDB.

n. No weight on the load cells.

9. Each load cell is marked appropriately on the upper ESS sheet guide.

10. If you have not run a Reference in maintenance mode with the ESS installed yet, do this now. There must be one reference recorded in the Experion MX system in order for the load-cell calibration to work properly. If a reference has already been performed, then proceed to the next step.

11. Disconnect water, air, and grounding wire from the ESS control head.

12. Insert two 0.4" spacer bars into the gap between the control and wheel head. These protect the load cells when the ESS control head is disconnected from the main scanner head.

Figure 8-19 Load-Cell Calibration: Insertion of Spacer Bars

13. Remove the bolts fastening the ESS control head to the main scanner head and turn it upside down on to the scanner beam.

    Keep the sensor electrically connected to the main scanner head during this procedure.

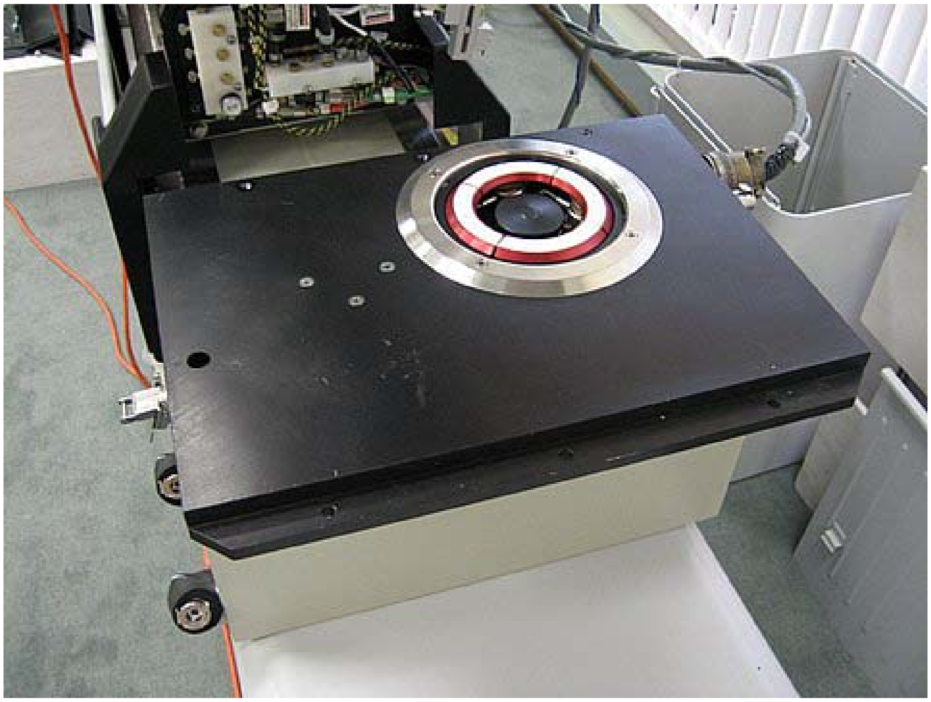


Figure 8-20 Load-Cell Calibration: Unfastening of Control Head

14. With no weights on the load cells, press sample.

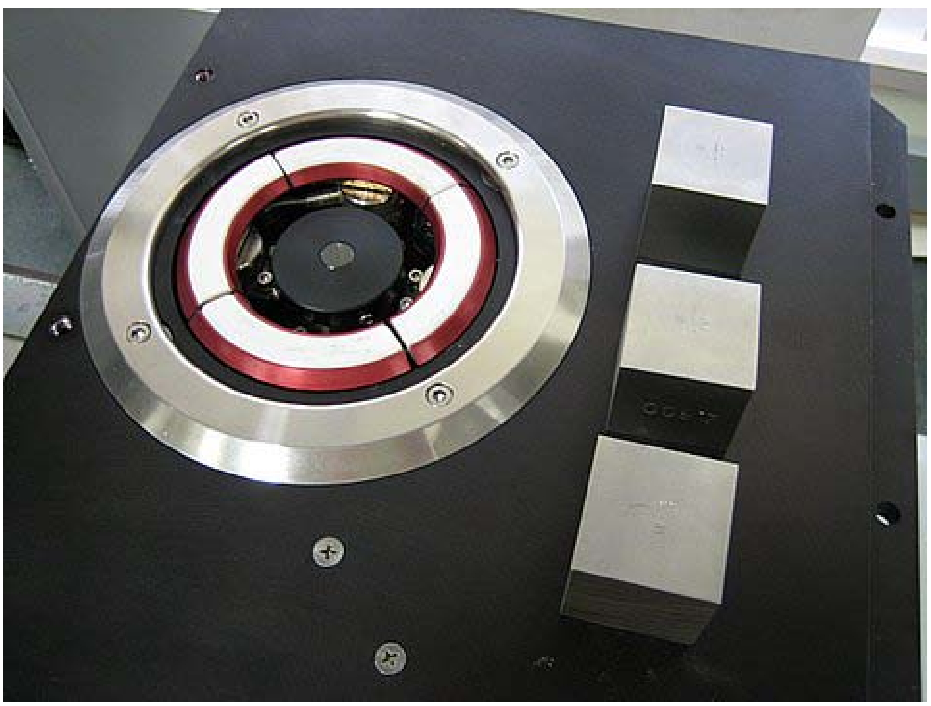


Figure 8-21 Load-Cell Calibration: No Weights

15. Apply Weight 1 to the MDA load cell and press the sample button on the scanner. Be sure to center the weight on the load-cell pad so that it is not touching the pass-line ring or adjacent load cells.

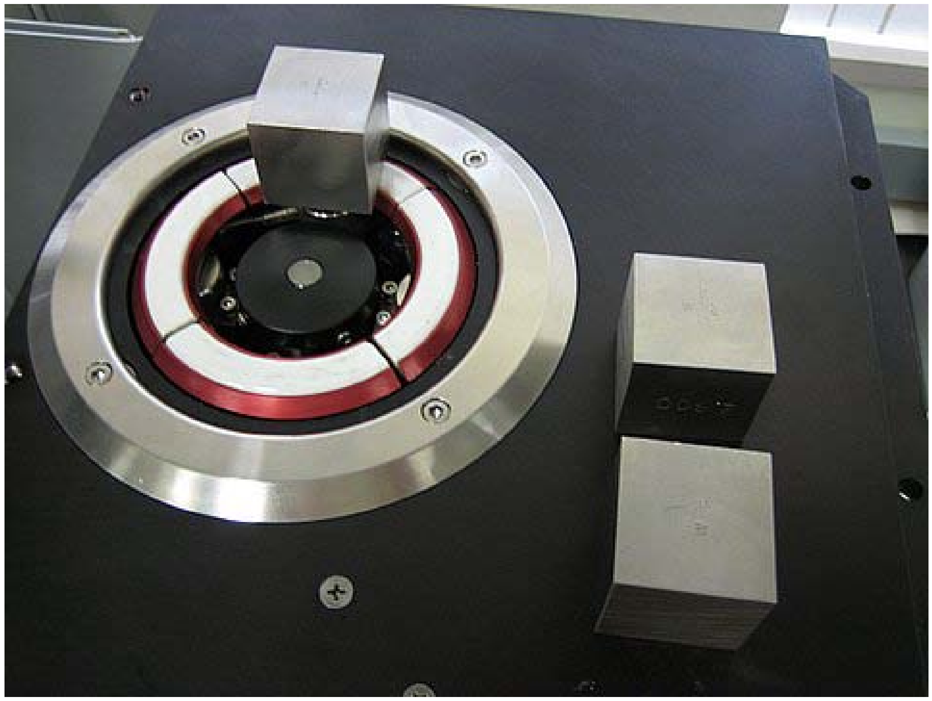


Figure 8-22 Load-Cell Calibration: MDA Weight 1

16. Apply Weight 2 to the MDA load cell and press.

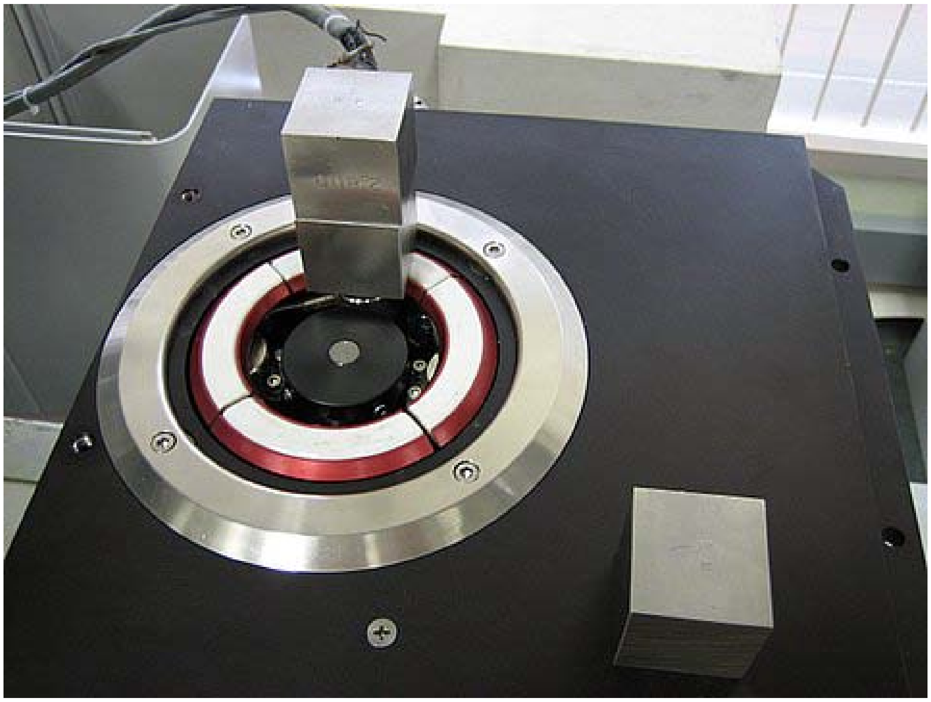


Figure 8-23 Load-Cell Calibration: MDA Weight 2

17. Apply Weight 3 to the MDA load cell and press sample.

18. Remove the weights from the load cell.

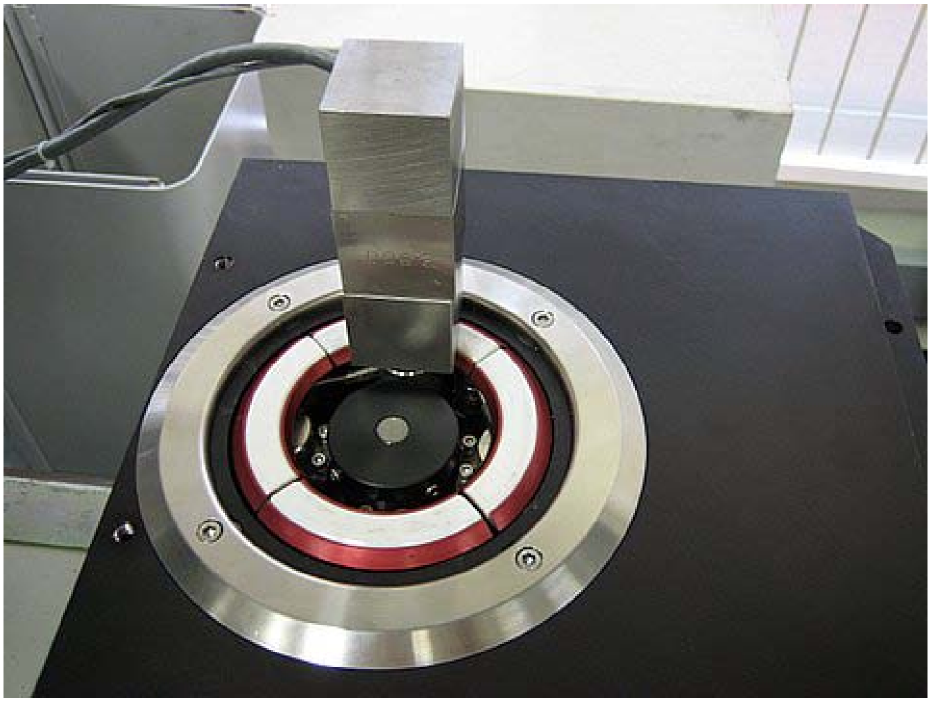


Figure 8-24 Load-Cell Calibration: MDA Weight 3

19. Repeat these steps for the remaining three load cells (MDB, CDA, and CDB).

20. With no weights on the load cells, press sample. All the rows in the lower right table are now populated with values.

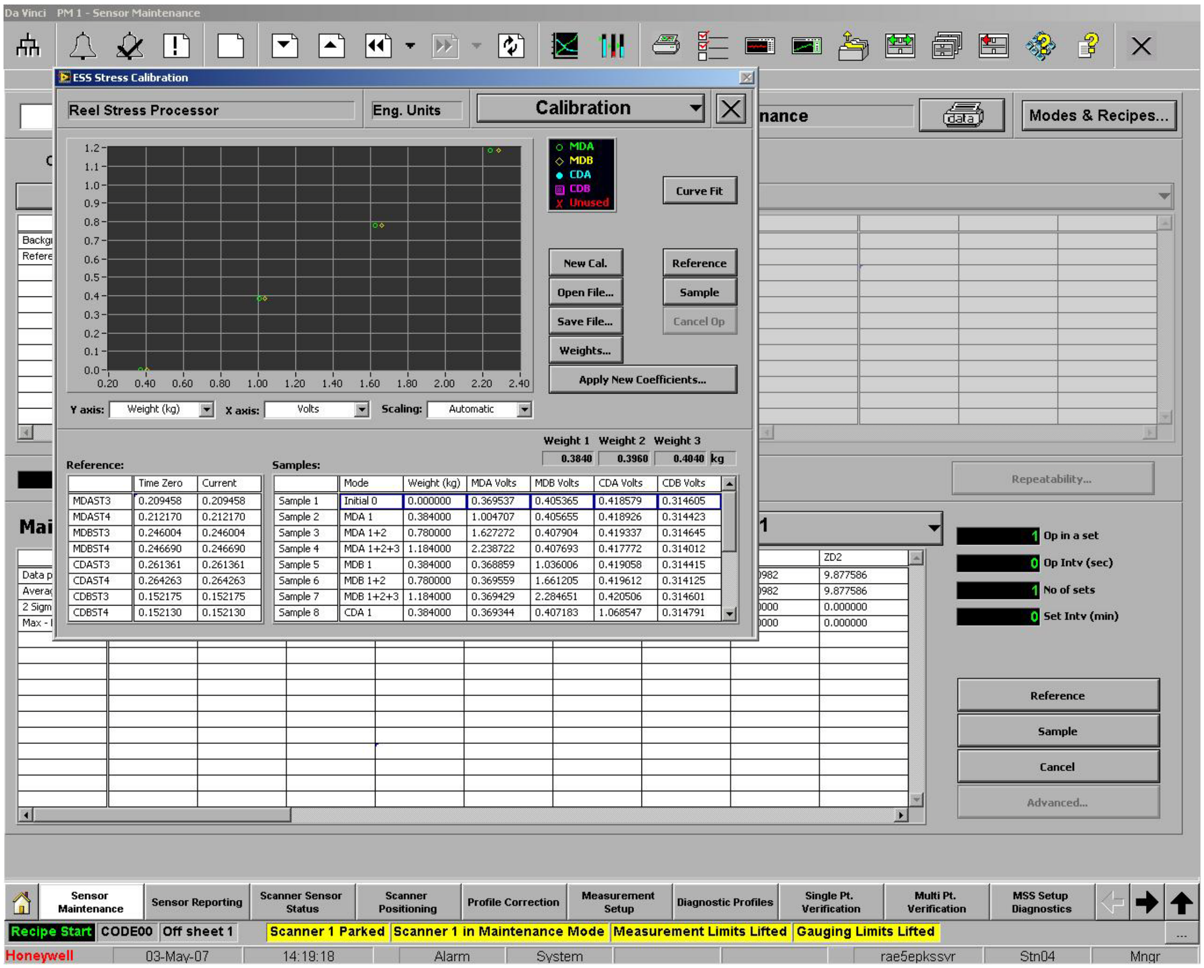


Figure 8-25 Load-Cell Calibration: Calibration Plots

21. Return to the Experion MX operator station to complete the calibration.

22. Click **Curve Fit**.

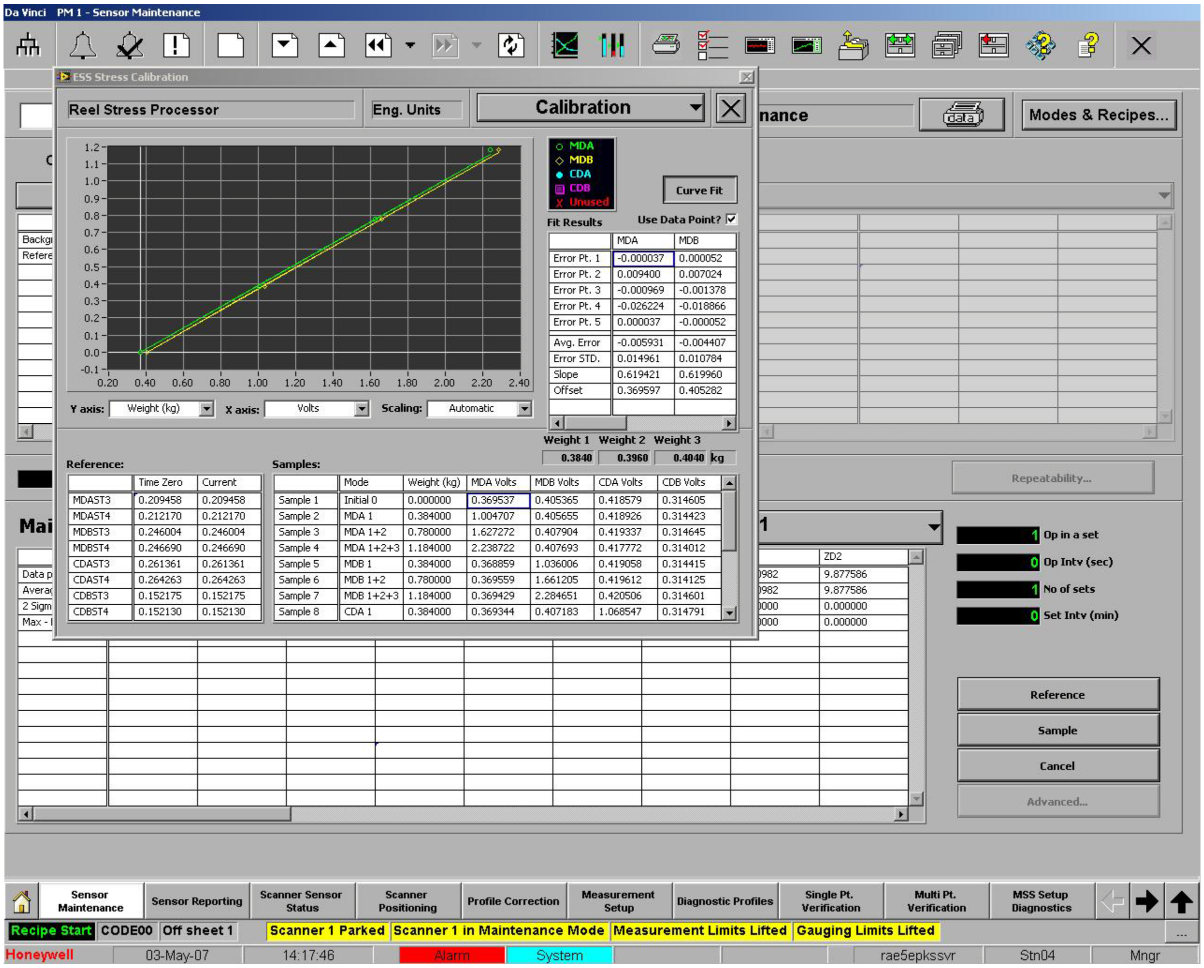


Figure 8-26 Load-Cell Calibration: Curve-Fitting (MD)

23. Check to make sure that none of the error numbers are red for both MD and CD results. If they are, re-run the calibration. If the numbers are still red it suggests one or both of the load cells in that set are bad. The reason should be evident by looking at data point deviations from linear fit.

24. Return to the scanner and re-attach the ESS control head to the main scanner head. Remember to leave the 0.4" spacer bars on the wheel head sheet guide until you finish this step. These are used to protect the load cells from damage.

25. Click **Reference** on the calibration screen and allow the sensor to perform these steps. The reference numbers populate the tables on the bottom left of the screen. The reference is necessary to measure zero-force values on the load cells when the sensor is oriented properly. This compensates for the weight of the load-cell pads hanging underneath. These zero-force values become the time-zero values for the sensor.

26. Click **Apply New Coefficients**. A new frame appears that shows what is going to be changed in the Experion MX setup. The left column is the slope for each of the four load cells. The right column shows all the updated time-zero values. Leave all the parameters checked. Click **OK**.

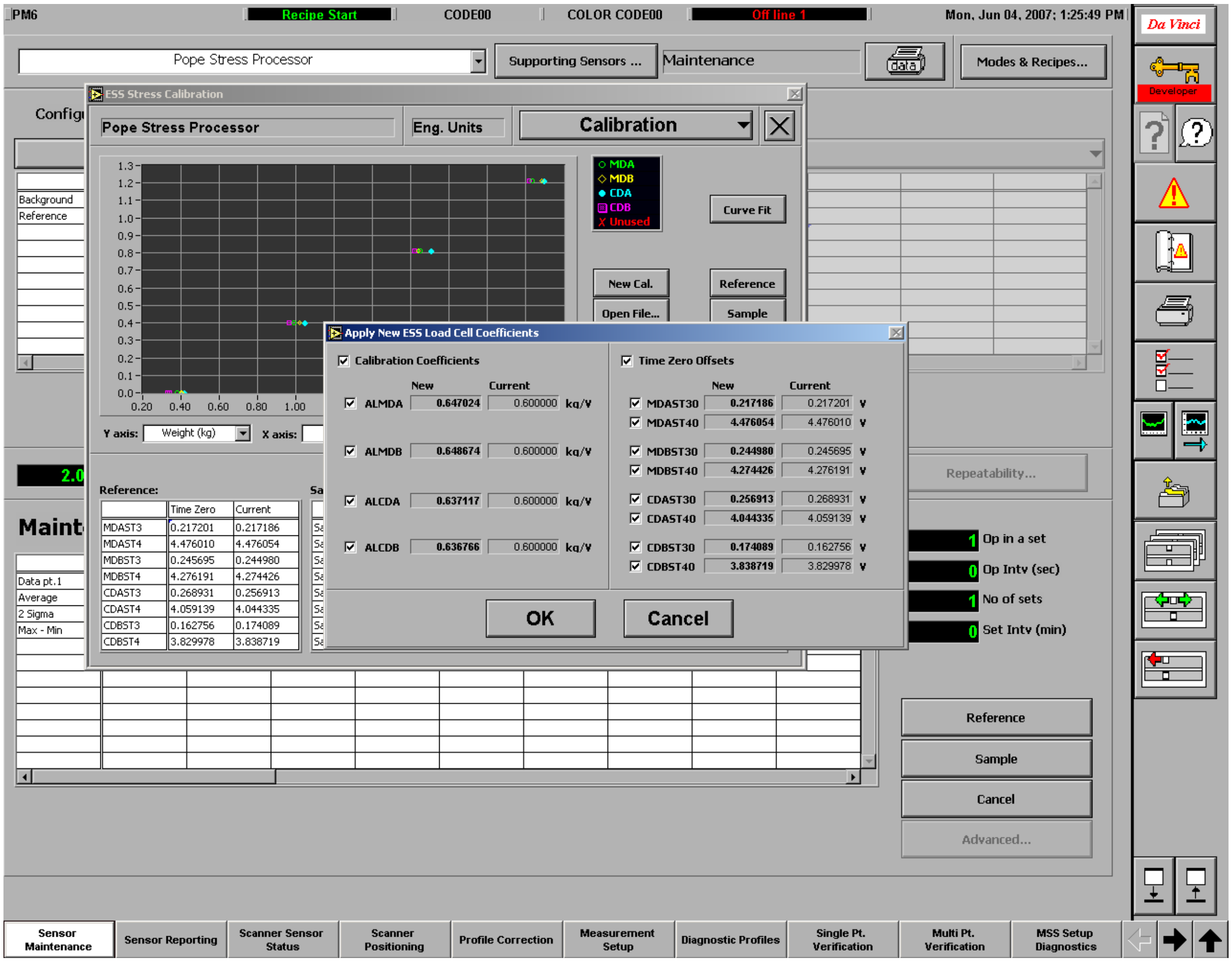


Figure 8-27 Load-Cell Calibration: Applying Coefficients

27. Close the load-cell calibration frame.

28. Re-connect the air and water to the ESS control head.

This completes the load-cell calibration routine.

Re-install and secure the ESS control head on to the scanner.

8.9. Replace the Wheel

The wheel assembly eventually wears either due to surface abrasion or bearing wear. It is advisable to replace the bearings every three years and the wheel as well if it is suffering from significant wear.

Removal of the wheel requires taking off the brake assembly on the one side as well as the locate assembly on the other. Remove the entire upper ESS head (replacing with dummy sheet guide) so you can work in a suitable space without risk of losing parts.

Activity Number:	Q4225-60-ACT-009	**Applicable Models:**	All
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	3 years
Duration (time period):	2 hours	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
Required Parts:	Qty 1 Wheel (6581800196), Qty 2 Bearings (6553100032)		
Required Tools:	Allen Keys breakable Loctite®		

To replace the wheel:

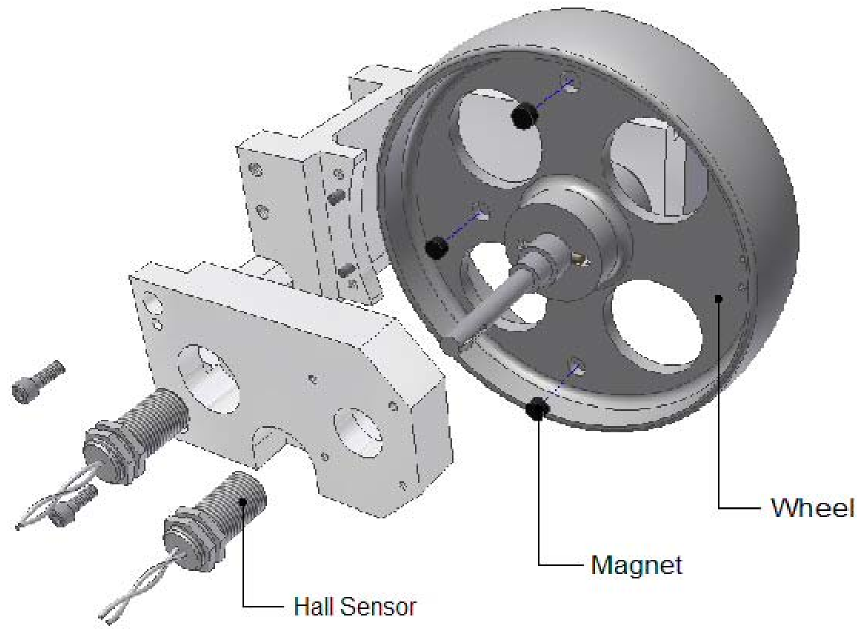


Figure 8-28 Wheel Replacement Assembly

1. Disconnect the stepper motor assembly (see Figure 8-29), hall sensor electrical connectors, and brake (see Section 8.6). Leave the hall sensors fastened in their mounting plate.

2. Remove the wheel assembly from the sheet guide by unfastening to two main screws attached to the pivot piece.

3. Unfasten the hall sensor mounting plate from the wheel assembly using the two locking screws.

4. Pull the wheel out of the assembly as well as the associated wheel bearings.

5. Replace with new wheel and bearings making sure that the wheel magnets face towards the hall sensor mounting plate.

6. Reassemble and fasten to the sheetguide in reverse order to steps 1-4.

7. Check the Z calibration (see Section 8.3) and update the parameters.

8.10. Replace the Stepper Motor Assembly

The stepper motor assembly is ordered as a complete unit. Within this unit is the linear actuator, mounting platform, limit switches, motor stop, protective bellow for the lead screw, and motor cover. Replace this part every five years unless inspection indicates an earlier schedule.

Activity Number:	Q4225-60-ACT-010	**Applicable Models:**	All
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	Average	**Cautions:**	None)
Availability Required:	Sensor Offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	5 years
Duration (time period):	1 hour	**# of People Required:**	1
Prerequisite Procedures:			
Post Procedures:			
Required Parts:	Stepper Motor Assembly (6581800075)		
Required Tools:	Allen Keys, breakable Loctite® Phillips screwdriver scissors		

To replace the stepper motor assembly:

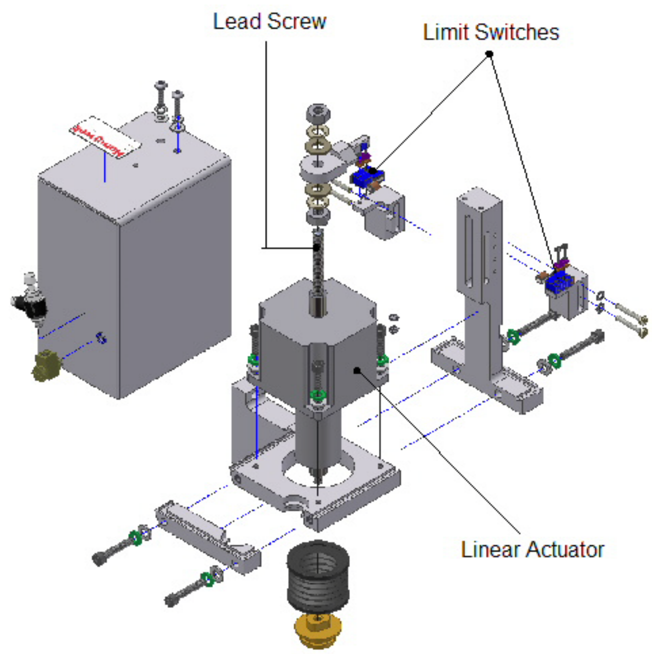


Figure 8-29 Stepper Motor Assembly

1. Disconnect the purge air going to the stepper motor cover.
2. Remove the cover.
3. Remove the two screws attaching the stepper motor assembly to the wheel assembly (Figure 8-30).

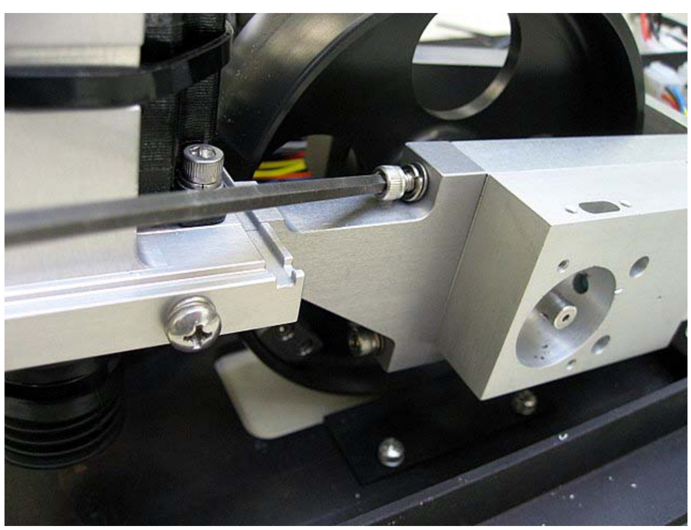


Figure 8-30 Removing stepper motor from wheel assembly

4. Unscrew the thin plate adjacent to the O-ring in order to obtain access to the flex cable.

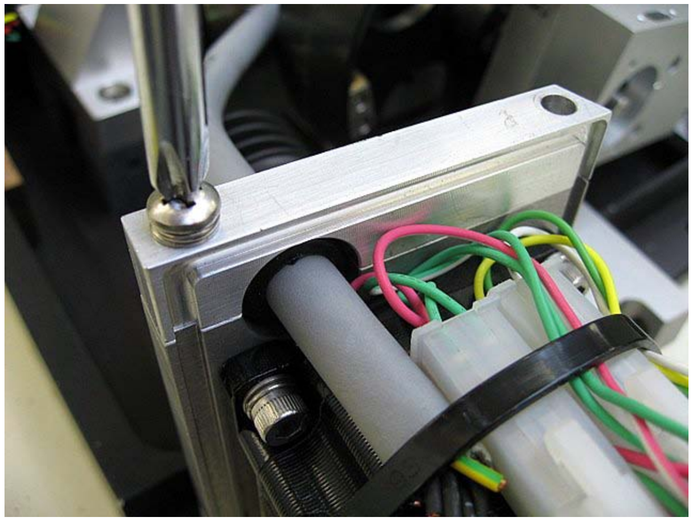


Figure 8-31 Gaining access to flex cable

5. Cut the tie wrap holding the flex cable against the stepper motor.

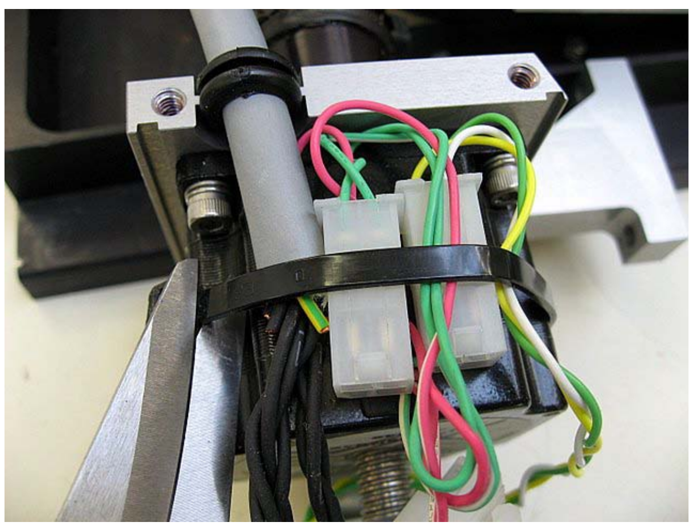


Figure 8-32 Cutting Tie Wrap

6. Disconnect the two Molex connectors and pull the flex cable away from the assembly.

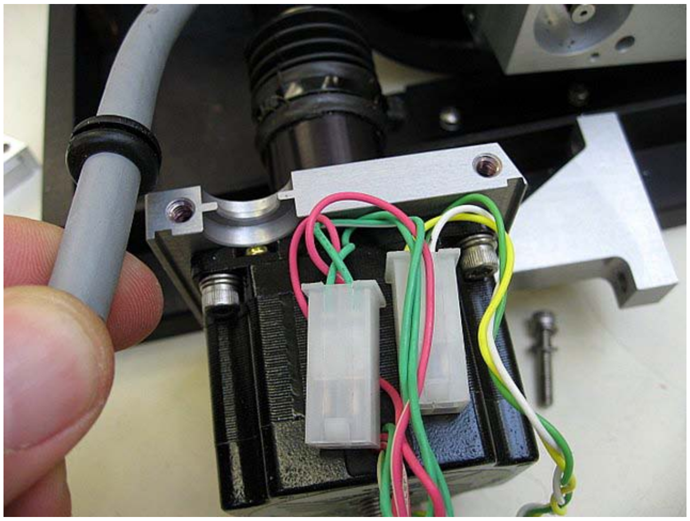


Figure 8-33 Disconnecting Molex connectors and removing flex cable

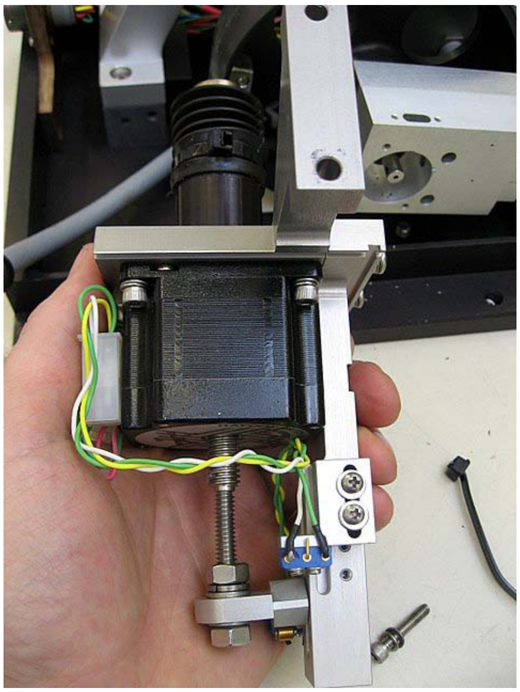


Figure 8-34 Stepper Assembly Removed

7. Compare the positions of the limit switches on the old assembly with the new one and adjust the new limits switches to the same locations.

8. Take the new motor assembly and attach it to the wheel assembly using two screws **and be sure to apply breakable Loctite.**

9. Connect up the Molex connectors, making sure to match label identifications with those on the flex cable.

10. Reattach the thin plate around the O-ring. Ensure that the flex cable sits snug in place and will not pull out of the assembly. **Be sure to apply breakable Loctite.**

11. Do not attach the stepper motor cover just yet, as the limit switch positions may need further adjustment.

12. Put the ESS into manual mode by following the procedure in Subsection 4.6.2.

13. Using the 4x1 button array, move the stepper motor so the wheel is retracted as far as possible (RETRACT limit switch engages).

14. Insert the wheel. This is a latching function.

15. Locate the wheel. This is the position used at standardize and where the wheel is at its highest point.

    All steps beyond this point assume the wheel is in the **locate** position.

16. Move the stepper motor upwards until it hits the INSERT limit switch.

17. Check to see if the wheel is pushing against the Z-sensor cap.

    If it does, you do not need to adjust the limit switches. If it does not, move the stepper motor away from this limit switch and adjust the switch’s position slightly by loosening the two fastening screws.

    Repeat steps 7 and 8.

    Continue doing this until the wheel pushes up slightly against the Z-sensor cap. You will see the upper sheet guide rise up slightly (approximately 1 mm).

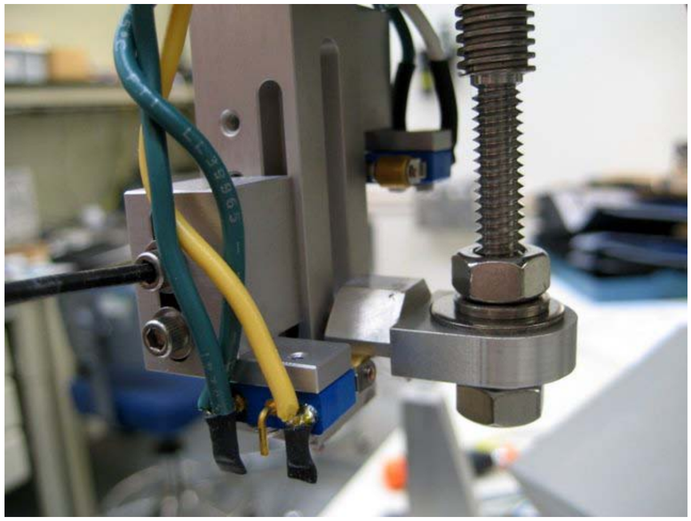


Figure 8-35 Limit Switch Adjustment

18. When you are satisfied with the new limit switch position, ensure the screws are fastened tightly. Do one more position check to ensure this tightening did not affect its position.

    Return the ESS to remote mode.

ATTENTION	Putting the sensor into manual mode generates a safety fault. You need to clear safety faults after putting the sensor back into remote mode before you can run the ESS in production.

    In some rare instances, after the scanner heats up, the head gap will widen and prevent wheel contact with the Z-sensor cap. Once the machine is running and temperatures have stabilized across the scanner, check wheel contact during Phase 4 of standardize. If there is no contact, repeat the steps in this procedure.

19. Attach the stepper motor cover and purge air.

20. Perform an Auto Z calibration (See Section 4.8). When asked to apply the coefficients, deselect everything under **Slope** and **Offset**, then click **OK**. This updates all the time-zero values for the position of the wheel during standardize, but leave values for slope and intercept IZ, AZ unchanged.

9. Troubleshooting

9.1. Alarm based troubleshooting

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

9.1.1. Remote Mode Is Off

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Remote Mode Is Off	MSS sensor safety test failed. The remote mode digital output is not set, the sensor's IO is in manual mode.	Set sensor to remote mode. See Section 4.6.2.

9.1.2. Z Max Test Failed

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Z Max Test Failed	MSS sensor safety test failed. The actual sheet deflection is greater than the [Z Max Volts] value. This check is made every slice during the scan. When this alarm occurs the sensor is disabled and the scanner is sent off-sheet in order to avoid breaking the sheet.	• Make sure the Z-target is less than [Z Max Volts]. • See Check Electro-Mechanical Functions • Confirm Auto-Z calibration is within limits. See Check Z-Calibration • Inspect the button on the z-sensor cap and other parts of the transducer cavity for wear.

9.1.3. At Insert Limit

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: At Insert Limit	MSS sensor safety test failed. Insert limit switch detected while over the product.	• See Check Electro-Mechanical Functions • See Replace the Stepper Motor Assembly

9.1.4. Insert Position Drift

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Insert Position Drift	Compares the Z-sensor insert position of the wheel compared to that at time-zero. This is completed during phase 4 of standardize when the wheel is pushing up against the Z-sensor. $\lvert InsertVolts_{standardize} - InsertVolts_{TimeZero} \rvert * Slope > DZ4LIM$	• See Check Electro-Mechanical Functions • Confirm Auto-Z calibration is within limits, see Section 4.8. • See Replace the Stepper Motor Assembly

9.1.5. 1024 Step Travel Drift

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: 1024 Step Travel Limit Alarm	When stepper motor is given the command to move 1024 steps between phase 2 and 3 of standardize, the positional difference read by the Z-sensor is outside the acceptable range. $\lvert StepTravel_{Standardize} - StepTravel_{TimeZero} \rvert > ZDLIM$ where $StepTravel = Position_{Retract} - Position_{1024\ Step}$	• See Replace the Stepper Motor Assembly • Confirm Auto-Z calibration is within limits, see Section 4.8 • See Check Electro-Mechanical Functions

9.1.6. 1024 Step Deflection Drift

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: 1024 Step Travel Drift Alarm	When stepper motor is given the command to move 1024 steps between phase 2 and 3 of standardize, the calculated deflection difference is outside the acceptable range. $\lvert StepDeflection_{Standardize} - StepDeflection_{TimeZero} \rvert > Z3LIM$ where $StepDeflection_{n}$=SensorRecess - $Position_{n}$	• See Replace the Stepper Motor Assembly • Confirm Auto-Z calibration is within limits, see Section 4.8 • See Check Electro-Mechanical Functions

9.1.7. Normal Deflection Over Limit

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Normal Deflection Over Limit	Sheet deflection in the normal position (i.e. wheel at highest point) exceeds the upper limit. $SheetDeflection_{Normal} > ZULIM$	• Wheel target is too high. Reduce the target value below 4.5mm.

9.1.8. Normal Deflection Under Limit

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Normal Deflection Under Limit	Sheet deflection in the normal position (i.e. wheel at highest point) is below the lower limit. $SheetDeflection_{Normal} < ZLLIM$	• Wheel target is too low. Wheel will not spin due to lack of sheet friction. Increase the target value. See Subsection 4.10.1

9.1.9. Tension Deflection Over Limit

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Tension Deflection Over Limit	Sheet deflection in the tension position (i.e. wheel at lowest point) exceeds the upper limit. $SheetDeflection_{Tension}$ >ZTULIM	• Wheel target is too high. Reduce the target value below 4.5mm

9.1.10. Tension Deflection Under Limit

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Tension Deflection Under Limit	Sheet deflection in the normal position (i.e. wheel at lowest point) is below the lower limit. $SheetDeflection_{Tension}$< ZTLLIM	• Wheel target is too low. Wheel likely won't spin due to lack of sheet friction. Increase the target value. See Subsection 4.10.1

9.1.11. MDA/MDB/CDA/CDB No Load Voltage Drift

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: No Load Voltage Drift	The no-load voltage from the load cell compared to time-zero has drifted beyond limit. $\lvert(Volts_{Standardize} - Volts_{TimeZero})/Volts_{TimeZero}\rvert$ > (MDALIM, MDBLIM, CDALIM, CDBLIM)	• Load cell has suffered an impact or is beginning to age • Load cell is damaged. • See Replace Load Cells/Pads

9.1.12. MDA/MDB/CDA/CDB Shunt Signal Drift

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Shunt Signal Drift	The shunt voltage from the load cell compared to time-zero has drifted beyond limit. $\lvert(Signal_{Standardize} / Signal_{TimeZero}) - 1\rvert >$ (MRSALIM, MRSBLIM, CRSALIM, CRSBLIM) where Signal=ShuntVolts – NoLoadVolts	• Replace Control Head PCB

9.1.13. MD Normal Stress Low

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: MD Normal Stress Low	The MD normal stress value is below limit. $MDStress_{Normal} <= 0.0$	• Z-Targeting is too low. Increase the target value. See Subsection 4.10.1 • See Replace Load Cells/Pads

9.1.14. MD Tension Stress Low

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: MD Tension Stress Low	The MD tension stress value is below limit. $MDStress_{Tension} <= 0.0$	• Z-Targeting is too low. Increase the target value. See Subsection 4.10.1 • See Replace Load Cells/Pads

9.1.15. CD Normal Stress Low

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: CD Normal Stress Low	The CD stress value is below limit. $CDStress_{Normal}$ <= 0.0	• Z-Targeting is too low. Increase the target value. See Subsection 4.10.1 • See Replace Load Cells/Pads

9.1.16. CD Tension Stress Low

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: CD Tension Stress Low	The CD stress value is below limit. $CDStress_{Tension}$ <= 0.0	• Z-Targeting is too low. Increase the target value. See Subsection 4.10.1 • See Replace Load Cells/Pads

9.1.17. Bad Input

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Bad Input	A generic error produced when one of the inputs is out of required range of - 10 to 10 VDC. Specific error is described with additional alarm.	Look for other alarm descriptions pointing to a specific cause.

9.1.18. Temperature Below Limit (ESS Head)

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: **Temperature Below limit** **Temperature Above limit** **Temperature Drifting**	Temperature signal out of limits set in the software.	• Check the real temperature in the head and compare with the limits set in the software. • Verify values of the software constants for head temperature slope and offset. • Check electrical connections to ESS Control Card. • Replace ESS Control Card.

9.1.19. Z-sensor Voltage Bad

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: **Retract Voltage Bad** **1024 Voltage Bad** **Insert Voltage Bad** **Normal Voltage Bad** **Tension Voltage Bad**	No signal from Z-sensor or voltage out of limit	• Check electrical connections to Z-sensor. • Check Z-Calibration. See Check Z-Calibration. • Replace Z-sensor and perform Z-Calibration.

9.1.20. Sheet Deflection Target Invalid

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Sheet Deflection Target Invalid	Bad input for the Sheet Deflection Target	Correct the Sheet Deflection value. See Subsection 4.10.1.

9.1.21. Sheet Deflection Off Target

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: Sheet Deflection off Target	Bad sheet deflection profile	• See Check Electro-Mechanical Functions. • Correct the Sheet Deflection value. See Subsection 4.10.1. • Perform the Sheet Deflection Calibration. See Subsection 4.10.3.

9.1.22. MDA/ MDB/CDA/CDB Normal / Tension Voltage Low / High

Symptom	Possible Cause(s)	Solution (Tasks)
Alarm: **ESS MDA Normal / Tension Voltage High** **ESS MDA Normal / Tension Voltage Low** **ESS MDB Normal / Tension Voltage High** **ESS MDB Normal / Tension Voltage Low** **ESS CDA Normal / Tension Voltage High** **ESS CDA Normal / Tension Voltage Low** **ESS CDB Normal / Tension Voltage High** **ESS CDB Normal / Tension Voltage Low**	Voltage signal from indicated load cell out of range of the electronics (-10 to 10 VDC).	• See Check Electro-Mechanical Functions. • Replace the indicated load cell. See Inspect for Wear.

9.2. Non-alarm based troubleshooting

Symptom	Possible Cause(s)	Solution (Tasks)
Z-standardize voltages are the same in all four phases.	There is air-pressure loss	Check air supply and pneumatic connections.
	Insert solenoid is disconnected or has failed.	• See Check Electro-Mechanical Functions • Replace solenoid if failed.
	There is air-cylinder failure	Replace cylinder if damaged.
	There is motor, driver failure.	Replace IO Link PCB. If that does not solve the problem,see Replace the Stepper Motor Assembly

Symptom	Possible Cause(s)	Solution (Tasks)
There are shifts in ZD23, ZD2, ZD3, and or DZ4.	There is shift in head alignment or gap width	• Re-run Z-calibration and update time-zero values (don't change IZ/AZ). • See Check Z-Calibration.
	Locate solenoid is disconnected or has failed.	• See Check Electro-Mechanical Functions. • Replace solenoid if failed.
	Air pressure is low.	Check air supply and pneumatic connections.
	Air cylinder shaft is loose.	Re-tighten air-cylinder shaft to clevis using breakable loctite.
	Z-sensor is unstable.	Replace Z-sensor.
Z-Standardize Phase 4 voltage is high.	There is fiber build-up in the cavity and/or on the Z-sensor cap.	Clean the transducer cavity. See Remove Buildup
	The wheel is dirty and requires cleaning.	Clean the wheel. See Remove Buildup
	Insert limit switch is not adjusted properly. Adjust limit switch so that wheel touches Z-sensor cap during Phase 4 of standardize.	See Replace the Stepper Motor Assembly
Zero standardize voltage exists for MD or CD load-cell.	There is damage to one or more load cells.	See Replace Load Cells/Pads
	Load cells are not connected to ESS control card.	Check connections for breaks. See Check Electro-Mechanical Functions
Sensor marks or breaks the sheet	Wheel target deflection is set too high.	Lower z-targeting and re-assess. See Subsection 4.10.1
	Wheel bearing is frozen.	Replace the wheel bearing.
	There is debris build-up on the control head.	See Remove Buildup
	Stepper motor limit switch has failed.	Replace the limit switch and see Replace the Stepper Motor Assembly (limit switch adjustment) and then Check Z-Calibration (auto-Z calibration) and update time-zero values (leave IZ/AZ untouched)
	Stepper motor has failed.	See Replace the Stepper Motor Assembly

Symptom	Possible Cause(s)	Solution (Tasks)
Loss of communication with the sensor	Control head electrical cable is disconnected.	See Check Electro-Mechanical Functions
	EDAQ (Experion MX) has a disconnected cable or PCB has failed.	Check connections and replace PCB if necessary
	ESS control card has failed.	Replace control card PCB
	ESS I/O link card has failed.	Replace I/O link card PCB

10. Storage, transportation, end of life

10.1. Storage and transportation environment

In order to maintain integrity of sensor components, storage and transportation of all equipment must be within these parameters:

Duration of Storage	Acceptable Temperature Range	Acceptable Humidity Range
Short Term (less than one week)	-20°C to 45°C	20-90% non-condensing
Long Term	-10°C to 40°C	20-90% non-condensing

10.2. Disposal

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

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

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

11. List of Acronyms

ALCDA	CDA Load Cell calibration slope
ALCDB	CDB Load Cell calibration slope
ALMDA	MDA Load Cell calibration slope
ALMDB	MDB Load Cell calibration slope
ATH, ATZ	Calibration slope for Z-Sensor temperature and Head temperature.
AZ	Calibration slope for Z-sensor
B1	MD (or CD) Coefficient of scan-average dependence on moisture
B2	MD (or CD) *Grade independent* scan-average intercept
B3	MD (or CD) Coefficient of scan-average dependence on basis weight.
B4	Coefficient of scan-average dependence on MD (or CD) Tension Mode term.
B5	Coefficient of scan-average dependence on MD (or CD) Normal Mode term.
B1..B5	Different depending on whether you are calculating MD or CD stiffness.
BDYN	MD (or CD) *Grade-dependent* dynamic correction constant (offset) for scan-average customer measurement.
BW	Basis weight from nuclear sensor.
C1	MD (or CD) Nominal Moisture
C2	MD (or CD) Exponent of basis weight in scan-average customer measurement calculation
C3	Exponent of Z in scan-average MD (or CD) customer measurement calculation
C4	MD (or CD) “Squash” profile corrector
C1..C4	Different depending on whether you are calculating MD or CD stiffness.
CDDEL	CD Load Cell height adjustment relative to MD load-cells.
CDANOWi, CDBNOWi, CDATNWi, CDBTNWi	Onsheet now slice values for CD load-cells in normal, tension modes, respectively.
CDASGL	No-load CDA signal
CDBSGL	No-load CDB signal

CDAST2, CDBST2, CDAST3, CDBST3, CDAST4, CDBST4	CD Load signals during 2nd, 3rd and 4^{th} phases of Standardize, respectively.
CDAST30, CDBST30, CDAST40, CDBST40	Time-zero CD load Standardize signals (Phases 3 and 4).
DIRECTION	Contact output that determines the direction of stepper motion
DZ4	Drift in Phase 4 of Z Standardize.
DZST	Drift in Phase 4 of Z Standardize in corrected signal.
FCDA	CDA Load during Sample.
FCDB	CDB Load during Sample.
FMDA	MDA Load during Sample.
FMDB	MDB Load during Sample.
FRACT	Move wheel this fraction above Z-sensor during auto-z calibration
INSERT LIMIT	Contact Input to check for possible sheet break condition.
INSERT	Contact output that inserts the wheel
ITH, ITZ	Z-Sensor calibration corrections to offset for head temperature and Z-probe temperature dependence.
IZ	Z-Sensor calibration constant (intercept).
LCD	CD Load, corrected for Z, during Sample operations.
LCDCi	CD Load, corrected for Z, in slice 'i', during scanning operation.
LCDTR, LMDTR	Trended scan average during end-of-reel limit check period of MD, CD Modulus terms, respectively.
LCDLL, LCDUL	Limit tolerances on CD Modulus term during end-of-reel limit check period, lower and upper limits, respectively.
LMDLL, LMDUL	Limit tolerances on MD Modulus term during end-of-reel limit check period, lower and upper limits, respectively.
LMD	MD Load, corrected for Z, during Sample and Scanning operations.
LMDCi	MD Load, corrected for Z, in slice 'i', during scanning operation.
LOAD	Force exerted by the deflected sheet on the MD or CD pads of the Extensional Stiffness Sensor, as measured by the load cells.
LOCATE	Contact output that orients the wheel for Standardize.
MDALIM	Limit on MDAST3 drift
MDBLIM	Limit on MDBST3 drift
CDALIM	Limit on CDAST3 drift
CDBLIM	Limit on CDBST3 drift
MDANOWi, MDBNOWi, MDATNWi, MDBTNWi	Onsheet now slice values for MD loads in Normal, Tension modes, respectively.

MDASGL	MDA Load signals during sample.
MDBSGL	MDB Load signals during sample.
MDAST2, MDBST2, MDAST3, MDBST3, MDAST4, MDBST4	MD Load signals during 2nd, 3rd and 4th phases of Standardize, respectively.
MDAST30, MDBST30, MDAST40, MDBST40	Time-zero MD load Standardize signals (Phases 3 and 4).
MODE	Contact output that switches the sensor between manual and remote states of operation.
MOTORSTEP	Stepper motor : Distance / step.
MOVE 1024	Contact output that steps the motor 1024 times.
NCDLL, NCDUL	Limit tolerance on CD Normal terms during end-of-reel limit check period, lower and upper limits, respectively.
NMDLL, NMDUL	Limit tolerances on MD Normal terms during end-of-reel limit check period, lower and upper limits, respectively.
POSITION CONTROL	Contact output that turns on targeting algorithm
RLAL1, RLAL2	Lower alarm limits for Roll/Set Summary.
RLCDA	Ratio of CDA Standardize Load to time-zero CDA Standardize Load.
RLCDB	Ratio of CDB Standardize Load to time-zero CDB Standardize Load.
RLMDA	Ratio of MDA Standardize Load to time-zero MDA Standardize Load
RLMDB	Ratio of MDB Standardize Load to time-zero MDB Standardize Load.
SCALF	Scale factor for Z signals so that ATZ and ATH will have reasonable values.
SHUNT RESISTORS	Contact output that enables the shunt-resistor relays
TCDTR, TMDTR	Trended scan average during end-of-reel limit check period of MD, CD Tension terms, respectively.
TCDLL, TMDLL, TCDUL, TMDUL	Limit tolerances on MD and CD Tension terms during end-of-reel limit check period, lower and upper limits, respectively.
TEMPH, TEMPZ	Analog inputs for the Extensional Stiffness Sensor head temperature and Z-Sensor temperature.
TFREQ	Frequency of Tension mode scanning.
TH0, TZ0	Time-zero temperatures of Ext Stiff upper head and Z-Sensor.
TH2, TH3, THST, TZ2, TZ3, TZST	Standardize Phase 2, 3 and 4 temperatures of head, Z-Sensor.
THA, TZA	Sample mode temperatures of head and Z-Sensor.
THAVG, TZAVG	Most recent temperatures of Ext Stiff wheel head and Z-Sensor probe from onsheet scan average or Phase 4 Standardize.

TMD,TCD	MD and CD load force during Tension mode.
TMDi,TCDi	Profile arrays for TMD and TCD.
TMDLL, TMDUL	Limit tolerances on MD Tension term during end-of-reel limit check period, lower and upper limits, respectively.
WHEELFACT	Translates displacement of stepper motor into displacement of wheel
Z	The Extensional Stiffness Sensor contains a Z-sensor similar to that in the Multi-sensor heads. It is used to measure the position ZD of the wheel (lower head) relative to a stop (control head). This is then used to calculate the sheet deflection Z.
Zi, ZTi	Normal and tension Z-sensor values during scanning operation.
Z3	Equivalent sheet deflection during Phase 3 of Standardize.
Z30	Time-zero value of Z3.
Z3LIM	Database limit tolerance on drift of Z3 (3rd Phase Standardize Z)
ZD	Position of the wheel relative to the Z-sensor stop.
ZD2, ZD3, ZD4	Wheel positions during 2nd, 3rd and 4th phases of Reference/Standardize.
DZ4LIM	Tolerance on drift of DZ4 from zero.
ZD23	Wheel travel between Standardize Phases 2 and 3.
ZD230	Time-Zero constant (calibration time-zero value for wheel travel between Standardize Phases 2 and 3).
ZDAC	DAC output used for controlling wheel height.
ZDEL	Distance from Z-sensor stop to plane of the MD and CD pads.
ZDLIM	Database limit tolerance on drift of ZD23.
ZDS, ZDT	Target Z deflection values corrected for temperature and output in Z-sensor voltage.
ZHUNT	Time to complete position control during auto-z calibration
ZLLIM, ZULIM, ZTLLM, ZTULM	Database limits for onsheet ZT_i and Z_i.
ZMAX	Maximum sheet deflection limit check, danger of breaking the sheet.
ZNOW	Z-sensor signals during Sample operation.
ZNOWi, ZTNWi	Z-sensor signals in Slice 'i' during onsheet operation, Normal and Tension mode, respectively.
ZSTD2, ZSTD3, ZSTD4	Signals read on Z-sensor during 2nd, 3rd, and 4th phases of Standardize, respectively.
ZST20, ZST30, ZST40	Time-zero (Calibration time) Z signals during 2nd, 3rd, and 4th phases of Standardize, respectively.
ZTGT	Target value of onsheet sheet deflection.
ZTGTA	Target value of Sample mode sheet deflection.
ZTEM2,ZTEM3, ZTEM4	Temperature-compensated Z signals during Standardize
ZTEM	Temperature-compensated Z signals signal Sample mode or onsheet for Normal mode.
ZTTM	Temperature-compensated Z signal onsheet for Tension mode.

A. Default Values of Database Constants

A.1. Default value of calibration data

Name	Default	Description	Nom.Unit
ALCDA	0.6	CDA load-cell calibration slope	kg/V
ALCDB	0.6	CDB load-cell calibration slope	kg/V
ALMDA	0.6	MDA load-cell calibration slope	kg/V
ALMDB	0.6	MDB load-cell calibration slope	kg/V
AZ	1.5	Calibration slope for Z-sensor	mm/V
IZ	-1.0	Calibration intercept for Z Sensor	mm
ATZ	0.0	Z sensor temperature corrector	-
CDDEL	-0.25	MD pad recess distance	mm
ZDEL	7.5	Z-Sensor recess distance – relative to MD pads	mm
IHT	0.0	Offset for head temperature measurement	C
AHT	10.0	Slope for head temperature measurement	C/V
IZT	-4.9	Offset for Z sensor temperature measurement	C
AZT	13.817	Slope for Z sensor temperature measurement	C/V
SCALF	70.710678	Scale factor for Z-temperature correction	-
ZTGTA	3.3	Sheet Deflection target – Sample Operation	mm
MOTORSTEP	0.0079375	Change in stepper motor position / step	mm/ step
WHEELFACT	0.4736	Translates displacement of stepper motor into displacement of wheel	-
FRACT	10	Move wheel this fraction above Z-sensor during auto-z calibration	%
ZHUNT	15000	Time to complete position control during auto-z calibration	ms

A.2. Default values of time-zero data

Name	Default	Description	Nom. Unit
CDAST30	0.2	Time-Zero CD Standardize Phase 3 signal, Load Cell A	V
CDBST30	0.2	Time-Zero CD Standardize Phase 3 signal, Load Cell B	V
CDAST40	4.5	Time-Zero CD Standardize Phase 4 signal, Load Cell A	V
CDBST40	4.5	Time-Zero CD Standardize Phase 4 signal, Load Cell B	V
MDAST30	0.2	Time-Zero MD Standardize Phase 3 signal, Load Cell A	V
MDBST30	0.2	Time-Zero MD Standardize Phase 3 signal, Load Cell B	V
MDAST40	4.5	Time-Zero MD Standardize Phase 4 signal, Load Cell A	V
MDBST40	4.5	Time-Zero MD Standardize Phase 4 signal, Load Cell B	V
ZST20	5.0	Time-Zero Z Sensor Standardize Phase 2 signal	V
ZST30	2.7	Time-Zero Z Sensor Standardize Phase 3 signal	V
ZST40	0.7	Time-Zero Z Sensor Standardize Phase 4 signal	V
Z30	4.4	Time-Zero Z Sensor Standardize Phase 3 insertion	mm
ZD230	3.7	Time-Zero Z Sensor Standardize Phase 2-3 travel	mm
TH0	40	Time-zero Ext Stiff head temperature	C
TZ0	65	Time-zero Ext Stiff-Z probe temperature	C

A.3. Default values of limit data

Name	Default	Description	Nom. Unit
DZ4LIM	1.0	DZ4 limit check in Standardize	mm
Z3LIM	2.0	Z3 limit check in Standardize	mm
ZDLIM	1.0	ZD23 limit check in Standardize	mm
MRSALIM	0.1	RLMDA limit check in Standardize	-
MRSBLIM	0.1	RLMDB limit check in Standardize	-
CRSALIM	0.1	RLCDA limit check in Standardize	-
CRSBLIM	0.1	RLCDB limit check in Standardize	-
MDALIM	2.0	MDAST3 limit in Standardize	-
MDBLIM	2.0	MDBST3 limit in Standardize	-
CDALIM	2.0	CDAST3 limit in Standardize	-
CDBLIM	2.0	CDBST3 limit in Standardize	-
ZLLIM	0.0	Normal Z lower limit	mm
ZTLLIM	0.0	Tension Z lower limit	mm

Name	Default	Description	Nom. Unit
ZULIM	4.5	Normal Z upper limit	mm
ZTULIM	3	Tension Z upper limit	mm
ZMAX	6	Maximum sheet deflection limit check	mm
ZValid Range	0.3	Z check onsheet to target	-
TCDLL	0.3	End-of-reel CD Tension lower limit check	-
TCDUL	0.3	End-of-reel CD Tension upper limit check	-
TMDLL	0.3	End-of-reel MD Tension lower limit check	-
TMDUL	0.3	End-of-reel MD Tension upper limit check	-
NCDLL	0.3	End-of-reel CD Normal lower limit check	-
NCDUL	0.3	End-of-reel CD Normal upper limit check	-
NMDLL	0.3	End-of-reel MD Normal lower limit check	-
NMDUL	0.3	End-of-reel MD Normal upper limit check	-

A.4. MD extensional stiffness

Name	Default	Description	Nom. Unit
B1	0.05		-
B2	-4.9		-
B3	0		-
B4	-4000		-
B5	4000		-
C1	7.5		-
C2	1.0		-
C3	2.0		-
BDYN	0.0		-

A.5. CD extensional stiffness

Name	Default	Description	Nom. Unit
B1	0.05		-
B2	159		-
B3	0		-
B4	-2636		-
B5	2636		-

Name	Default	Description	Nom. Unit
C1	7.5		-
C2	1.0		-
C3	2.0		-
BDYN	0.0		-

B. Part Numbers

Part Number	Name
6580801691	Cable Assembly, ESS External Upper Head
6580801692	Cable Assembly, ESS External Lower Head
6580801645	Cable Assembly, ESS, Upper
6580801693	Cable Assembly, ESS Internal Lower Head
6580801646	Cable Assembly, ESS, Lower