Honeywell

Laser Caliper Measurement

System Manual

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Laser Caliper Measurement

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Contents

List of Figures

List of Tables

Introduction

This manual provides an introduction to the single-sided laser (optical) caliper measurement, and detailed instructions for its installation, calibration, operation, maintenance, and troubleshooting.

Audience

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

About This Manual

This manual contains nine chapters and five appendixes.

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

Chapter 2, **System Components**, describes the software and firmware components for the system.

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

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

Chapter 5, **Preventive Maintenance**, describes recommended ongoing preventive maintenance tasks.

Chapter 6, **Tasks**, describes procedures for maintenance and diagnostic tasks.

Chapter 7, **Troubleshooting**, describes symptoms, alarms, possible causes, and links to associated diagnostic or troubleshooting tasks.

Chapter 8, **Storage, Transportation, and End of Life**, describes methods for storing, transporting, and disposing sensor components.

Chapter 9, **Glossary**, describes the terms and acronyms used in this manual.

Appendix A, **Part Numbers**, provides a list of part numbers and descriptions for the laser caliper measurement.

Appendix B, **FDA Laser Safety Submission**, provides laser safety documentation (as submitted to the USA FDA) explaining the classification of the scanner system as a Class-1 laser device.

Appendix C, **Laser Caliper PCBA Signal Descriptions**, provides PCBA signal and LED descriptions for the laser caliper measurement.

Appendix D, **Assembly Drawings**, provides assembly drawings for the laser caliper measurement.

Appendix E, **Installation of CorrectorUtility**, provides installation instructions for the *CorrectorUility* program.

Related Reading

The following documents contain related reading material.

Honeywell Part Number	Document Title / Description
6510020198	Laser Caliper 4213 Safety and Service Manual
6510020381	Experion MX MSS & EDAQ Data Acquisition System Manual
6510030134	Laser Caliper Sensor - comprehensive gauge test

Conventions

The following conventions are used in this manual:

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

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

1. System Overview

1.1. Introduction

The laser caliper measurement is designed to accurately measure sheet caliper online without sheet damage. The single-sided contacting nature of the measurement minimizes wear and build-up problems, and can be used for applications for which *contacting* caliper sensors are not suitable. Accurate and reliable caliper measurements are required to build high quality rolls, to meet product specifications, and to reduce material usage and waste.

Offline caliper measurements are usually based on the TAPPI T411 standard. Such a measurement employs a measurement foot which presses the sheet into an anvil 16-mm (0.63 in.) diameter at 1 mm/s (0.04 in./s), with a force of 50 kPa, for two seconds. Such a measurement cannot be made online on a continuous process. The most common type of online measurement employs a ferrite (ferromagnetic material) on one side, and a bridge on the other. The magnetic inductance of the completed circuit gives a measurement of the caliper. This measurement can be affected by the strong vibrations of the sheet at high speeds, or dirt build-up from coatings or filler.

The device can be easily damaged because the two sides of the device must be of light-weight construction, light enough to allow it to follow the sheet movement. The contacting surfaces can wear due to abrasive ash in the sheet, which can lead to incorrect measurements and necessitate frequent replacement.

The model 4213-x2 laser caliper is a third generation device. The current version of the sensor uses a vacuum air clamp to hold the bottom surface of a sheet firmly against a zirconia button. The top surface is measured with a laser triangulation sensor. The distance between the laser and the bottom surface is inferred with an inductive displacement sensor.

There are two versions of the sensor. The sensors are common up to the static (STA) module assembly, and the calibration (CLB) module assembly. The 4213-02 sensor is installed in a 4000 series scanner with which it communicates using a

Smart Data Acquisition (SDAQ) PCBA. The 4213-52 sensor is installed in a Q4000 scanner using an Ethernet Data Acquisition (EDAQ) PCBA. This manual generally deals with only the model 4213-52 sensor; however, most details are also applicable to the model 4213-02 sensor.

The previous version of the sensor was sometimes called the non-contacting caliper (NCC). The marketing model name of the sensor is Optical Caliper. These names may still appear in places, mainly in software or marketing material; however, they all refer to the laser caliper measurement sensor.

1.2. Measurement Overview

1.2.1. Modules

The laser caliper measurement sensor measures displacements. The gauge consists of two modules:

- the static (STA) module
- the calibration (CLB) module

The sensor is intended to be installed with the STA module in the upper scanner head, and the CLB module in the lower scanner head.

The STA module contains an inductive proximity sensor (the Z-sensor) and a laser triangulation sensor, among other things.

The CLB module includes the patented sheet stabilizing air clamp (US Patents 7,892,399 and 8,083,896, and other patents pending), and a stepper motor-driven stainless steel target (also called the dome).

In Figure 1-1, the STA module is shown as mounted in the upper scanner head, and the CLB module is mounted in the lower scanner head.

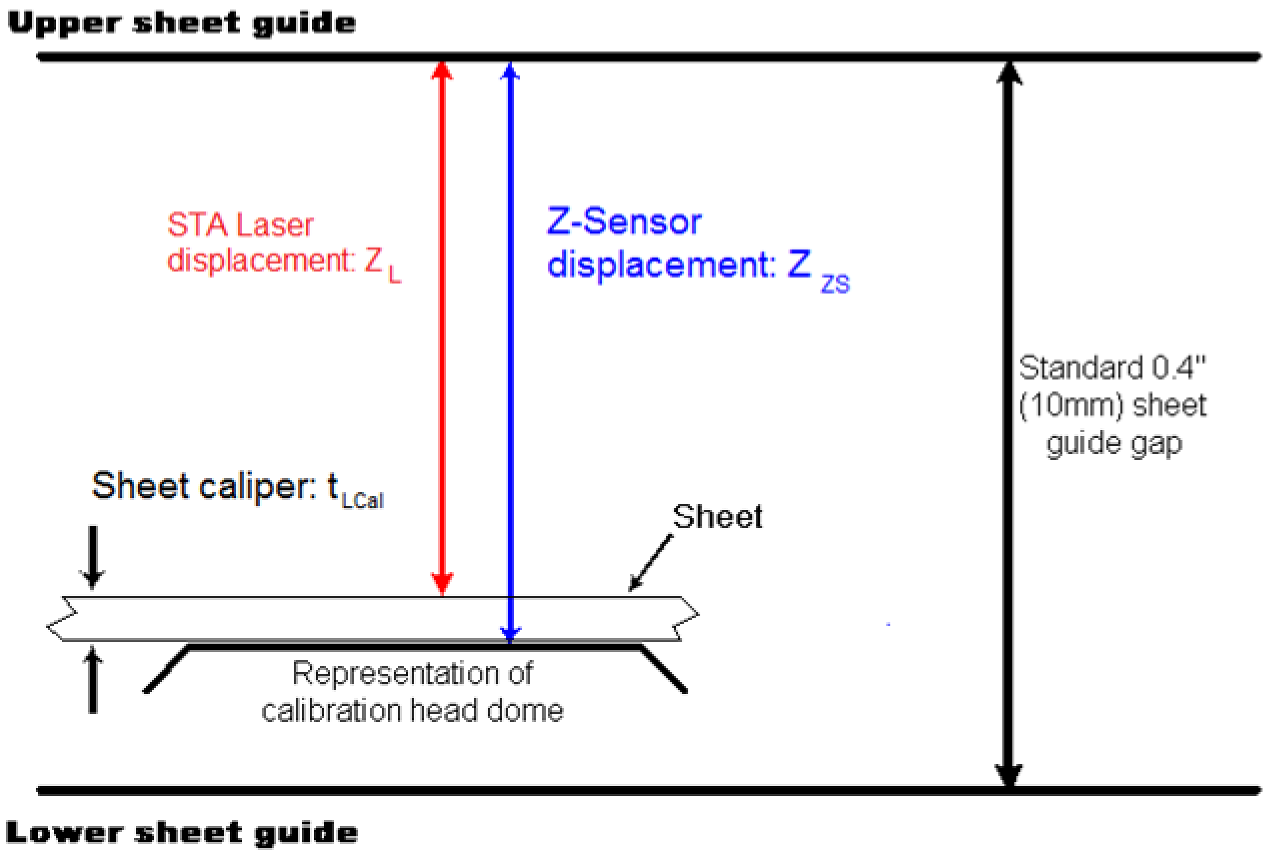


Figure 1-1 Basic Uncorrected Laser Caliper Measurement

Figure 1-1 also shows the uncorrected caliper reported by the gauge as the difference of two displacements.

The Z-sensor measures the gap between the two heads, and the distance between the upper sheetguide and the top surface of the stainless steel target in the CLB module, while the STA module measures the distances between the upper head and the upper surface of the sheet.

The simplest expression for uncorrected laser caliper, to within a static offset Δt_o, at every cross direction position, x is expressed as $t_{LC}(x)$ in Equation 1-1.

$$t_{LC}(x) = Z_{ZS}(x) - Z_L(x) + \Delta t_o,$$

Equation 1-1

where $Z_{ZS}(x)$ and $Z_L(x)$ are, respectively, the Z- and laser sensor displacements at each cross direction position.

The laser triangulation sensor and the Z-sensor provide voltages to Experion MX that are interpreted as displacements. The translation from voltage to displacement is done through the device lookup table (LUT).

The simplicity of Equation 1-1 hides the complexity of the gauge. In addition to the laser triangulation sensor and the Z-sensor, an additional sensor, the LVDT (linear variable displacement transducer), is included to enable online calibration and to provide a reference for the dome position. Like the laser triangulation sensor, and the Z-sensor, the LVDT is interpreted through a calibration relationship that provides the link between the LVDT measured voltage and the displacement it is seeing. Unlike with the laser triangulation sensor, and the Z-sensor, the LVDT calibration cannot be performed online in an Experion MX system. The LVDT calibration relationship is determined outside the sensor at manufacture.

A stepper motor is present to drive a target through the operational range of the laser triangulation sensor, and the Z-sensor, to enable online calibration refreshment, and to permit a level of control over the sheet position in the gap during operation. Onboard firmware is included to send command signals to the stepper motor and to keep track of positional limits.

The gauge controls the sheet position for measurement using an air clamp. This air clamp applies aerodynamic forces to the sheet so that the sheet is robustly held against the surface of the air clamp where its top surface can be accurately measured with the laser triangulation sensor. The gauge includes plumbing to route the air flow through the sensor to the two *Coanda* slots and two vacuum slots.

An imaging optical measurement is extremely sensitive to dust. To improve the dust resistance of the gauge, the laser mount is designed with an air purge to keep the optical window free of debris.

For temperature stability, the gauge includes two temperature controllers. The mechanical case of the laser triangulation sensor is held at constant temperature through a control system actuated by a thermo-electric cooler (TEC) and instrumented by an embedded thermistor. Also, the ceramic coilform that provides the mechanical structure for the Z-sensor is temperature controlled with a pair of TECs.

1.2.2. Hardware

The CLB module has the ability to move a target through a calibration range such that the inductive Z-sensor and the laser triangulation sensor can be calibrated against an LVDT. The CLB module is intended to be in the lower scanner head.

1.2.2.1. The CLB Module

Figure 1-2, Figure 1-4, and Figure 1-5 identify the major components of the CLB module. Assembly drawings are included in Appendix D.

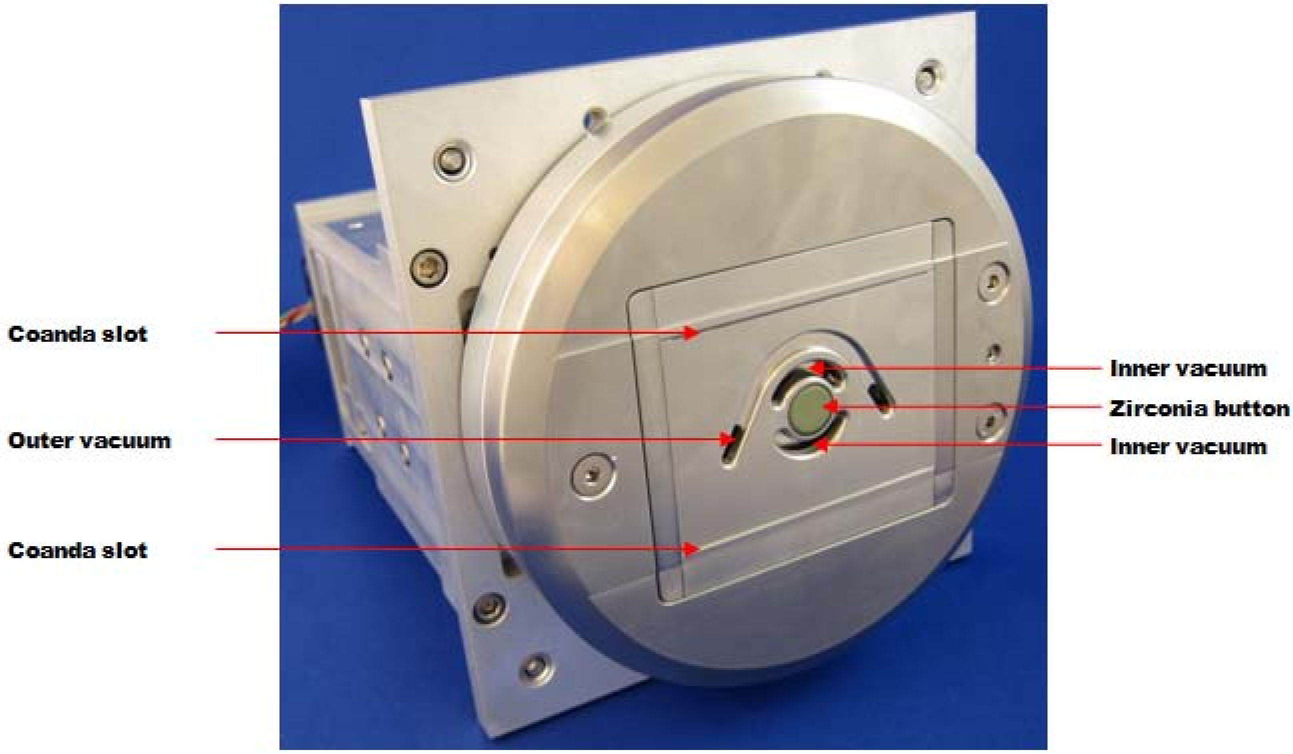


Figure 1-2 CLB Module: Dome and Air Clamp

Basic features of the CLB module include the stainless steel target, which is the part of the module that emerges through the scanner hole and faces the sheet. It is six inches in diameter. The target can be raised or lowered, towards or away from the sheet by an on-board stepper motor and sliding-table arrangement. There are two purposes for the target movement:

- to enable online calibration, that is, moving a flag through the ranges of the devices being calibrated and re-establishing their voltage-to-displacement relationships
- the moveable dome allows flexibility in selecting the dome position for optimum measurement

The dome does not move during regular on-sheet measurement operations. In order to avoid interference with protruding parts of other sensors, such as the bezel of the color sensor, the dome retracts when the scanner heads are split.

The air clamp has various features (see Figure 1-2 and Figure 1-3). There are two straight Coanda slots which provide large flows of air, parallel to the sheet, upstream and downstream from the vacuum zone. These are effective for creating a large-volume low-pressure zone to pull the sheet close to the vacuum region of the air clamp. The vacuum is provided through three slots. The crescent-shaped slot is called the outer vacuum. The two semi-circular slots close to the button are the inner vacuum. The inner vacuum is usually set to a lower level than the outer vacuum for best performance. The outer vacuum is intended to be upstream of the measurement position.

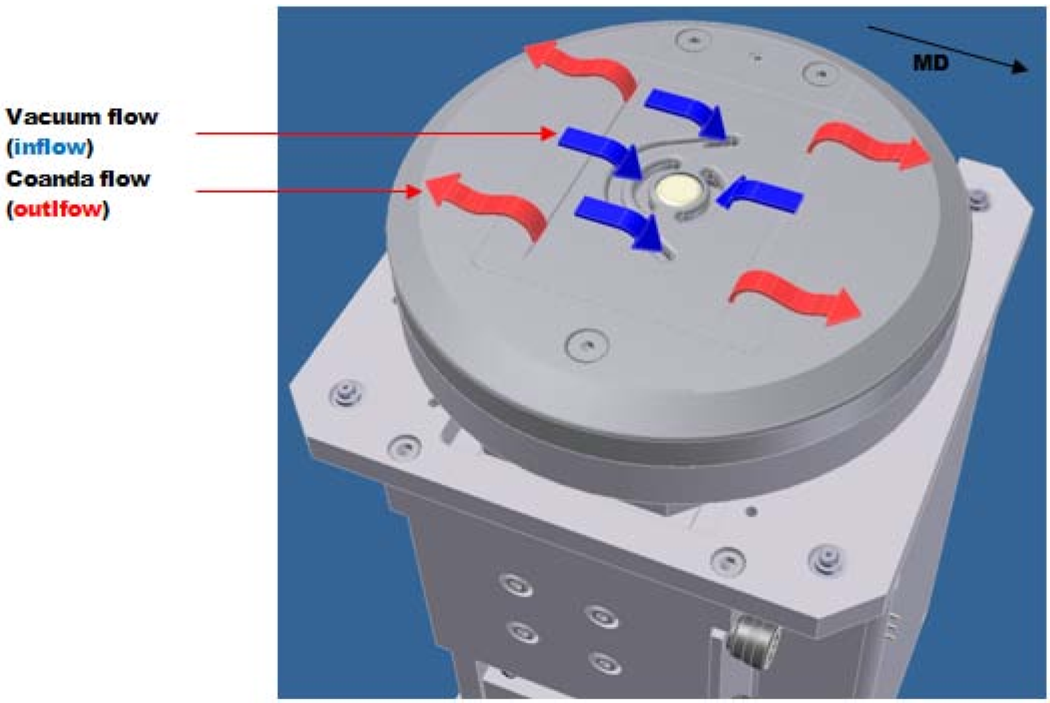


Figure 1-3 Air Flows Through Air Clamp

At the center of the air clamp vacuum zone is a very hard zirconia (a type of ceramic material) button. The sheet is held very flat against this button with the vacuum such that the laser in the STA module can accurately make a measurement of the upper surface of the paper.

The airflow to the air clamp can be manually adjusted through four pressure regulators (see Figure 1-4). The bank of regulators is fed from two 8-mm (0.31-in.) diameter tubes from the scanner head. The tubes attach with quick-disconnect fittings. The vacuums are generated with a pair of vacuum generators, the exhaust lines of which are directed through bulkhead fittings to exit outside of the scanner head. The pressures and vacuums are monitored electronically with sensors on the PCBA. For the underside detail of the air clamp, including the identification of air-provisioning hoses, see Appendix D.

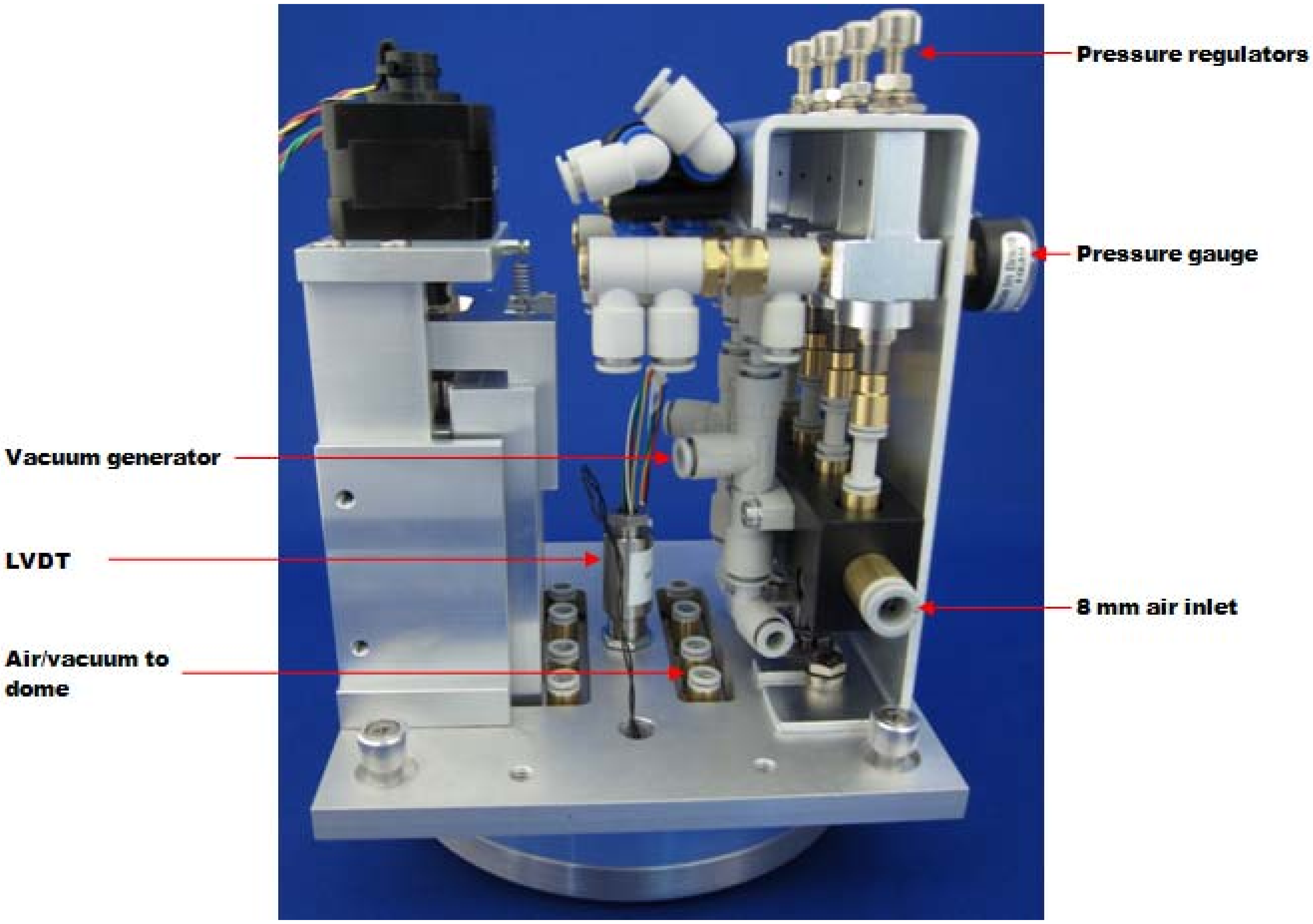


Figure 1-4 CLB Module: Air Handling (tubing not shown)

The stainless steel dome and air clamp act as a target for the inductive Z-sensor in the STA module. These are held on to the dome backing plate with three socket-head screws so that the dome can be removed and replaced if necessary. The pressure and air passes to the air clamp through o-ring seals. A fourth hole in the dome can be used to insert one of the screws so that it can be used to pull up on the dome for easier removal. A thermistor is also screwed into the back of the dome to monitor the dome temperature.

The entire dome can be translated vertically in order to calibrate the devices in the STA module. A stepper motor pushes the dome via a sliding translation stage. The step size is 1.5 microns.

The LVDT accurately measures the position of the dome. The LVDT provides a voltage signal that is interpreted as a displacement by Experion MX. The LVDT calibration relationship is derived at the Honeywell factory and is included as a computer file with shipment of the sensor.

There are two purposes for the LVDT:

- The LVDT acts as a displacement standard during calibration. As the target carries the flag through the calibration range of the laser and Z-sensor, the LVDT reports the target displacement at every point. Using the displacement array from the LVDT and the signal arrays collected from the direct devices, Experion MX is able to build the calibration relationships for these devices.

- The LVDT is used to accurately position the dome while scanning or while standardizing if this option is selected. The LVDT is positioned directly behind the laser measurement position in order to minimize the effects of any small mechanical distortions in the dome position caused by mechanical forces.

The dome is designed to allow very little tilt or transverse motion through the use of a high-precision translation stage (see Figure 1-5) on one side of the dome, and a guide shaft and linear bearing on the other.

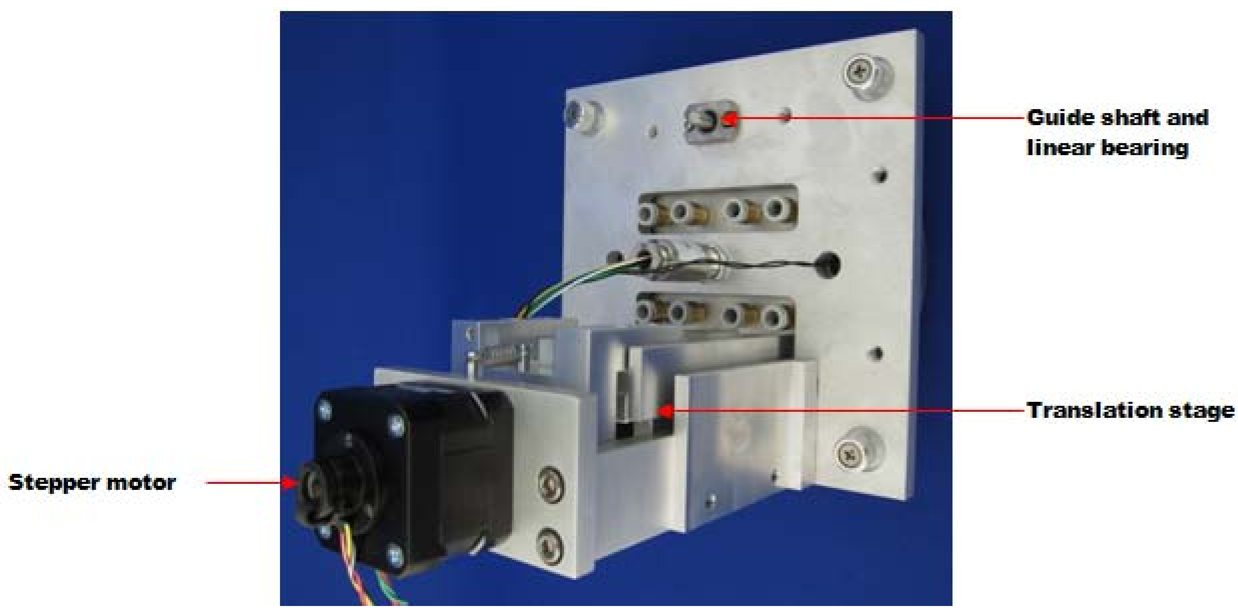


Figure 1-5 CLB Module: Stepper Motor and Translation Stage

There are two PCBAs mounted in the CLB module: the CLB module interface PCBA, and the EDAQ PCBA that interfaces with every sensor.

CLB Module Electronics

The CLB module interface PCBA interfaces with the EDAQ through analog and digital signals, and with the scanner head power distribution PCBA for DC electrical power.

The interface PCBA provides electrical interfaces to the stepper motor, LVDT, pressure sensors, and temperature thermistors. A layout drawing of the front of the CLB module interface PCBA is shown in Figure 1-6.

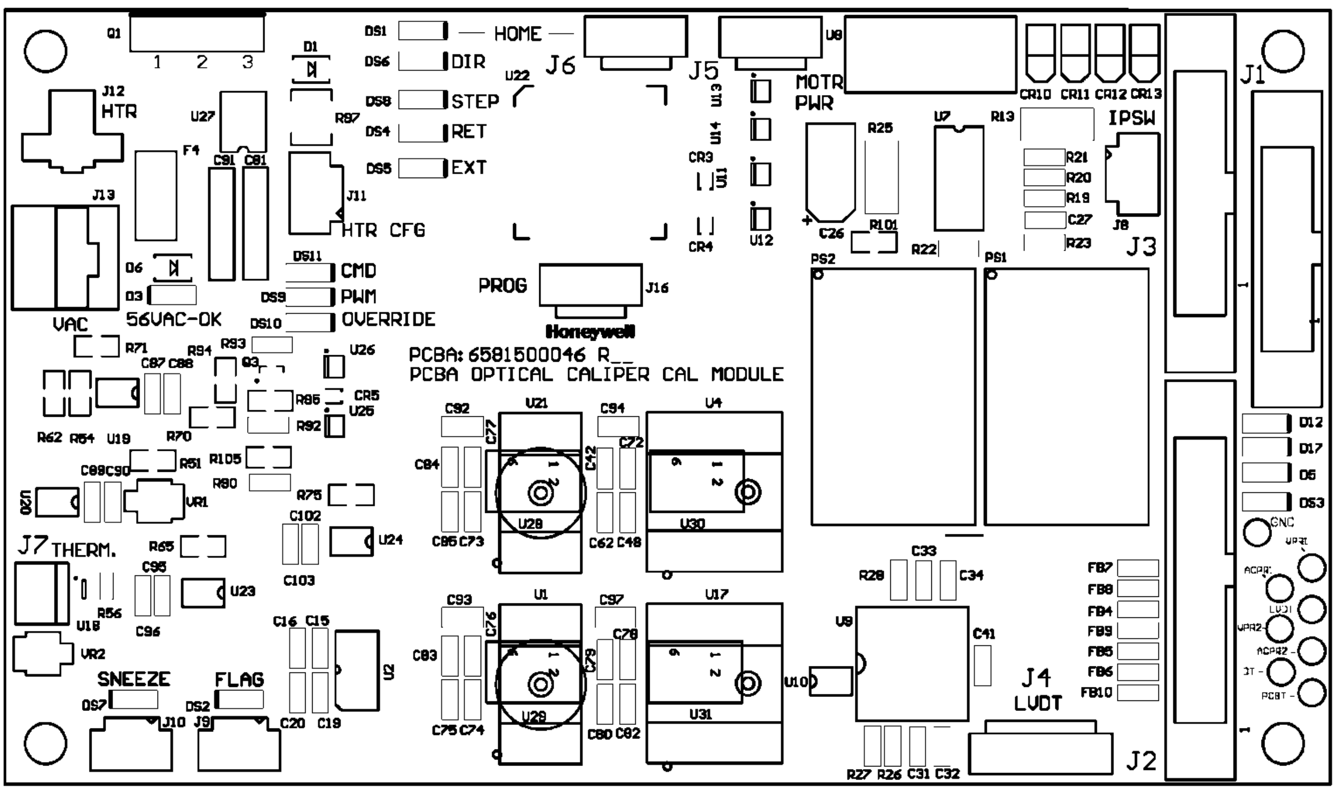


Figure 1-6 CLB Module Interface PCBA

The CLB module interface PCBA test points and LEDs are shown in the lower right-hand area of Figure 1-6.

In addition to data acquisition, the sensor EDAQ is responsible for generating and reporting the stepper motor control signals such as direction, step, and fully retracted and fully extended limits.

For troubleshooting purposes there are test points and LEDs on the PCBA to which clip-type DMM probes can be attached. These LEDs and test points can be identified in Table 1-1. With the current version of the sensor, all signals are passed onto the sensor EDAQ board and further through the Ethernet LAN connection to the Measurement Sub System (MSS).

Table 1-1 CLB Module PCBA Test Points, LEDs, and Connectors

PCBA Screen Print Label	Signal Indication or Function	Expected Signal for Properly Functioning Sensor
GND	Ground	Reference
VPR1	Vacuum Pressure #1	0–9 V DC; should indicate approx 9 V DC with no vacuum, and vary as vacuum increases.
ACPR1	Air Clamp Plenum Pressure #1	0–8 V DC; should indicate approx 0.5 V DC with no air and vary as pressure increases.
LVDT	LVDT displacement	-10–10 V should move when dome moves.
VPR2	Vacuum Pressure #2	0–9 V DC; should indicate approx 9 V DC with no vacuum, and vary as vacuum increases.
ACPR2	Air Clamp Plenum Pressure #2	0–8 V DC; approx 0.5 V DC with no air and vary as pressure increases.
DT	Dome Temperature	For a 20 kΩ thermistor, approx. 4 V@25 °C (77 °F)
PCBT	PCBA Temperature	20 mV/°C, approx 0.5 V@25 °C (77 °F)
HOME	LED-GRN: Stepper Motor Home position HW detection	Limits movement range, located on top of the stepper motor assembly. Should be inactive (off) on moving range.
DIR	LED-GRN: Movement direction Command	DIR=ON retracting, DIR=OFF extending
STEP	LED-GRN: Movement step Command	STEP=toggling for movement, STEP=OFF for no movement
RET	LED-GRN: Fully retracted feedback from Motor CPLD	RET=ON normal range, RET=OFF retracted limit reached.
EXT	LED-GRN: Fully extended feedback from Motor CPLD	EXT=ON normal range, EXT=OFF extended limit reached.
FLAG	LED-GRN: Flag status	ON if flag command active (not currently used)
SNEEZE	LED-GRN: Sneeze status	ON if SNEEZE command active (not currently used)
DS3	LED-GRN: 5Vdc Board power	ON
DS5	LED-RED 24VS Thermal Protection tripped	OFF
DS12	LED-RED 24VE Thermal Protection tripped	OFF
D17	LED-RED 24VE Thermal Protection tripped	OFF
56VAC-OK	LED-GRN: AC power present (optional feature)	ON
CMD	LED-GRN: heater command available (optional feature)	Toggles with a variable duty cycle

PCBA Screen Print Label	Signal Indication or Function	Expected Signal for Properly Functioning Sensor
PWM	LED-GRN: heater command (optional feature)	Toggles with a variable duty cycle
OVERRIDE	LED-GRN: Heater Override command	Off, heater is remotely enabled
J1	Connects to Head Power Distribution PCBA	
J2	EDAQ Analog	
J3	EDAQ Digital	
J4	LVDT	
J5	Stepper Motor	
J6	Stepper Motor Home Sensor	
J7	Dome thermistor	
J8	In-place switch (should be jumpered)	
J9	Flag solenoid (not used)	
J10	Sneeze solenoid (not used)	

1.2.2.2. STA Module

The laser caliper measurement is based on a laser triangulation sensor and a Z-sensor. Some explanation of the principles of operation of these devices is provided here in order to assist with device troubleshooting and suitability of application. Top-level drawings of the STA module are included in Appendix D.

Laser Triangulation

The laser triangulation sensor directs a diode-laser beam towards its target projecting a spot. This spot can then be imaged onto a light sensitive CMOS array which reports its position. Knowledge of the reflected angle and the geometry of the device is enough to calculate the distance to the sheet (see Figure 1-7).

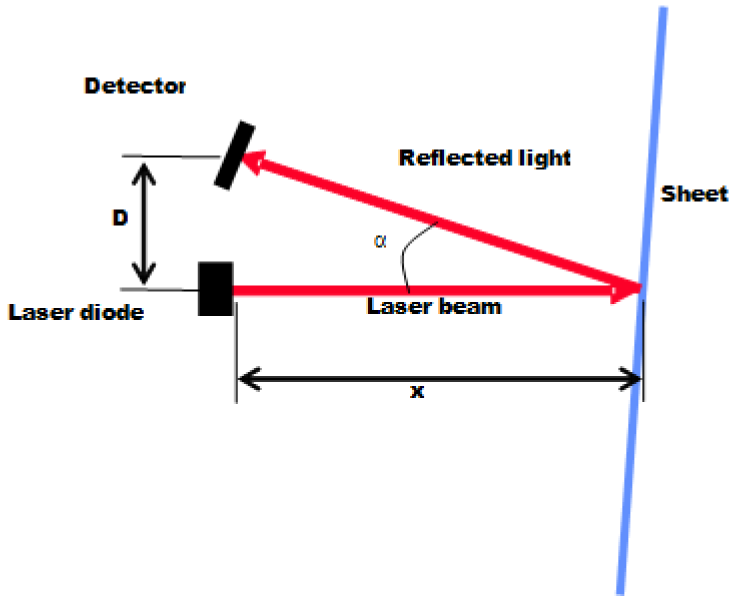


Figure 1-7 Principle of Laser Triangulation

Inductive Distance Sensing

Figure 1-8 shows the principle of inductive distance measurement. The Z-sensor drives an alternating current through a multi-turn coil. The EM field induces a current in the stainless steel target. The interaction with the target is measured as a change of inductance. This can be related to distance. This measurement is not affected by non-magnetic materials such as paper or plastic–the sensor sees right through the sheet to the dome. Because the measurement is temperature sensitive, the coil is wrapped around a highly thermally conductive aluminum nitride ceramic coilform which can be temperature controlled.

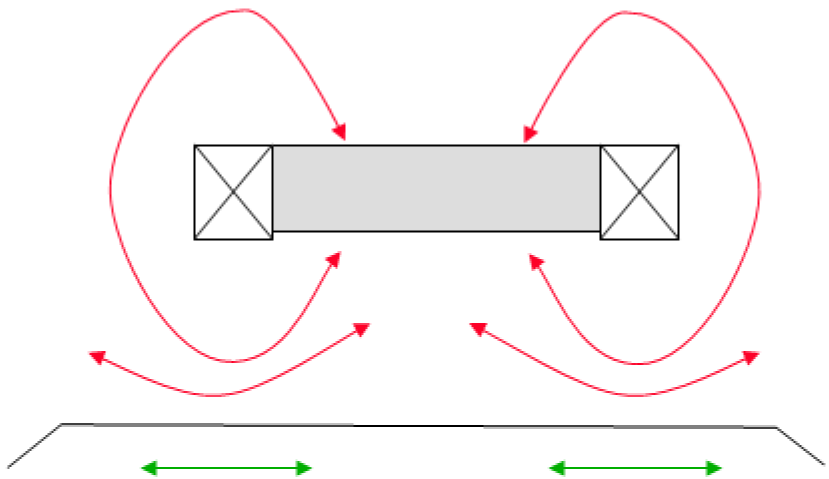


Figure 1-8 Principle of Inductive Distance Measurement

In contrast to the CLB module, the STA module position remains fixed. The basic features of the STA module are described in this section.

The STA module includes a laser triangulation sensor that reports an output voltage from which the distance to the sheet from the CLB module can be inferred through the calibration relationship. The aluminum structure of the laser triangulation sensor is in thermal contact with a temperature controlled Invar bracket. The temperature of this bracket is monitored by an embedded thermistor. Electronics on the STA module PCBA provide active feedback to hold the laser case at approximately 37 °C (98.6 °F).

There are two PCBAs in the STA module (see Figure 1-9 and Figure 1-10).

- STA interface PCBA
- EDAQ PCBA

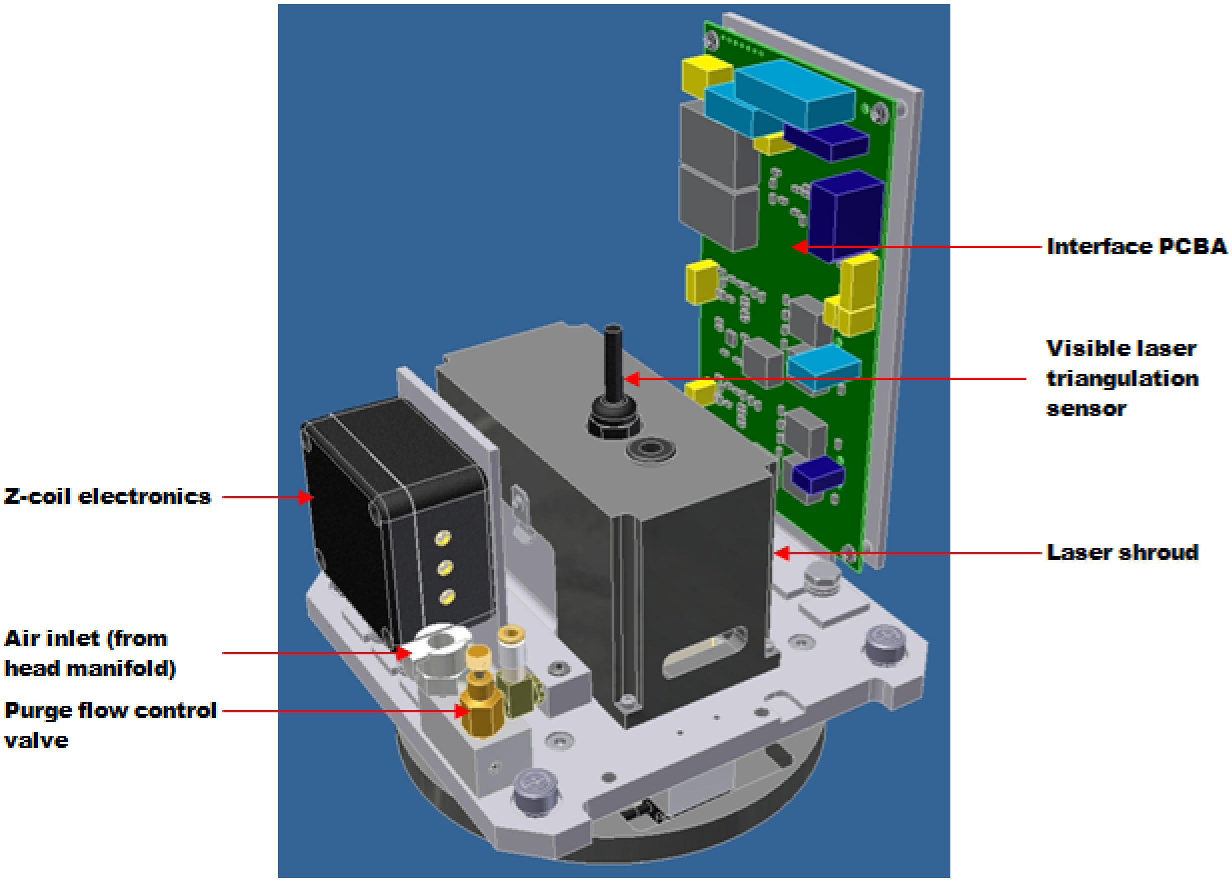


Figure 1-9 STA Module: Detail A

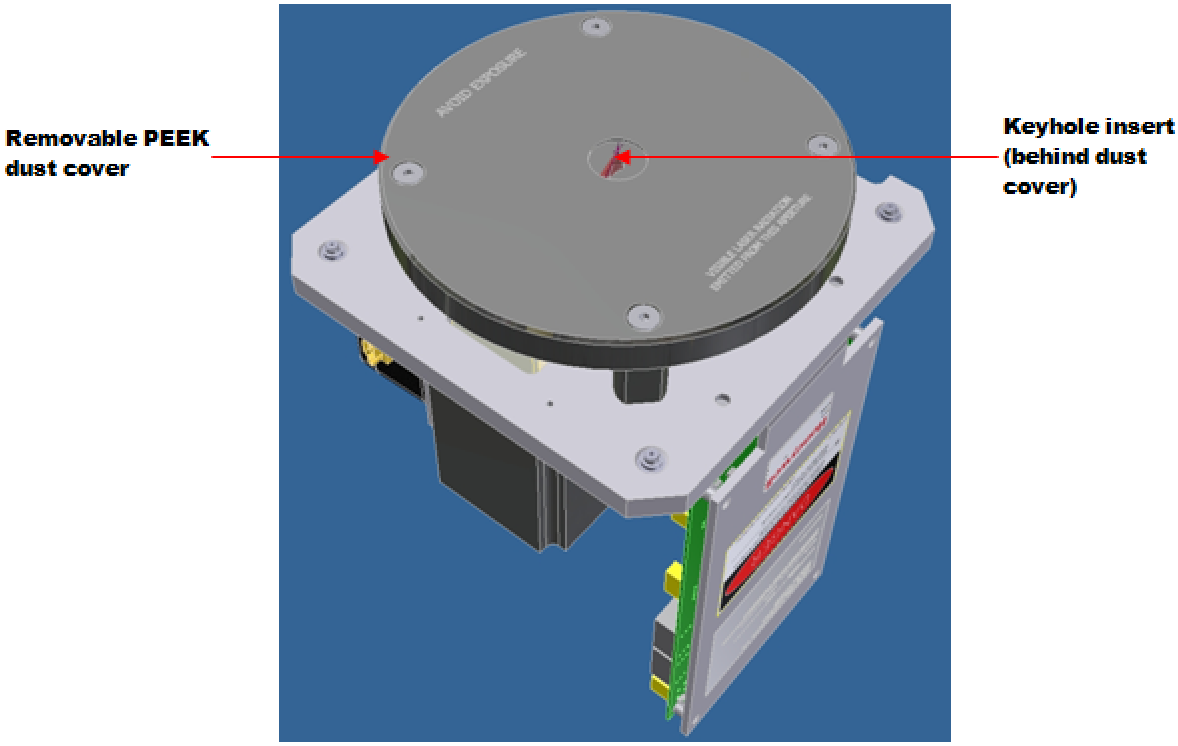


Figure 1-10 STA Module: Detail B

The Z-sensor determines the head separation of the modules, and provides the Z(x) term required to express the measurement of Equation 1-1. The Z-sensor consists of controlling electronics and a ceramic coilform around which wire wraps are affixed. The controlling electronics are shown in Figure 1-9, and the coil itself is seen in the detail of Figure 1-11.

The Z-sensor coilform is mechanically attached to the laser triangulation sensor so that there can be no relative movement between the two devices. The Z-sensor coilform is temperature controlled by two TECs. The TECs are located between the Z-coilform and the feet of the STA module baseplate. The laser triangulation sensor baseplate feet act as a heat sink for the TECs. Thermistors are permanently embedded into the Z-coilform and routed electrically to the STA module interface PCBA. Electronics on the interface PCBA actively supply current through the TECs so that the coilform temperature is fixed to 41–42 °C (105.8–107.6 °F) with a stability < 0.2 °C (0.4 °F).

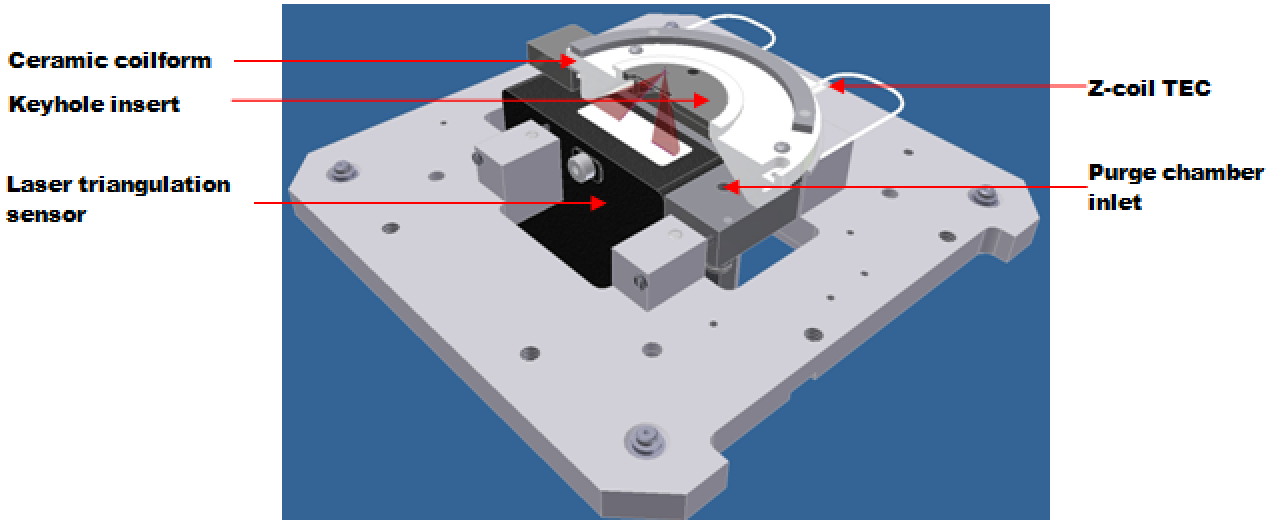


Figure 1-11 Laser Triangulation Sensor Purge Arrangement

The purged chamber between the laser triangulation sensor and the ceramic coilform is shown in the cutaway in Figure 1-11.

For dust resistance, the STA module includes a purge function intended to keep the optical path free of dust buildup. Figure 1-1 shows the details of the purge arrangement. A tube provides flow to a purge chamber that is formed below a keyhole insert. The mechanics that form the purge chamber mount around the base of the laser triangulation sensor and slide concentrically into the Z-coilform. The keyhole insert can be removed to clean the triangulation optics.

Laser Triangulation Sensor Electronics

The laser triangulation sensor interfaces with the EDAQ through analog and digital signals and with the head power distribution board for DC electrical power. Power is provided to the laser through the sensor interlock PCBA.

The assembly provides electrical interfaces to the laser and Z-coil, double TEC controllers, and multiple temperature measurements. For troubleshooting purposes there are test points on the PCBA to which clip-type DMM probes can be attached (see Figure 1-12). With the current version of the sensor, all signals are passed on to the sensor EDAQ board and further through the Ethernet LAN connection to the MSS.

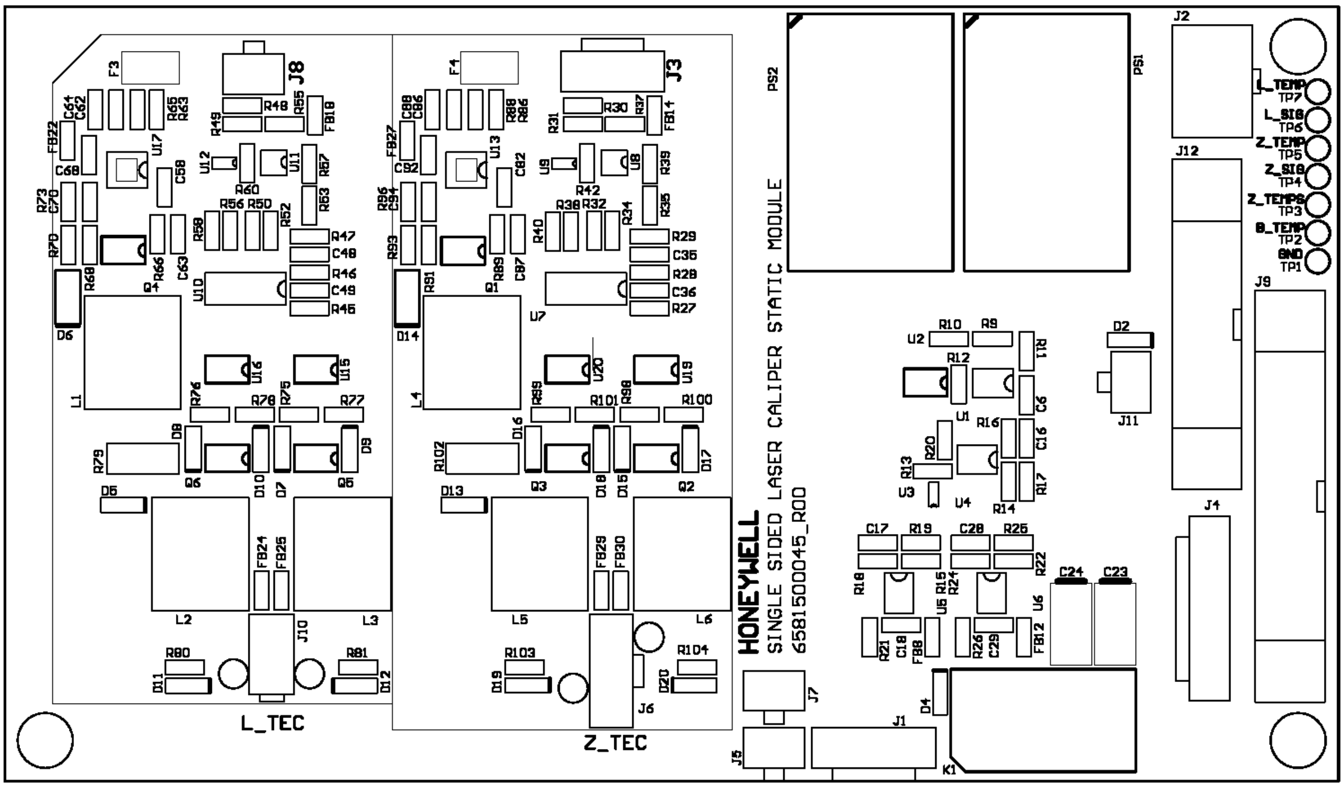


Figure 1-12 STA Module PCBA Layout

The STA module test points are shown on the upper right in Figure 1-12. The test points are listed and described in Table 1-2.

Table 1-2 STA Module PCBA Test Points, LEDs, and Connectors

PCBA Screen Print Label	Signal Name or Function	Expected Signal for Properly Functioning Sensor
L_TEMP	Laser triangulation sensor control loop temperature	1.22–1.26 V
L_SIG	Laser triangulation sensor displacement	0–10 V should change when dome moves

PCBA Screen Print Label	Signal Name or Function	Expected Signal for Properly Functioning Sensor
Z_TEMP	Z-module Z-coil control loop temperature	1.22–1.26 V
Z_SIG	Laser triangulation sensor displacement	0–10 V should change when dome moves.
Z_TEMPS	Z-module Z-coil monitor temperature	1.25 V
B_TEMP	PCBA temperature	100 mV/°C, approx 2.5 V@25 °C.
GND	GND	Reference
D2	LED-GRN: Flag status	ON if flag command active
D4	LED-GRN: L_Interlock	ON if interlock path closed
D11	LED-BLU: Laser TEC active	ON-heating
D12	LED-GRN: Laser TEC active	ON-cooling
D19	LED-BLU: Z-coil TEC active	ON-heating
D20	LED-GRN: Z-coil TEC active	ON-cooling
D5	LED-GRN: Laser TEC Power OK	ON
D13	LED-GRN: Power OK	ON
J1	Connector to Z-sensor	
J2	Power connector	
J3	Z-sensor thermistors	
J4	Laser-displacement sensor connector	
J5	In-place switch (not used)	
J6	Z-coil TEC	
J7	Head-split switch	
J8	Laser-displacement sensor thermistor	
J9	EDAQ connector	
J10	Laser-displacement sensor TEC	
J11	Solenoid (not used)	
J12	EDAQ	

1.2.2.3. Overview of the EDAQ

The EDAQ is used for various things in the laser caliper measurement:

- checking the laser key switch status for interlock enabling
- generation of stepper motor pulse sequences
- interaction between MSS and the laser caliper measurement

For more information on the EDAQ, see Chapter 3 of this manual, and refer to the *Experion MX MSS & EDAQ Data Acquisition System Manual* (p/n 6510020381).

1.3. Safety Notes and Interlock Description

1.3.1. Gauge Radiation Certification and Safety Notes

If the LCAL is integrated into a Q4000 scanner, it is classified as a class I device (cannot emit laser radiation at known hazard levels), and complies with *21 CFR 1040.10* and *1040.11*. Power the device only when it is properly integrated into the scanner, because the scanner acts as an enclosure for the embedded red laser. If powered outside the scanner, it would be classified as class 3R. Class 3R lasers are only hazardous for intra-beam viewing (directly into eye). For a visible beam, the eye limits its exposure through a blink response (0.25 s).

The scanner enclosure includes an interlock that extinguishes laser emission for conditions where it would be otherwise possible to view the beams. The class I designation relies on this interlock.

WARNING

Do not attempt to defeat or otherwise tamper with the interlock system.

1.3.2. Laser Interlock

The function of the interlock is to prevent human exposure to laser radiation at unsafe levels. The interlock circuit ensures that the scanner heads are together and that the scanner endbell laser keyswitch and pushbutton are on. See Figure 1-13 for a generalized schematic of the interlock.

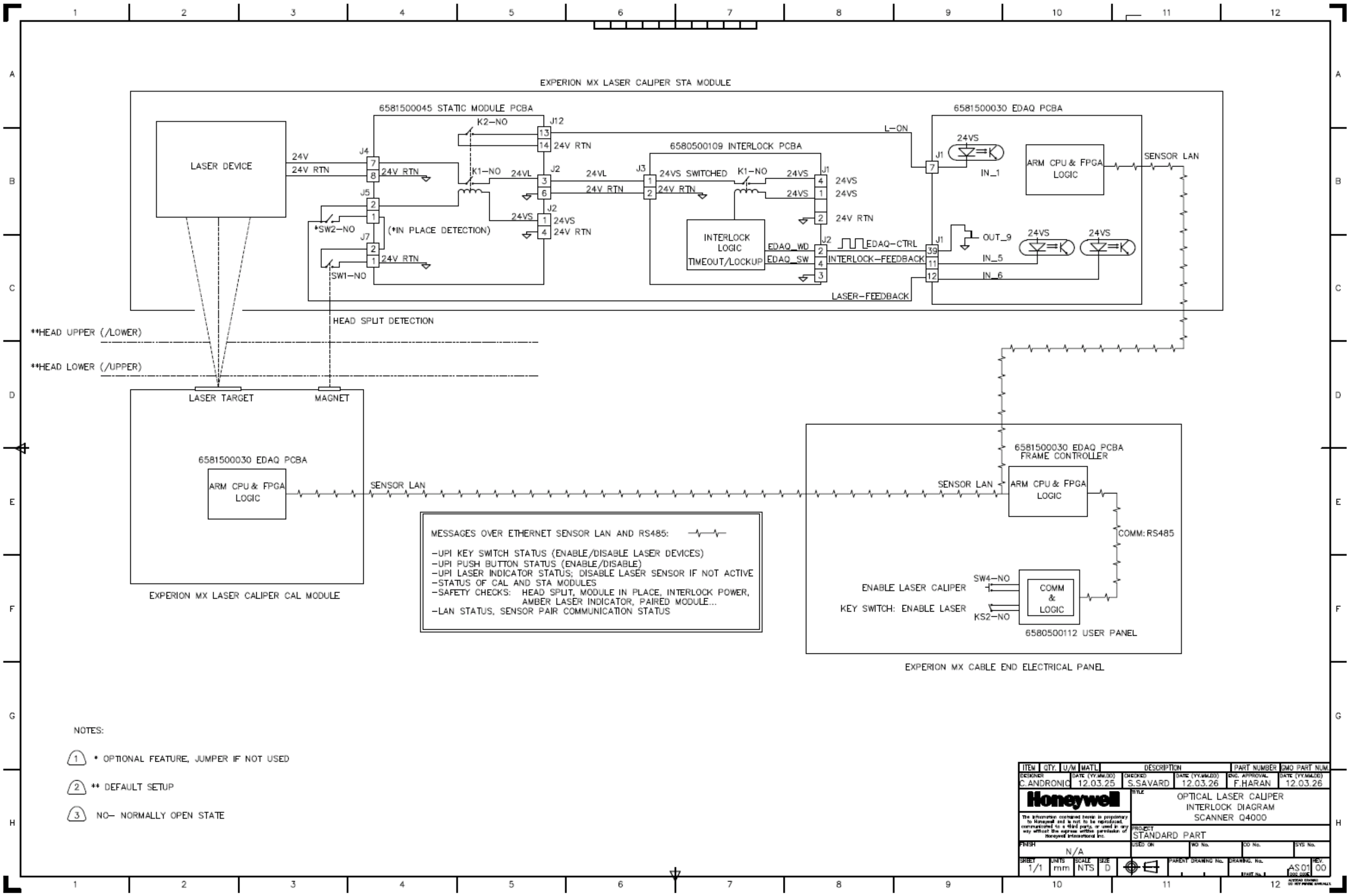


Figure 1-13 Interlock Schematic

The principle of the interlock is (if any of the following actions occur, the laser is extinguished):

- local hardware check: the heads are split
- scanner user panel: the laser key switch is turned off
- scanner user panel: the LCAL enable pushbutton is disabled
- scanner user panel: the LCAL amber LED is not lit
- overall system check: communication with any of the sensor EDAQs is interrupted
- overall system check: signaling between the laser triangulation sensor EDAQ and the interlock board is interrupted or not matching expected feedback (the interlock board reports the laser power status command back to EDAQ)

The reed switch shown in Figure 1-14 will not close until it is within ~12 mm of the magnet (see Figure 1-15).

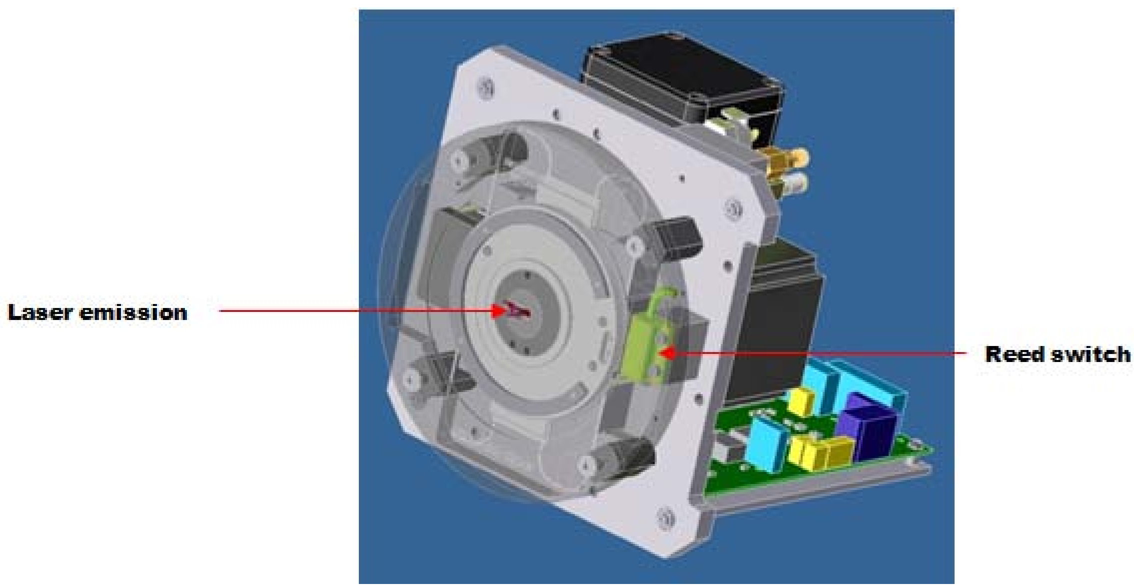


Figure 1-14 STA Module in Upper Head: Reed Switch must be closed to complete the Interlock Circuit

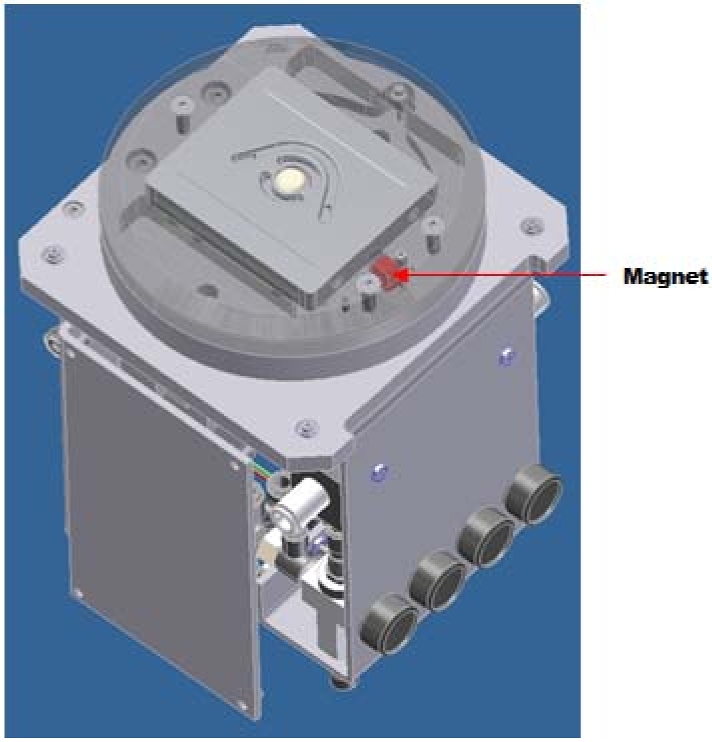


Figure 1-15 CLB Module In the Lower Head: Magnetic field must close STA reed switch to complete Interlock Circuit

Two separate power paths have to be closed (pulling a + 24 V source to ground) in order for the interlock to be satisfied (see Figure 1-13). Within the sensor, the active element is the reed switch in the laser triangulation sensor, which senses the proximity of the magnet in the stainless steel dome of the CLB module (see Figure 1-14).

If the CLB module is close enough to the laser triangulation sensor to activate the switch, there is no danger of accidental exposure to the laser. The reed switch plugs into the STA module PCBA. It is extremely unlikely that the reed switch will fail in the closed position, considering that the switch is actually comprised of two switches in series and each of these switches has an expected lifetime of 5M cycles. In the expected lifetime of any sensor, the switches are expected to be toggled only a small fraction of this number. If this part of the interlock is satisfied, the relay K1 is closed which allows the + 24 VL to power the laser.

The second power path provides the + 24 VL through the interlock PCBA. This PCBA implements a watchdog function and enables its output relay (therefore laser DC power) if the laser triangulation sensor EDAQ resets the hardware watchdog control signal within 0.5 s. In order to prevent lock-ups, the interlock board watchdog will reset its relay if the STA module EDAQ control signal is stuck active high or active low.

The status of the interlock output relay is monitored by the laser triangulation sensor EDAQ. If status of the interlock board relay does not match the expected functional state, the STA module EDAQ will interrupt generating the watchdog signal causing the interlock board to disconnect power from its output relay and turn the laser power off.

Several interlock status signals are monitored by the STA module EDAQ, and reported further to the operator through status and error messages. For example, the laser triangulation sensor EDAQ monitors the laser caliper CLB module in-place output, the laser triangulation sensor K1 contacts status (laser *on* signal), and the feedback from the interlock board. These signals can be used to assist with troubleshooting.

In addition to all these hardware functional checks, at the sensor application level, supplementary safety features are implemented through the Experion MX user panel interface (see Figure 1-16).

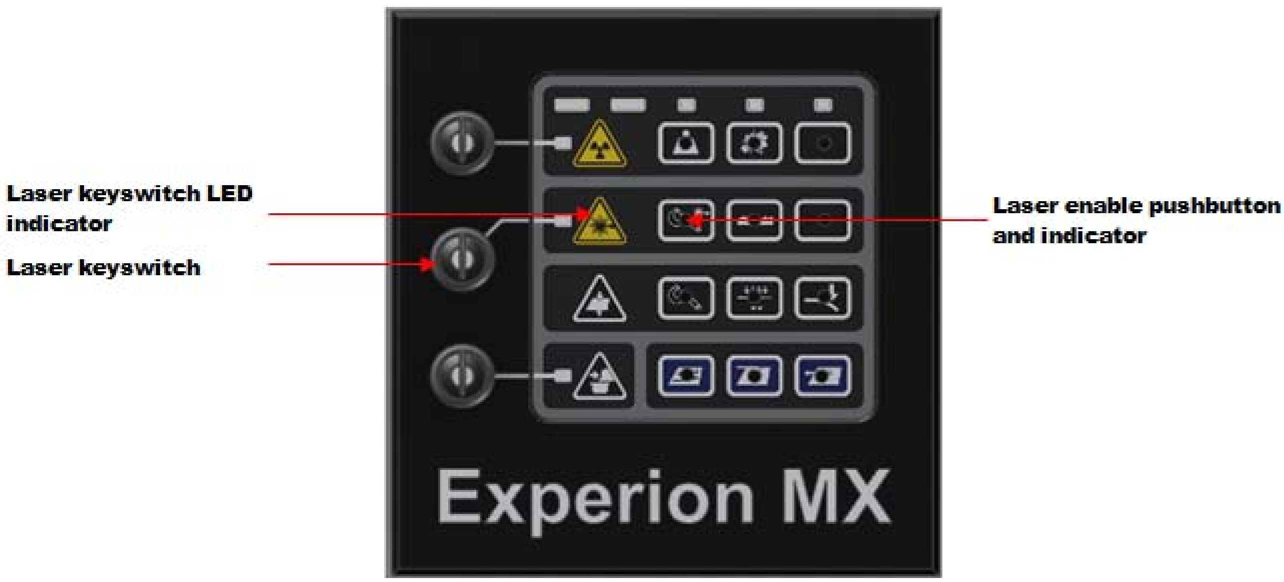


Figure 1-16 MX User Panel Interface and Keyswitches

In order to enable power to the laser device (power to the interlock board), a keyswitch on the panel must be activated. After that, the laser enable pushbutton must be pressed. The status of these two switches is reported throughout the sensor LAN allowing additional SW checks. For example, the laser triangulation sensor EDAQ will deny power activation requests for the laser if any of its safety checks are not complete (CLB module in place, communication with CLB module not valid, or sensor is not properly configured in the system).

After successful completion of the safety checks, the laser triangulation sensor EDAQ will enable the interlock board watchdog, and will also activate the laser ON indictor on the user panel. The status of the user panel laser indicator is monitored by the user panel and reported on the sensor network. All safety conditions and user input signals are monitored by both the STA module and CLB module EDAQs. Any change in the interlock path, for example, head split or user input status (disable laser button, or inactive laser indicator), will immediately cause the deactivation of the laser device. Safe procedures for servicing the laser caliper measurement sensor are described in Chapter 6.

1.4. Measurement Range

The laser caliper gauge is designed to be integrated into Q4000 scanners with a nominal 10-mm (0.4-in) gap between the sheetguides. Because the measurement relies on both the upper and lower head positions, the setup of the scanner influences the overlap range (see Figure 1-17).

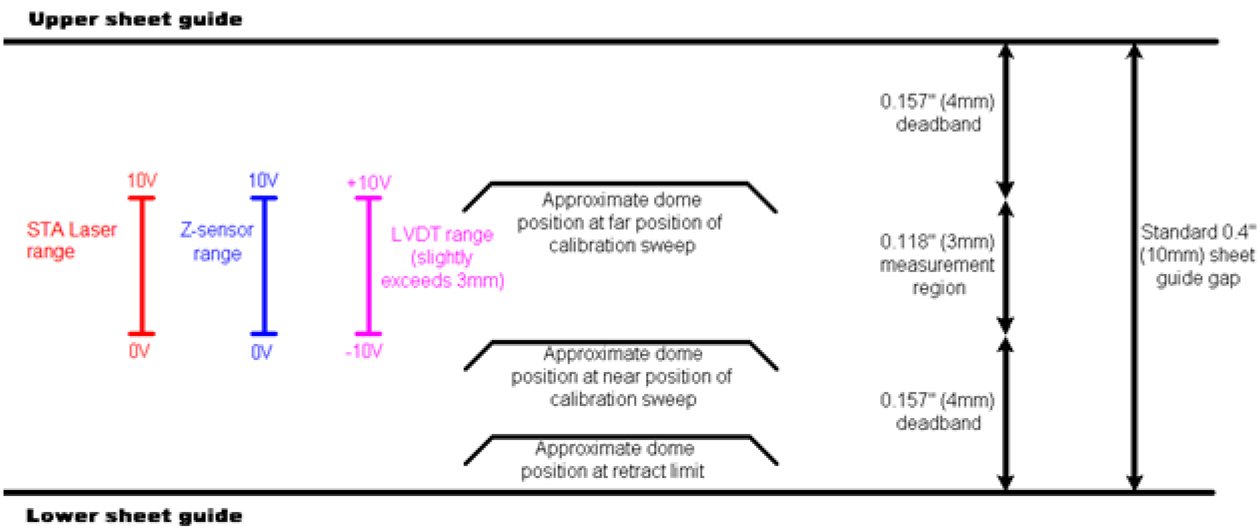


Figure 1-17 Measurement Range, Deadbands, and Typical Dome Positions

Installed scanners usually have different gap sizes. Furthermore, gaps vary due to the influence of mill temperatures on scanner dimensions. In order to get a laser caliper measurement, the laser triangulation sensor and Z-sensor have to be measuring within range. In order to get a good calibration, the LVDT also has to be within range. The laser triangulation sensor and Z-sensor both have 4-mm (0.16-in.) ranges, and the LVDT has a 3.5-mm (0.14-in.) range. The sensor is designed such that the LVDT range is centered at the centre of the laser triangulation sensor and Z-sensor range when the gap is 10-mm (0.39-in.) wide.

If the scanner head gap is not to specification, it will suffer in measurement overlap range (see Figure 1-18).

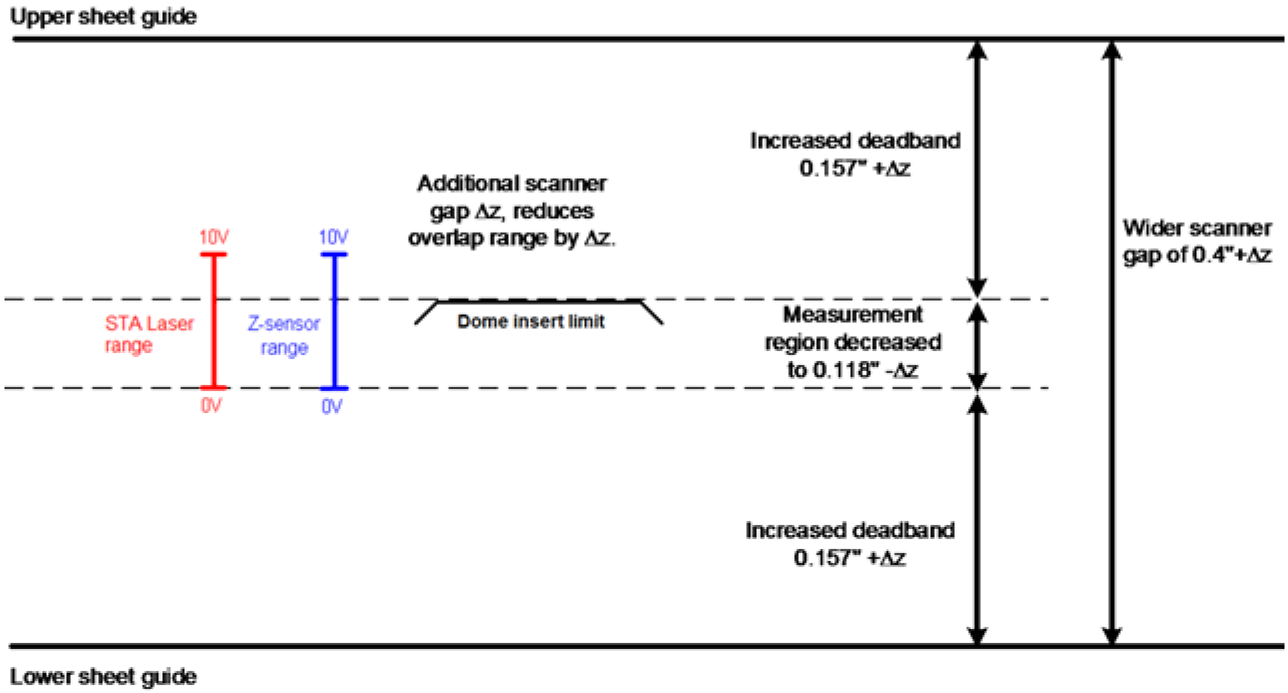


Figure 1-18 Overlap Range as Influenced by Scanner Sheet Gap

A scanner with a non-ideal gap reduces the overlap range in which a measurement can be made. This reduction can be accommodated by positioning the air clamp relative to the remaining overlap range, but remember that there are consequences to a non-ideal sheet gap. A reduced range will determine the range over which the dome can be set to a desired position.

1.5. Calibration Function and LUT Generation

The role of the calibration process is to refresh the signal to displacement relationships for the laser triangulation sensor and the Z-sensor. These sensors are calibrated against the LVDT.

In the calibration process, the calibration module target can move up and down in the sheet gap, through the action of the stepper motor. During a calibration, the dome retracts out of the gap, and then incrementally moves farther into the gap, through the calibration range of the laser triangulation sensor and the Z-sensor. At each calibration point, the signal of the LVDT, in volts, is recorded and translated to a displacement, in microns, with use of the LVDT calibration data (included with the system). Then, for both the laser triangulation sensor and the Z-sensor, its signal, in volts, is recorded by the MSS. To that signal, the corresponding LVDT displacement is assigned. In this way, one point on the displacement/signal curve for the laser triangulation sensor and the Z-sensor is obtained. The target moves a small increment upward, and the displacement assignment process is repeated, establishing another point on the displacement/signal curve for the laser triangulation sensor and Z-sensor. This process is repeated at, typically, 150 points through the calibration range of the gauge to generate the full displacement/signal relationships for the laser triangulation sensor and Z-sensor.

The LVDT ships with a calibration LUT. The LUT is determined in the Honeywell factory and shipped as a supporting text file on the Experion MX system. Any replacement LVDT assembly is also shipped with an LUT. The LVDT displacement-to-voltage output is almost, but not exactly, linear. The relationship is expressed as:

$$Z_{LVDT}(V_{LVDT}) = Z_o + \left(\frac{dZ}{dV}\right)_{LVDT} V_{LVDT} + Z_{LUT}(V_{LVDT})$$

Equation 1-2

For computational efficiency, the nonlinear displacement function is divided by the best fit slope, so, Equation 1–2 is rewritten as:

$$Z_{LVDT}(V_{LVDT}) = Z_o + \left(\frac{dZ}{dV}\right)_{LVDT} (V_{LVDT} + V_{LUT})$$

Equation 1-3

The LVDT LUT appears as a single column text file. The descriptions of the entries are listed in Table 1-3.

Table 1-3 LUT Format

Element	Entry description	Units
0	The number of LUT entries per volt of signal *[dN/dV]*	[V^{-1}]
1	Signal value corresponding to the zeroth entry in the LUT, V_0	[V]
2	Number of entries in the LUT	[N/A]
3	The offset, Z_o, of Equation 1-3	[μm]
4	The best fit slope, *(dZ/dV)LVDT*, of Equation 1-3	[μm/V]
5	Enumerating from 0 to N-1, this is the zeroth entry of the LUT	[V]
N+4	Enumerating from 0 to N-1, this is the (N-1)-th entry of the LUT	[V]

In practice, the LUT is employed in the following way:

- the MSS reads a signal value, in volts, from the LVDT conditioning hardware
- the read signal value is V_{LVDT} in Equation 1-3
- V_{LVDT} is used to identify which LUT entry should be used for *VLUT* in Equation 1-3

The specific LUT entry index, *n*, is computed as:

$$n = \left(\frac{dn}{dV}\right)\left(V_{LVDT} - V_0\right).$$

Equation 1-4

Thus, the n^{th} corrector value is extracted from the LUT array and included in Equation 1-3 to report the displacement, Z_{LVDT}. The LUT calculation is performed in the same manner for the Z- and laser sensors. Section 2.4 describes how to calibrate the Z- and laser sensors through the Experion MX software.

In general, a successful calibration shows near linear response for the laser and a smooth parabolic-looking shape for the Z-sensor relationship. Sharp discontinuities in the signal/displacement relationship suggest a problem. Also, the slope and offset of that particular calibration run are presented in the **Calibration Coefficients** area of the display. The value of the calibration slope can be an indication of device health. Nominally, the slopes of the Z- and laser sensor displacement/signal functions should be 500 microns/V (± 10 microns/V). Values which differ from this might indicate problems.

It is possible that Experion MX may present a misleading slope calculation if the Z- and laser sensors are not fully in range during the calibration. For example, if the sheet gap is too wide or too tight, a properly functioning laser caliper gauge can appear to be malfunctioning. If the region through which the target moves at calibration does not align well with the measurement ranges of the other devices, the device calibration could represent a portion of deadband and a portion of valid calibration. If the portion of deadband is included in the calibration, the calibration will show a linearly sloped portion and a flat portion, the nonlinearity will appear large, and the slope will be outside the guidelines suggested in the previous paragraph. Correct evaluation of the calibration slope, by eliminating the deadband, can be performed by changing the fit limits in the **LCAL Setup** menu (see Subsection 2.2.2).

1.6. Standardization

The standardization function for the laser caliper gauge occurs as with the other gauges in the system. During a standardize event, the dome moves to its standardize position and the laser measures the position of the zirconia button, and the Z-sensor measures the position of the dome. Like other sensors, the standardize operation is intended to provide an indication of device drift and a means to recover from it. A known issue with the laser caliper measurement sensor is that the laser does not read all zirconia buttons properly which means that standardize reports are not as useful as they could be.

2. System Components

The **Station - rae - Laser Caliper** display (Figure 2-1) provides an overview of the sensor status, the correctors employed, the last standardize and current values, and buttons by which additional laser caliper displays are accessed.

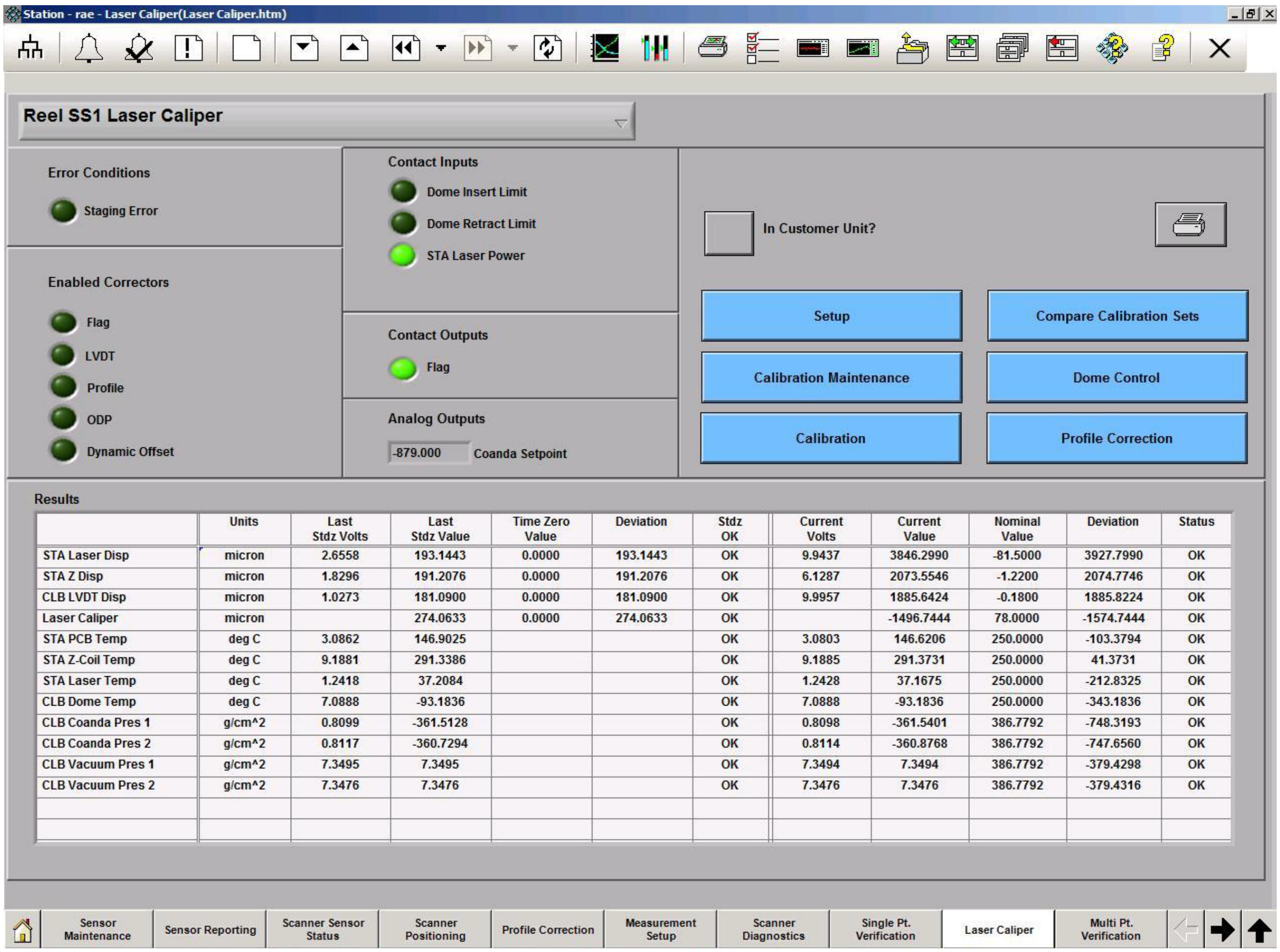


Figure 2-1 Station - rae - Laser Caliper Display

This chapter describes the laser caliper-specific Experion MX displays. The Experion MX system includes a dedicated **Laser Caliper** tab as shown in Figure 2-1.

This **Laser Caliper** tab is available under the **Scanner/Sensor** tab for users with manager or higher status.

2.1. Laser Caliper Measurements

The laser caliper measurement sensor has a number of measurements that can be selected as profiles (see Table 2-1).

Table 2-1 Measurement Profiles

Profile	Measurement
LCL STA Laser Disp	Laser displacement
LCL STA Z Disp	Z-sensor
LCL CLB LVDT Disp	LVDT
Laser Caliper	Calculated caliper
Laser Caliper (16SA)	Spatially averaged caliper

The spatially averaged caliper is created from laser caliper and is spatially filtered with a 16-mm (0.63-in.) width to match the size of the contacting caliper and the size of the anvil specified in the TAPPI 411 standard. The spatially averaged measurement should be significantly less noisy than the laser caliper measurement, and can be used for display purposes. For control purposes, the laser caliper signal should be used.

For other measurements that are periodic see Appendix C.

2.2. LCAL Setup Display

The **LCAL Setup** display (Figure 2-2) allows input of various basic parameters for gauge operation. This display is divided into several functional areas as described in Subsection 2.2.1 through to Subsection 2.2.8.

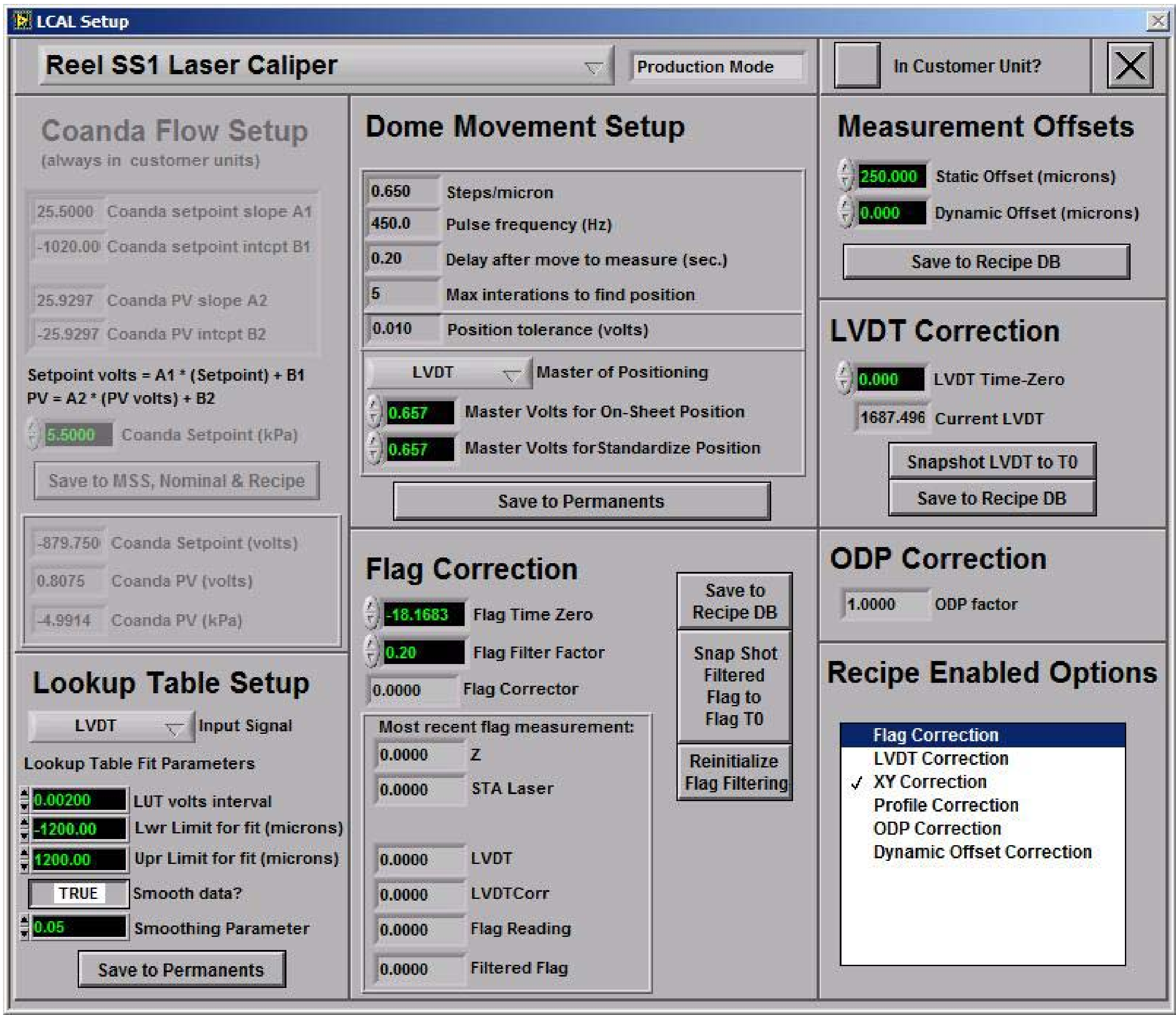


Figure 2-2 LCAL Setup Display

2.2.1. Coanda Flow Setup

The **Coanda Flow Setup** area of the **LCAL Setup** display is not currently used on this release of the gauge. The flow rate through the air clamp is manually adjustable only. The plenum pressure is measured electronically, and is available on Experion MX, but there is no electronically controlled valve.

2.2.2. LUT Setup

The **Lookup Table Setup** area of the **LCAL Setup** display allows specification of how the LUTs stored in the real-time data repository (RTDR) are computed. As described in detail in Section 1.5, the LUTs are used by Experion MX because they are an efficient way to store the generally nonlinear signal displacement relationships for the on-board measurement devices.

The first parameter allows specification of the granularity of the LUT, in units of volts. An entry of 0.002 V is recommended.

In computing the LUT, the computation fits a line to the signal/displacement relationship. The fields **Lwr Limit for fit (microns)** and **Upr limit for fit (microns)** indicate the displacement range over which the fit to determine the slope will be done. The default values of - 1200 µm and + 1200 µm are appropriate entries for the limits, for all devices, when the scanner head gap is at the 10.16 mm (0.4 in.) specification. The most common reason to deviate from the ± 1200 µm default values for these parameters is when the scanner gap is wider than normal. In this situation, the calibration can include significant deadband. While the reported slope may be misleading, the LUT generated will be accurate regardless of the limits.

If **Smooth data?** is not selected, the LUT will be directly interpolated from the points in the calibration table.

If **Smooth data?** is selected, Experion MX will generate a smoothed line that does not pass through all the points in the calibration table. The higher the smoothing parameter, the more smoothing will be applied. A figure of 0.05 is the default value for the smoothing parameter.

2.2.3. Dome Movement Setup

The **Dome Movement Setup** area of the **LCAL Setup** display permits selection of a master for dome positioning, and selection of the signal values corresponding to the desired dome positions for standardizing and onsheet. The master sensor for onsheet should be either the LVDT, or the Z-sensor. If **STA Laser** is selected, the onsheet positioning might not work because the laser may not read within range when it is offsheet (where the positioning takes place).

See Section 1.4 for a description of how to physically select the appropriate position of the dome for onsheet measurement. After the physical position is selected, be sure that it is the signal level, in volts, not the displacement value, that is entered into **Dome Movement Setup**.

In most cases, the standardize volts should be set to be the same as the onsheet volts.

2.2.4. Flag Correction

The **Flag Correction** area of the **LCAL Setup** display is not used in this version of the sensor.

2.2.5. Measurement Offsets

In the **Measurement Offsets** area of the **LCAL Setup** display, the measurement offsets have been implied in the expressions for the caliper computation thus far. **Static Offset** and **Dynamic Offset** are merely scalar constants that will be added to the computed caliper so that the absolute value of the computation is sensible. The expression for caliper is:

$$t_{LCal}(x) = Z_Z(x) - Z_{LAS}(x) + \Delta t_o + \Delta t_o^{'}.$$

Equation 2-1

The static offset is a grade-independent variable, whereas the dynamic offset is a variable which may be entered into grade recipes. This value may change due to surface effects such as gloss or coating. The static offset will have to be adjusted after the sensor is re-calibrated. If there are various grades requiring differing offsets, a good approach is to base the static offset on a flag reading, and then to set different dynamic offsets for different grades.

2.2.6. LVDT Correction

The **LVDT Correction** area of the **LCAL Setup** display should not be used in this version of the sensor.

2.2.7. ODP Correction

The **ODP Correction** area of the **LCAL Setup** display should not be used in this version of the sensor.

2.2.8. Recipe Enabled Options

The **Recipe Enabled Options** area of the **LCAL Setup** display enables you to determine which, if any, correctors are being used to report the LCAL measurement. The correctors can be turned on and off with a double-click. However, these settings will be lost upon a recipe change. Permanent changes should be set on the **Recipe Maintenance** display in the *LCALPxx* configuration table. The only options which should be used with the 09421352 version of the sensor are the Profile Corrector (see Section 4.4), the XY Corrector (see Subsection 2.2.8.1), and the Dynamic Offset (see Subsection 2.2.5).

2.2.8.1. XY Correction

XY correction is meant to correct for the slight dependence that the Z-measurement has on XY movement of the Z-target. It should be enabled. The coefficients must be determined during sensor installation (see Section 4.3).

2.3. LCAL Calibration Maintenance Display

The **LCAL Calibration Maintenance** display (Figure 2-3) is useful for implementing previously stored calibrations.

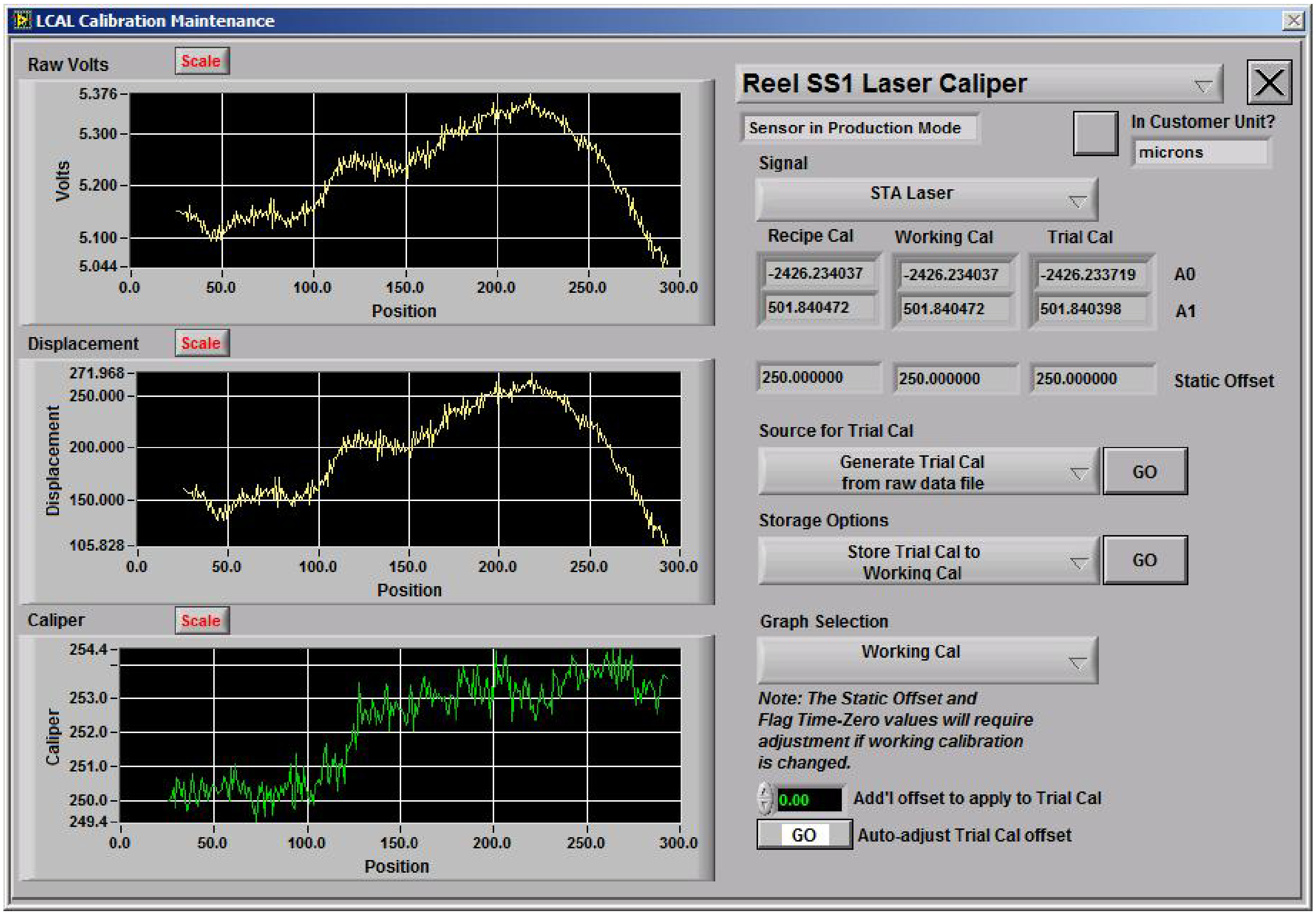


Figure 2-3 LCAL Calibration Maintenance Display

It is not possible to have the gauge physically perform a calibration operation from the **LCAL Calibration Maintenance** display, only to work with calibrations previously saved to disk. It is possible to manipulate the working calibrations while the sensor is in production mode. Be aware that this will yield discrete step changes in measurement.

The most common application of the **LCAL Calibration Maintenance** display is to apply a previously saved calibration (saved from the **LCL Calibration** display, not the **LCAL Calibration Maintenance** display) to the RTDR for measurement. Usually, this is done immediately following the performance of a physical calibration operation and a consequent saving-to-file of the raw calibration data. It is not possible to enter calibrations into the working values through the **LCL Calibration** display. In that display, it is possible only to save a calibration to the current recipe, after which it would be required to reload the recipe if seeking to use the most recent calibration for measurement. This might be undesirable because reloading the recipe may overwrite parameters associated with other sensors, for example, moisture, weight, and color targets, that have been manually adjusted by mill operators. The **LCAL Calibration Maintenance** display allows entry of the unique laser caliper calibrations to the working storage of the RTDR, and to recipes, without influencing parameters associated with other sensors.

Another use of the **LCAL Calibration Maintenance** display is to show what calibration parameters are currently being used. Experion MX employs an LUT to internally represent the signal/displacement relationship for all three measurement devices on the laser caliper gauge. The precise format of the LUT is a single column ASCII text file with entries defined in Table 1–3.

A device LUT can contain up to ten thousand individual entries, and Experion MX does not present the entire LUT on the display. Only the slope and intercept of the signal/displacement relationships are presented. The offset, in units of microns, is presented by the calibration constant A0. The slope, in units of microns per volt, appears as the calibration constant A1.

Toggle the **Signal** drop-down arrow to inspect the slopes and offsets of the LUT currently being used for a specific device. Also, the consequences on measurement of changing the LUT can be previewed on the display before the actual update is done. For whatever device is selected under the **Signal** drop-down arrow, the display will show the signal profile of the device in volts, the displacement profile in units of microns, and the consequent caliper reading. This data is useful to assess if any profile errors are a consequence of outdated calibrations.

Select any of the three devices to update their RTDR calibration values. Only the laser triangulation sensor and the Z-sensor have their calibrations updated in the display. If an LVDT is replaced on-site, it will arrive with an LUT from the factory, and this LUT must be entered into Experion MX. This is the only instance where it is expected that the LVDT calibration parameters are manipulated. If an LVDT replacement does occur, to up-load its LVDT LUT:

1. Copy the LUT file delivered with the LVDT to the Experion MX server.

2. Select LVDT as the **Signal**, and choose the **Read Trial Cal from Disk File** from the **Source for Trial Cal** drop-down arrow (see Figure 2-4).

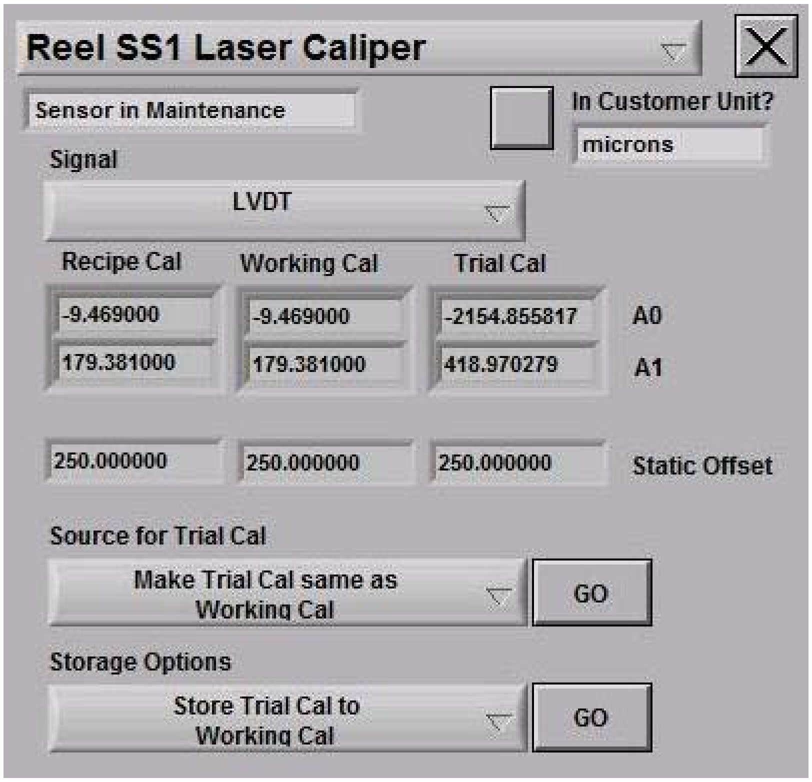


Figure 2-4 LCAL Calibration Maintenance Display: Entering an LUT for the LVDT

3. In the **Trial Cal** column, new A0 and A1 appear as the contents of the text file are read into the RTDR. At this point, the calibration is not yet active, it is merely a trial for review.

4. If the LUT is considered valid (this can be judged by inspection of A0 and A1), from **Storage Options** drop-down arrow, select the appropriate storage locations, typically **Store Trial Cal to Working & Recipe Cal**. Be aware that an LUT stored only to **Working** will be overwritten by the contents of the recipe, should the grade be reloaded.

In principle, it is possible to directly load an LUT, in the form of a single column text file, for the laser triangulation sensor and the Z-sensor. While possible, such an operation is improbable.

To load a calibration for the laser triangulation sensor or Z-sensor:

1. Put the scanner in maintenance mode to ensure that the calibration update will apply to all grades.
2. Return to the **LCAL Calibration Maintenance** display.
3. Select the signal for the calibration update. After a calibration has been performed, the operations to load individual device calibrations into the RTDR have to be repeated for each device. The reason for this is so that if only a single device is thought to need updating, this can be done for that device without forcing an update for the rest.
4. From the **Source for Trial Cal** drop-down arrow, select **Generate Trial Cal from Raw Data File**. The dialog shown in Figure 2-5 appears.

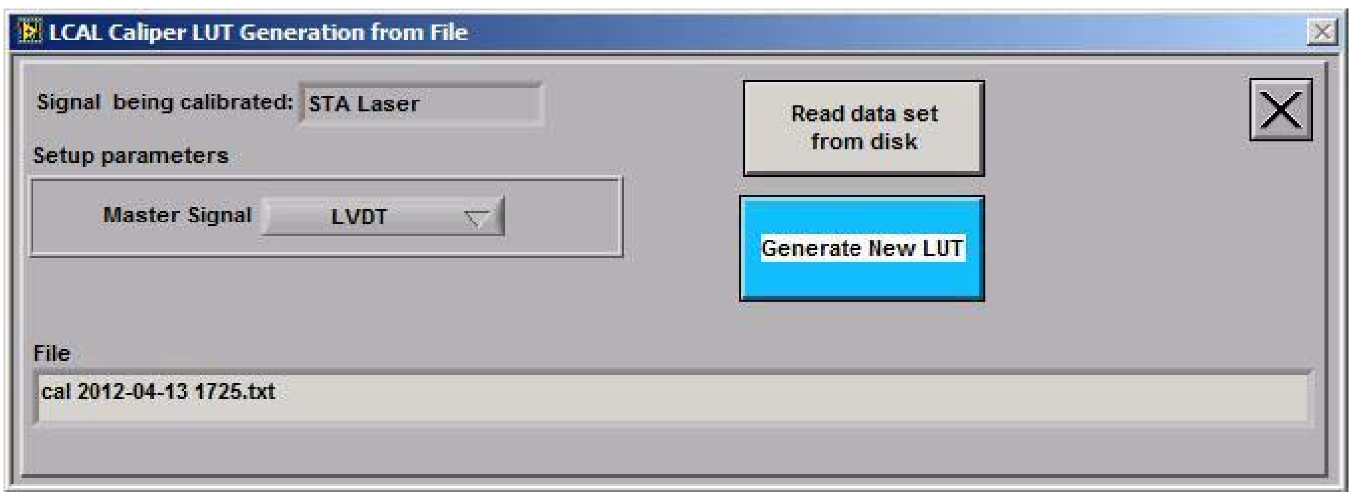


Figure 2-5 LCAL Caliper LUT Generation from File Dialog

As shown in Figure 2-5, this selects a raw calibration data file to generate an LUT.

5. Clicking **Read data set from disk** opens a dialog from which raw calibration files can be identified. The selected file appears in the **File** field.
6. Select the correct item from the **Master Signal** drop-down arrow. This is usually the LVDT. However, sometimes it might be necessary to

calibrate the Z-sensor to the laser triangulation sensor, or the laser triangulation sensor to the Z-sensor.

7. Click **Generate New LUT**. A graph appears similar to the one in Figure 2-6. The graph expresses the nonlinearity of the device, not the error (as it is labeled in the image). If the nonlinearity is very large, adjust the limits for the calibration fit (see Subsection 2.2.2).

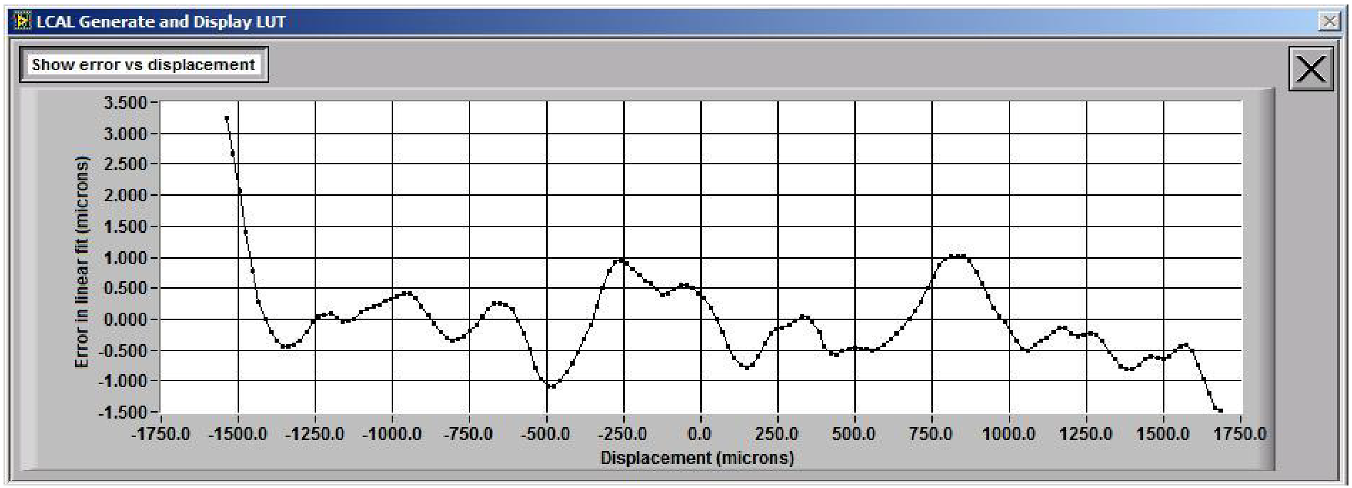


Figure 2-6 Graph of LUT Nonlinearity

The graph of LUT nonlinearity shown in Figure 2-6 is generated from a raw calibration data file.

8. Entering new calibrations will affect the absolute caliper readings. Clicking **Auto-adjust Trial Cal offset** on the **LCAL Calibration Maintenance** display will make the new average caliper value agree with the existing one. If an additional change is required, the adjustment can be entered in the **Add'l offset to apply to Trial Cal** text field on the **LCAL Calibration Maintenance** display.

9. In the **Trial Cal** fields in the upper right corner of the **LCAL Calibration Maintenance** display, the A0 and A1 constants are updated. To accept these constants for measurement, under the **Storage Options** drop-down arrow, select the appropriate storage locations, typically **Store Trial Cal to Working & Recipe Cal**. Be aware that an LUT stored only to **Working** is overwritten by the contents of the recipe, if the grade is reloaded.

10. If storage to the recipe is included in the selection, the **Select ID and groups to apply** dialog (Figure 2-7) appears, to select which pointers should be associated with this LUT. Select the **apply to all** check box because device calibrations are generally grade-independent.

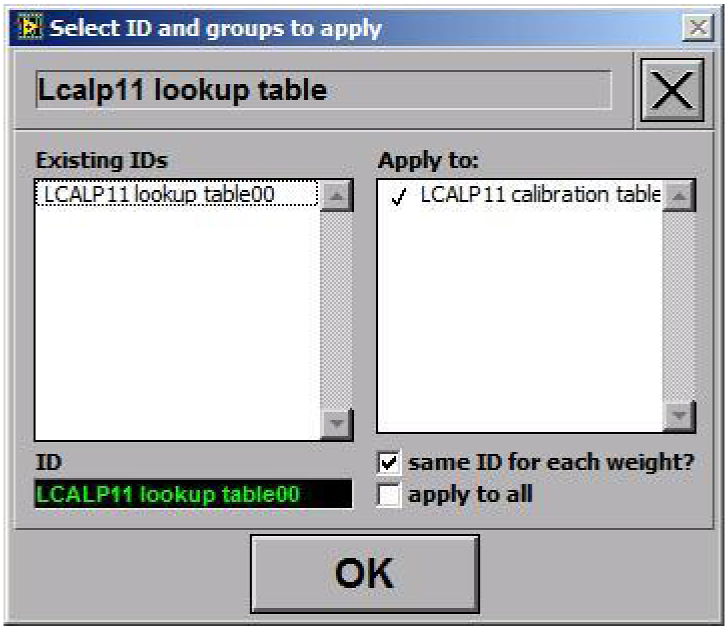


Figure 2-7 Select ID and groups to apply Dialog

11. After the LUTs have been entered into the recipe, the A0 and A1 parameter fields also reflect the update.

12. Perform steps 1–8 in maintenance mode and return the scanner to production mode. Verify that the proper A0 and A1 appear in both the **Recipe Cal** and **Working Cal** fields. **Working Cal** fields are what the sensor will use when it is making production measurements. If the working values are not the expected A0 and A1, perform steps 1–9 again, but this time in production mode. This will update the working values.

2.4. LCL Calibration Display

The **LCL Calibration** display (not the **LCAL Calibration Maintenance** display) is intended to initiate the physical calibration of the gauge, and this section describes how to execute that process.

Calibration activity must be performed in maintenance mode, or the relevant displays and controls will be grayed out. Click **Calibration** on the **Station - rae -**

Laser Caliper display (Figure 2-1), and the **LCL Calibration** display appears (Figure 2-8).

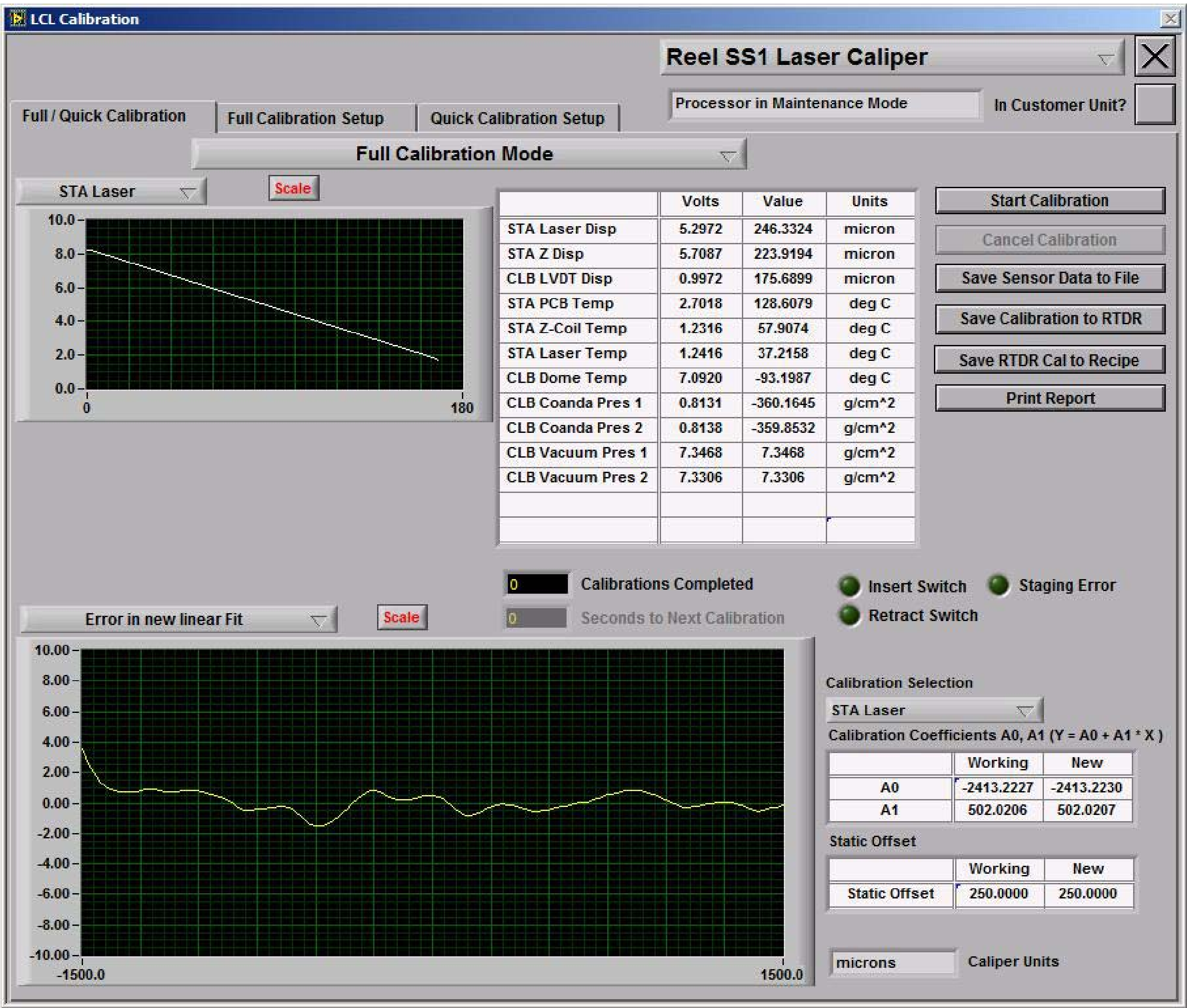


Figure 2-8 LCL Calibration Display: Full / Quick Calibration Tab

Some setup parameters are required before starting a calibration. Select the **Full Calibration Setup** tab (see Figure 2-9).

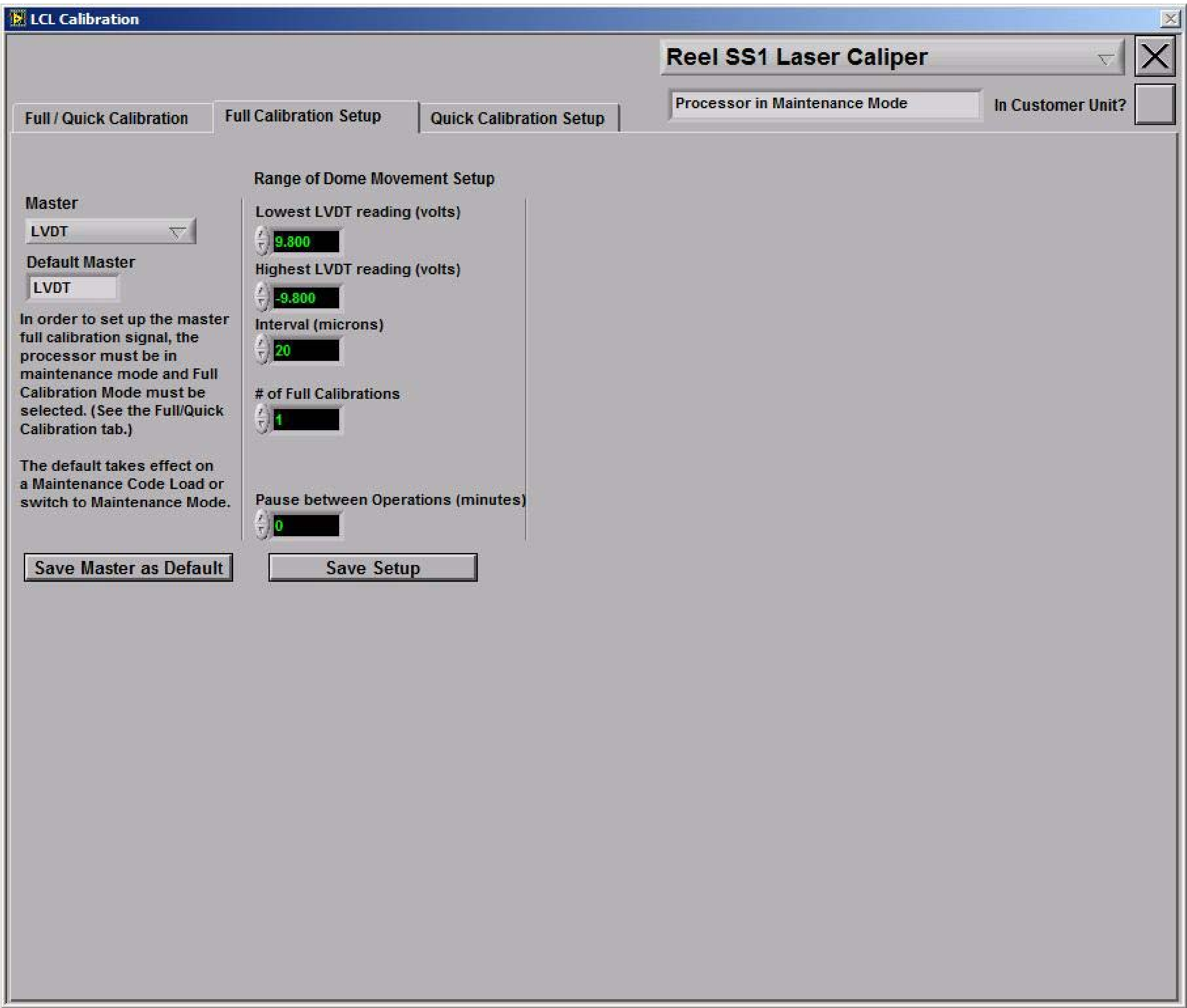


Figure 2-9 LCL Calibration Display: Full Calibration Setup Tab

One device must be used to determine the calibration limits. This is called the *Master*. The choice of master defines what device is used to determine the upper and lower travel limits of the CLB module target as it passes through the calibration range. These values are in units of volts, not displacement.

The master device is normally the LVDT, though it is possible to select the laser triangulation sensor or the Z-sensor to specify the calibration travel limits of the CLB module target. The limits on the LVDT indicate the signal level at the lowest point to the highest point of the dome. This is normally a high voltage of + 9.8 V (dome retracted into the lower head) for example, to a low voltage of - 9.8 V (dome extended towards the upper head). See Figure 1–17 for a schematic of expected physical positions and signal levels in the gauge.

The full signal range of the LVDT ± 10 V covers slightly more than the 3 mm (0.12 in.) calibration range of the gauge. It is prudent to set the upper and lower limits just inside the ± 10-V rails to prevent the gauge from attempting to find a position inside its deadband. The displacement increment between calibration points is also user-selectable. Twenty-five microns is a sensible value that will generate sufficient point density in the calibration without being unduly time consuming to execute.

When the **# of Full Calibrations** text field is selected, the system repeats the calibration several times, for which Experion MX will report the average calibration. After the setup is done, return to the **LCL Calibration** display, select the **Full / Quick Calibration** tab, and click **Start Calibration**.

The gauge proceeds through the specified number of calibrations. The display appears as in Figure 2-10. The axes of the upper graph are:

- calibration step index on the X-axis
- device signal on the Y-axis

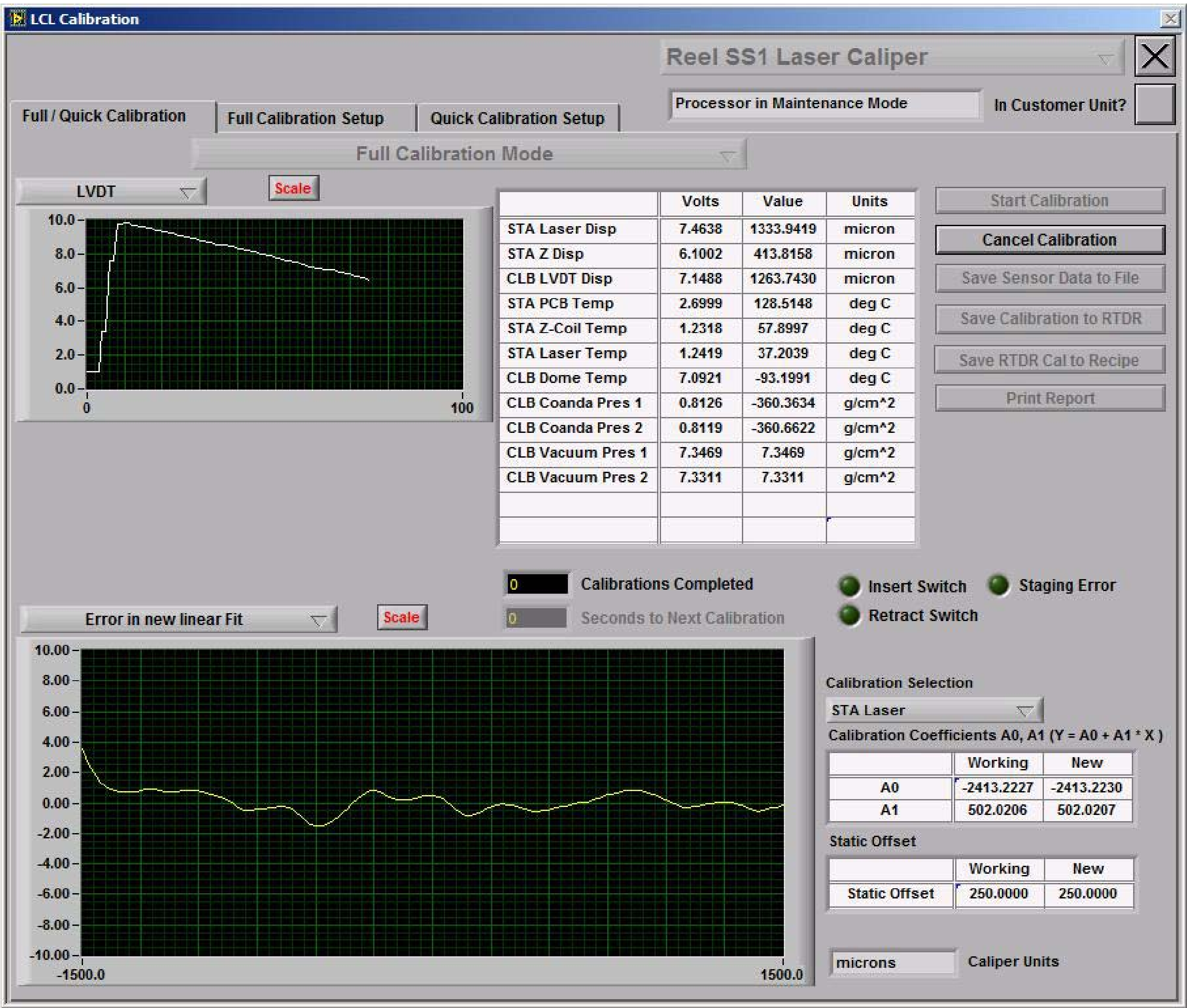


Figure 2-10 LCL Calibration Display: Full / Quick Calibration Tab (calibration in progress)

The upper plot can show only the LVDT result when the calibration is in progress. After the calibration is complete, the displacement/signal relationship for any of the devices can be viewed.

A calibration takes a few minutes to execute. During the calibration, the small graph in the upper left hand corner displays the LVDT voltage against the step number. Track the progress with this display. If the voltage does not seem to change, stop the calibration and restart it. If the dome will not move, see Section 7.2.

Details of the calibration can be viewed on this display for purposes of determining the validity of the calibration. The lower plot shows the nonlinearity of the device signal/displacement relationship. There are three choices available on this drop-down menu:

- **Error in new linear Fit** plots specific device nonlinearity in units of displacement against absolute displacement as given by the LVDT.

- **Lookup table correctors** plots the signal increment, in volts, which will be added to the measured signal so that the sum of these signals can by multiplied by the best fit slope to obtain the device displacement, recall the last term in parentheses in Equation 1–3.

  The LUT correctors plot is simply scaled version of the error in new linear fit plot, with the best fit slope being the scale factor.

- **Difference of new & working** allows comparison of the values of the displacement nonlinearities between the most recently completed calibration and the current working calibration.

The slope, A1, and offset, A0, of the most recently generated LUT are displayed in the **New** field under **Calibration Coefficients A0, A1 (Y = A0 + A1 * X)**. These can be immediately compared to the current working values on the display. If you deem the calibration to be valid, you have the opportunity to renew the calibration being used for measurement. The **LCL Calibration** display offers several choices as to how to store and enter calibrations for measurement. It is possible that a calibration can be entered into the recipe, but not the working field of the RTDR, from this display. A reloading of the entire recipe (with potential unwanted impact on other non-LCL parameters) would then be required if this display is used to save the calibration to the recipe.

When the calibration is complete, and determined to be good, enter it into the RTDR and the recipe (following the details described in Section 2.3) after the raw calibration file has been saved to disk from the **LCL Calibration** display. To save a raw calibration file to disk, click **Save Sensor Data to File**, name the file, and save it in the **Choose or Enter Path of File** dialog (Figure 2-11).

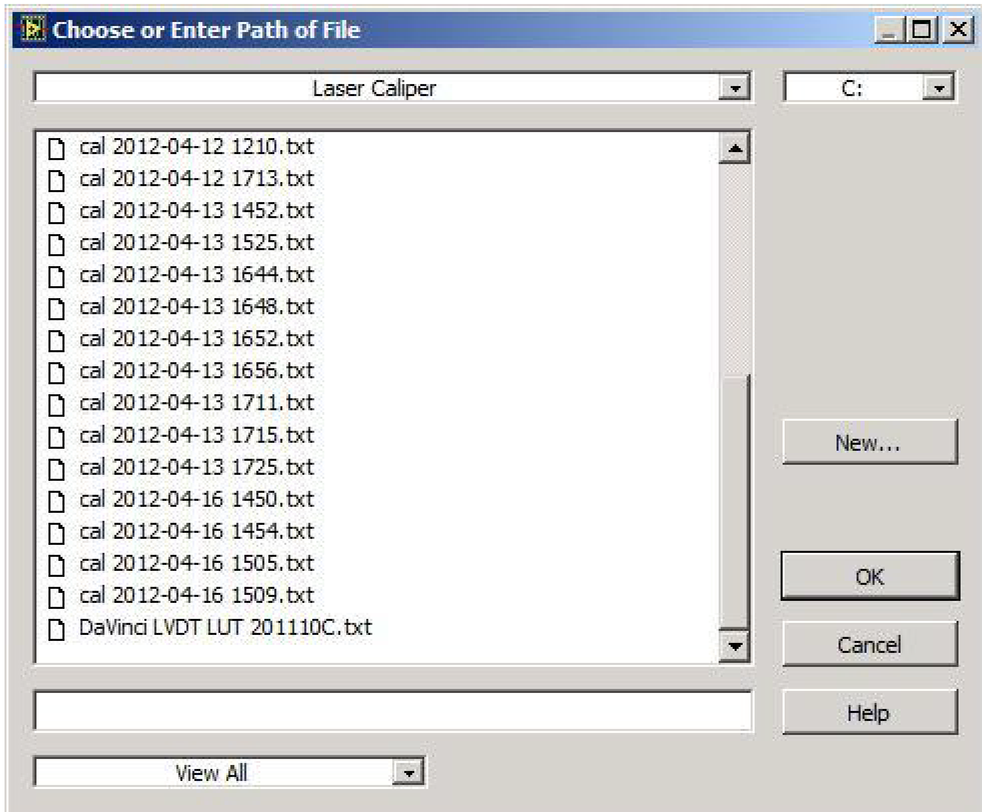


Figure 2-11 Choose or Enter Path of File Dialog

It is recommended that you print copies of the calibration parameters. If all the steps are not followed properly when entering the calibration to the recipe, a calibration can be temporarily lost. In order to print copies of the calibrations, select each device in turn with the **Calibration Selection** drop-down arrow, and click **Print Report**.

The raw calibration data file is an ASCII text file delimited by tab characters. The first line of the file is reserved for an optional comment, otherwise, the rows of the raw calibration file indicate individual points of the calibration.

It is generally more reliable to enter working calibrations through the **LCL Calibration Maintenance** display. Remain in maintenance mode, and follow the steps outlined in Section 2.3 to update the working calibration entries.

The calibration routine creates text files from which the LUTs are generated. The first line is a text header followed by the displacement and voltage data. To analyze these files it is necessary to know the column identifications (see Table 2-2).

Table 2-2 Calibration File Column Identification

A	B	C	D	E	F	G	H
LAS Volts	LAS previous displacement	Z Volts	Z previous displacement	Not used	Not used	LVDT Volts	LVDT Disp

Columns B and D are the displacements generated from the in-memory LUT.

2.5. LCAL Compare Calibrations Display

This section can be used to import, view, and compare calibration sets stored in text files. This is best used to determine the measurement repeatability. Figure 2-12 shows two calibrations which agree to within a small fraction of a micron. For instructions on using the **LCAL Compare Calibrations** display, see Subsection 4.2.5.

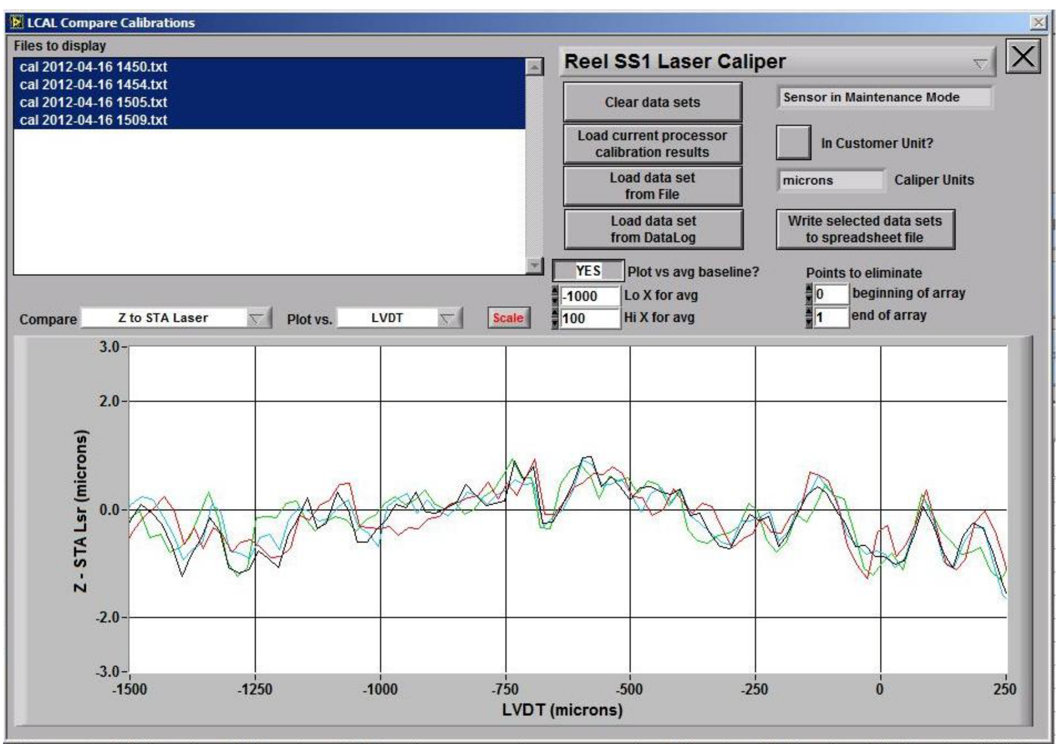


Figure 2-12 LCAL Compare Calibrations Display

Calibrations for comparison can be loaded by **Load current processor calibration results**. They can be plotted through selection in the **Files to display** area of the display.

2.6. LCAL Dome Control Display

The **LCAL Dome Control** display (Figure 2-13) allows basic moves with the dome in maintenance mode. By choosing different modes from the **Dome Operation** drop-down arrow, you can make discreet up and down moves by a specified number of microns, seek a dome position that corresponds to a specific measurement device voltage, or force the dome to move to the onsheet position or retract to the home position.

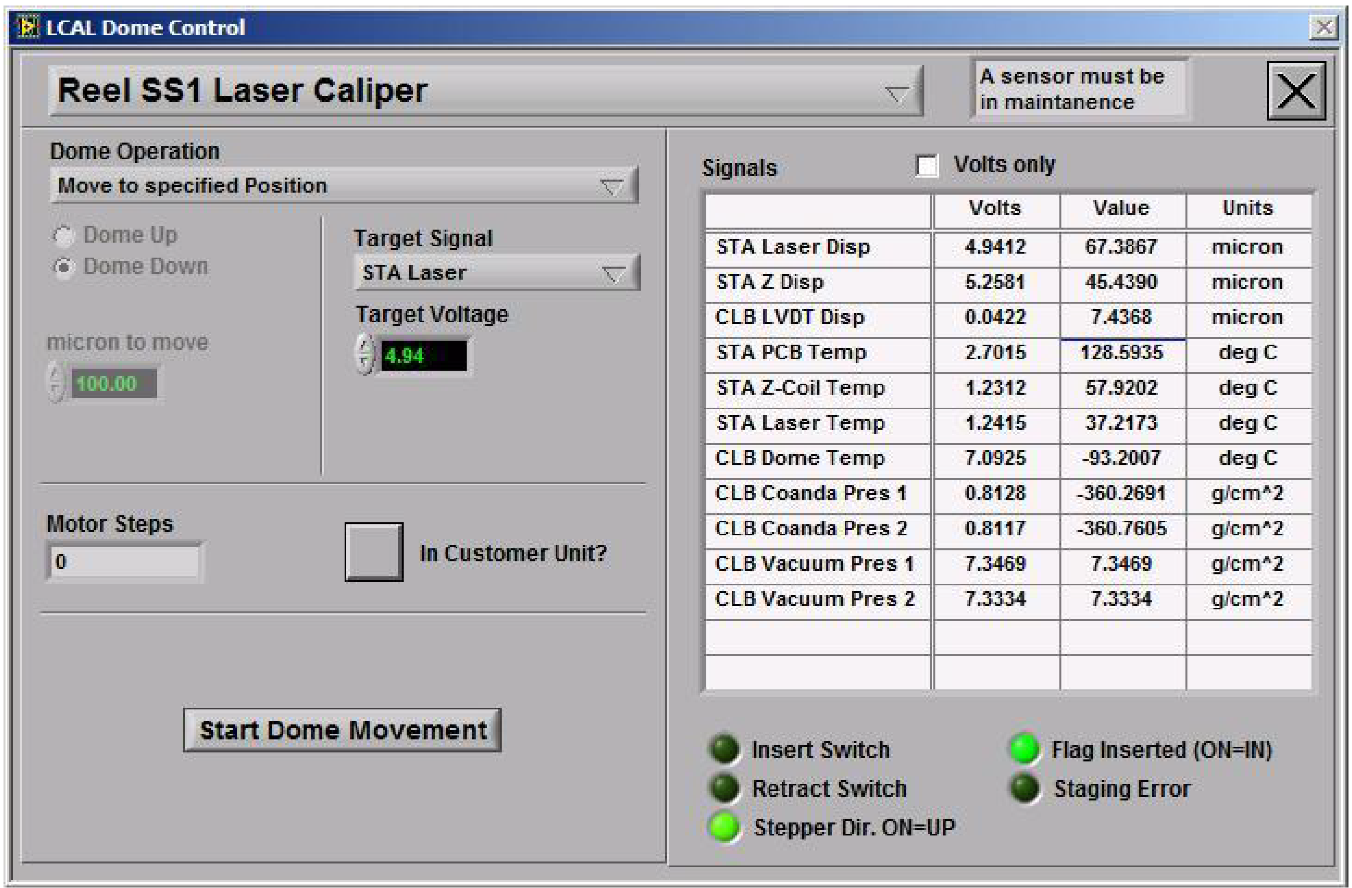


Figure 2-13 LCAL Dome Control Display

2.7. LCAL Profile Correction Display

Figure 2-14 shows the **LCAL Profile Correction** display.

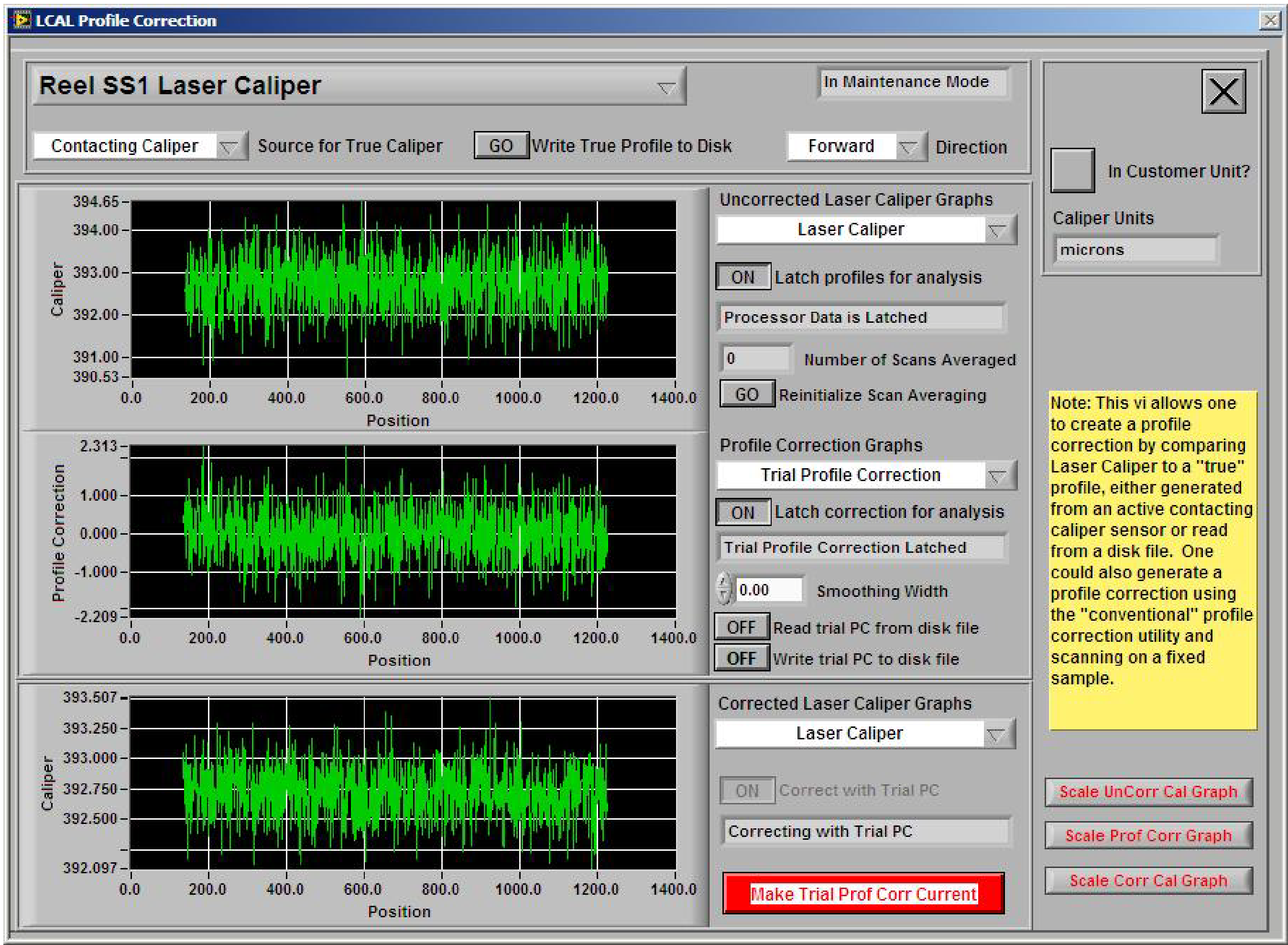


Figure 2-14 LCAL Profile Correction Display

Profile correction for the laser caliper is extensively covered in Chapter 4. Profile correction can be made against a smooth flag material, in which case the more generic **Scanner/Sensor > Profile Correction** display can be used. To make a profile corrector to a contacting caliper sensor, or lab data with the same bin size as the scanner, this screen can be used. To make a profile corrector using differently-spaced lab data or using multiple lab files, see Chapter 4.

If the desired source for the true caliper is the contacting caliper:

1. Select **Contacting Caliper** from the **Source for True Caliper** drop-down arrow as shown in the upper left in Figure 2-14. Click the button to the left of **Latch profiles for analysis** so that it reads **OFF**.

2. Click the **GO** button to the left of **Reinitialize Scan Averaging**, and wait until a sufficient number of scans has been collected (> 50). The re-initialization affects both the forward and reverse directions and the scan count is the number of scans in the indicated direction. Note that the profiles here will usually be reversed because they are plotted in terms of the scanner base profiles, not the mill direction profiles.

   If the **Source for True Caliper** is a disk file (as would be the case for lab data), then **Disk File** should be selected. Then click the **GO** button to **Read True Profile from Disk**. It should be noted that the text file must be in the same format as a profile correction text file and that the orientation must be in scanner base bins. To see an example of the proper formatting, export a trial profile corrector and use the same format. After the file has been imported, proceed to Step 3.

3. Select **Latch profiles for analysis**, and then **Latch correction for analysis**. That makes the **Read trial PC from disk file** button, and the **Write trial PC from disk file** button visible. A smoothing width can be selected, but it is recommended that this be set to 0.00.

4. To implement the profile correctors, click **Make Trial Prof Corr Current**. Remember to do this for both forward and reverse directions.

5. At some mills the sheet width is slightly variable. It may be necessary to pad out the edge values. To do this, the profiles must be exported by clicking the **Write trial PC from disk file** button, edited using the Notepad program, and then imported using the **Read trial PC from disk file** button.

2.8. MSS Functions

In addition to executing calibrations, the MSS performs a few other dome-positioning functions:

- retracts dome when heads are split in order to avoid damage to the laser caliper dome or to other sensors

- positions dome at standardize and onsheet voltages
- initializes the dome

2.8.1. Dome Initialization

The MSS initializes the laser caliper with the following procedure:

1. The MSS verifies that the laser power indicator is on. This is required if the MSS is to continue the script.
2. The MSS sets the motor direction to DOWN.
3. The MSS then sends a large number of steps to the motor–the number can be set in RTDR (*./Scanner x/Mss/Ssx nc caliper/Setup/Steps full retract*). The number of steps must be sufficiently large so that the dome will retract and trigger the electronic home (retract) switch on the base of the stepper motor.
4. When the retract switch indicates HOME, the CLB module interface card resets its internal step count to zero. From there, the internal count monitors the state of the insert limit state. There is no hardware physical insert limit switch; the insert switch is simply indicated after the interface card measures 6000 up-going counts.
5. Finally, Experion MX sends another series of steps based on another RTDR value (*./Scanner x/Mss/Ssx nc caliper/Setup/Steps away from retract*) to move the dome up into the LVDT measurement range, and it iterates the dome position until the dome is at the so-called onsheet voltage of the master signal.

This procedure is initiated every time the MSS is restarted or initialized, and when the sensor interlock moves from an open to closed status.

3. EDAQ

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

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

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

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

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

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

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

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

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

3.1. Physical Layout

Figure 3-1 and Figure 3-2 show the EDAQ PCBA as it is mounted next to a sensor. To the left are the digital and analog I/Os, which connect directly to a sensor. Below these two large connectors is a 16-pin expansion connector that is only used when the EDAQ is attached to the FC expansion board.

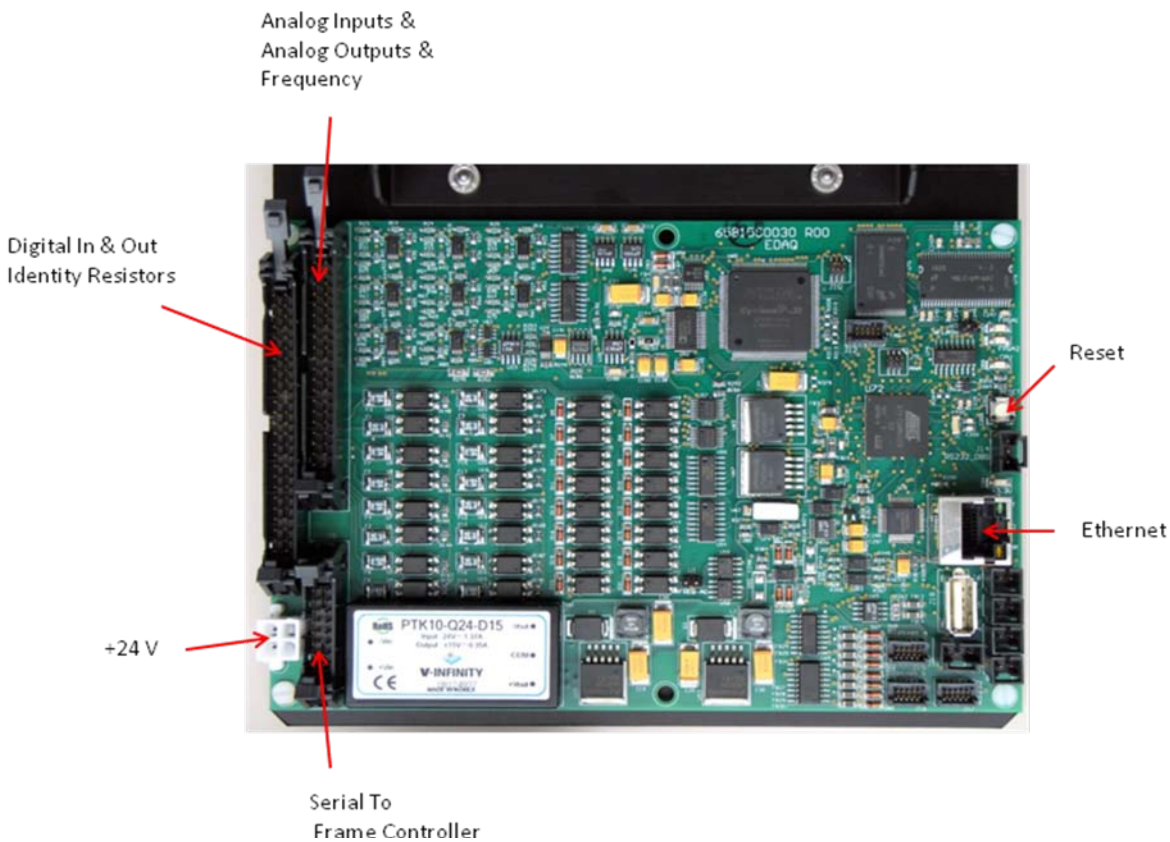


Figure 3-1 EDAQ Board

As shown in Figure 3-2, J1 is the large 50-pin connector on the far left. J2 is the smaller 40-pin connector. J8 on the lower left is used for the FC only. To the right are the Ethernet port, some diagnostic LEDs, serial connections, and temperature inputs. There are no test points for use in the field. A serial debug port is available (115200 kb/s, no flow control, 8N1) that may be connected to any PC running a serial terminal program. For diagnostic purposes, service personal may be asked to connect a serial cable between the debug port and the RS-232 of any neighboring EDAQ.

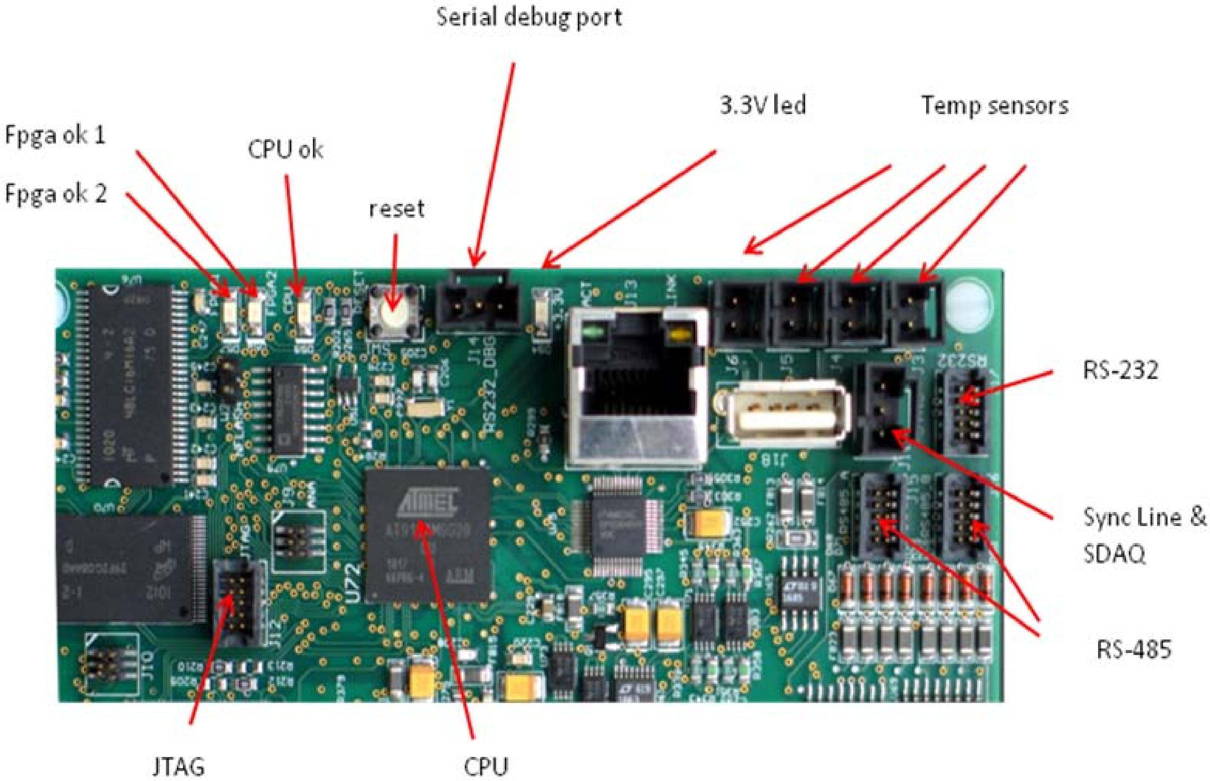


Figure 3-2 EDAQ Board: Ports and Diagnostic LEDs

3.2. Hardware Status Information

There are four diagnostic LEDs on the EDAQ (see Figure 3-2).

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

The Ethernet connector contains two LEDs:

- amber indicating a good link to the switch
- green indicating activity on the network

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 QCS operator station.

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

3.4. EDAQ Sensor Identification and IP Addressing

Assuming the firmware (flash code) is the same, all EDAQs are identical. EDAQs can be freely interchanged between sensors and the scanner endbell.

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

For sensor-connected EDAQs, there is a sensor model resistor embedded in the cable harness connecting the sensor to the EDAQ. This resistor determines the function code. Function codes are unique for each sensor model to the extent that the EDAQ needs to differentiate the models. For example, all Source 9 basis weight measurement sensors presently have the same function code, regardless of radioactive isotope.

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

Refer to your scanner system manual to troubleshoot the EDAQ if it does not identify itself properly (or to find the correct resistor values).

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

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

3.5. Obtain Status Information

An overall status page is available from a QCS operator station under the **MSS Setup Diagnostics** tab (select the **MSS Summary** display).

On the left side of the **MSS Summary** display, as shown in Figure 3-3, is the list of expected EDAQs with three types of status indicators (from left to right).

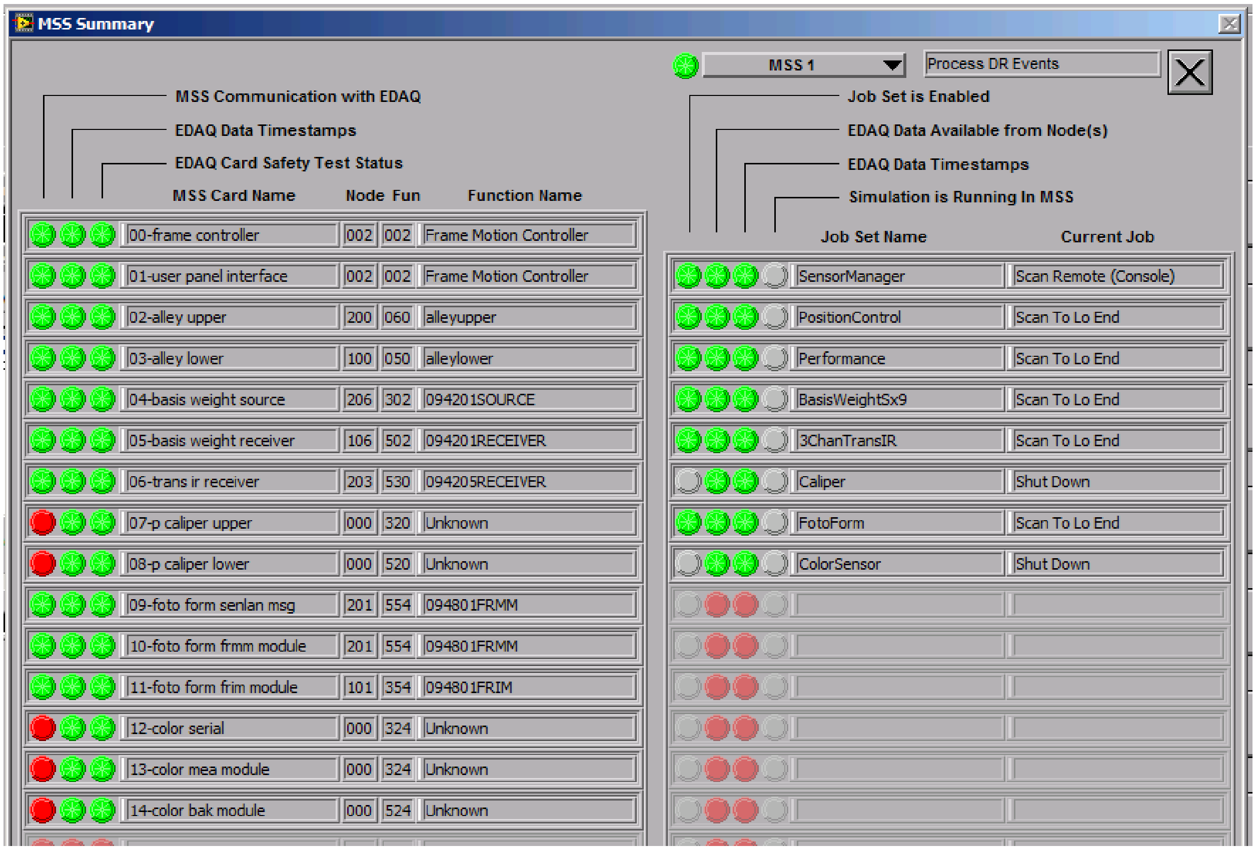


Figure 3-3 MSS Summary

Table 3-1 MSS Summary Display Status Indicators and Descriptions

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

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

3.6. MSS and EDAQ Web Pages

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

- go to the **MSS Diagnostic** tab, click on **MSS Monitor**, choose the appropriate MSS, and click on **MSS Web** page
- open a browser on any computer connected to the Experion MX level network, and use the address *http://192.168.10.101/mss.php* (the first MSS on the LAN), or the address set up for the MSS in the Experion MX system
- open a browser on any computer connected to the scanner LAN switch, and use the address *http://192.168.0.1/mss.php* or *http://192.168.10.101* (for the first MSS on the system)

Figure 3-4 shows **PHP MSS Page** (the main MSS Web page).

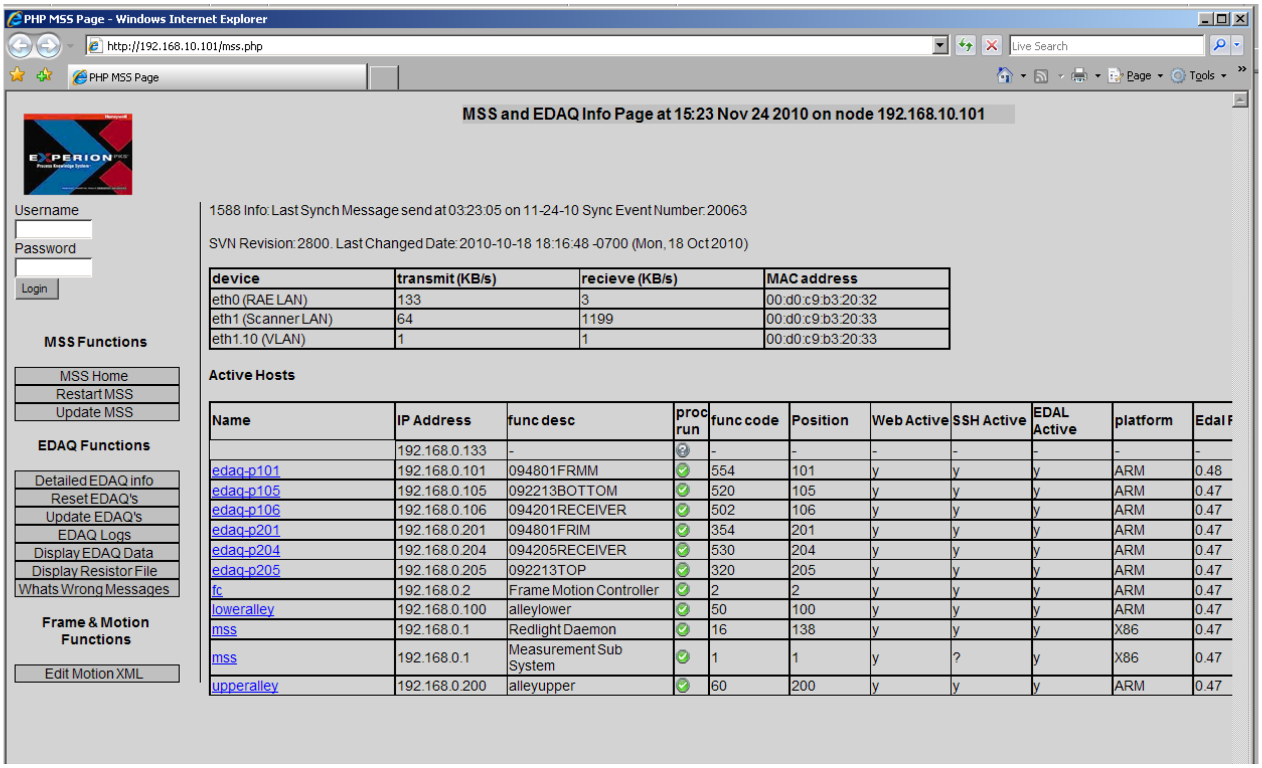


Figure 3-4 PHP MSS Page

The left panel shows a column of options divided into:

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

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

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

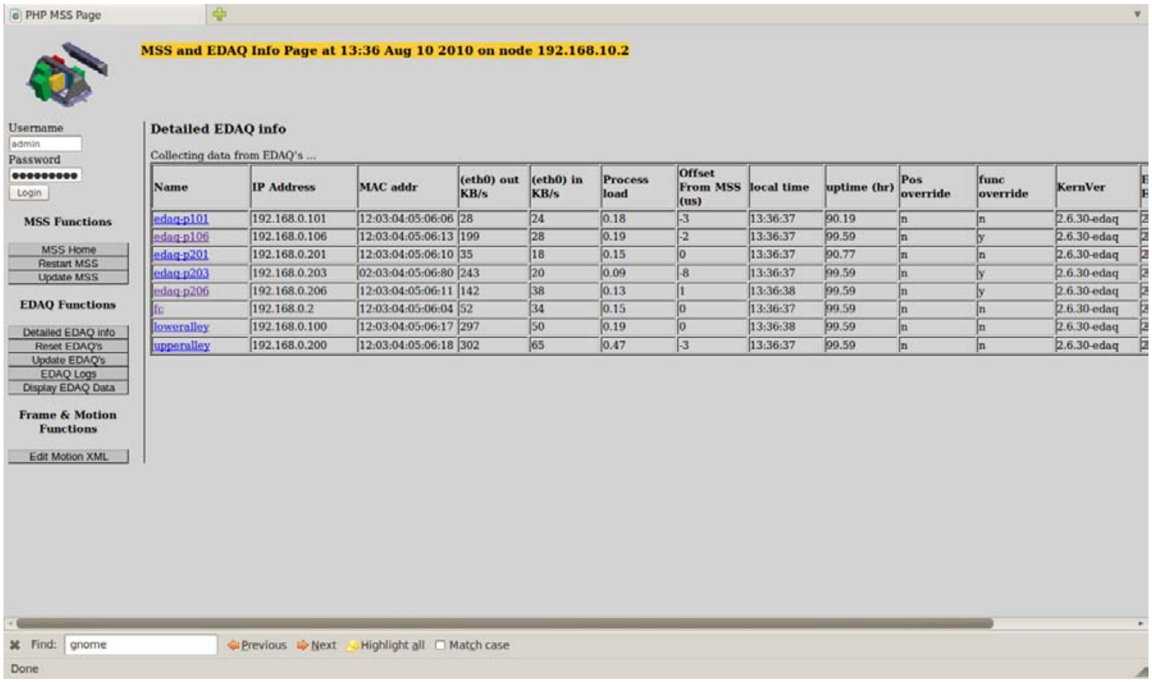
The second table lists all EDAQs discovered on the scanner LAN, their IP numbers, a brief description (related to model number), a program status column, the associated function code and position code, and whether the communication protocols are running (http, SSH, and Edal, the proprietary sensor data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

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

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

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

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



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

Figure 3-5 Detailed EDAQ Information: Partial Display

4. Installation and Calibration

4.1. Gauge Installation

4.1.1. Air Requirements

The laser caliper measurement uses air for purge and sheet control. The air must be clean and dry instrument air. The airflow requirements for the laser caliper measurement are as follows.

- **STA module purge**: The purpose of this purge is to prevent contamination degrading the performance of the laser triangulation sensor optics. It can consume up to 50 SCFH. This air can be sourced from either the flow line or from the sensor line. However, if one of these supplies is cleaner, that is the one which should be used because dirt or oil in the air will affect the measurement. The required pressure is 40–60 psi at the endbell.

- **CLB module air clamp**: The purpose of the air clamp is to position the sheet for measurement. It can consume up to 475 SCFH. Generally, this air should be from the flow line. The required pressure is 40–60 psi at the endbell.

4.1.2. Mechanical Installation

The sensor should arrive pre-installed on the Q4000 platform.

Ensure that the screws used to attach the modules to the baseplates are tight.

4.1.3. Electrical Installation, Power-up, Basic Commissioning

1. Power up the scanner. The MSS will first check that the laser interlock is closed. If there is a problem at this stage an MSS alarm will be displayed. If this occurs, see Chapter 6 and Chapter 7.

2. After the MSS has verified that the interlock is satisfied, the gauge undergoes an initialization routine as described in Subsection 2.8.1. You can observe the dome retracting and inserting. If this is completed properly, there will be no MSS errors. If that is not the case, see Chapter 6 and Chapter 7.

3. It is recommended that you verify that all temperatures are within range.

4.1.3.1. Verify All System Temperatures Are In Range

View the **Station - rae - Laser Caliper** display (see Figure 2–1) to determine if the temperature measurements and control loops are functioning correctly.

Table 4-1 Expected Temperatures

Device	Expected Temperature Range
STA PCB Temp	20–65 °C (68–149 °F)
STA Z-Coil Temp	39–42 °C (102.2–107.6 °F)
STA Laser Temp	34–36 °C (93.2–96.8 °F)
CLB Dome Temp	20–90 °C (68–194 °F)
CLB PCB Temp	20–65 °C (68–149 °F),

If the temperatures do not fall within these ranges, see Section 6.6.

4.2. Field Calibrations of Laser and Z-sensors

See Chapter 1 for a detailed description of the gauge hardware and measurement principles before attempting to perform a sensor calibration.

Calibration of the laser caliper gauge requires the measurement of the true change in the laser triangulation sensor response and in the Z-sensor response as a function of distance from the device to a target. Obtaining an accurate calibration of the laser triangulation sensor and the Z-sensor is critical to the performance of the laser caliper measurement.

Initial calibrations of the laser triangulation sensor and the Z-sensor are obtained from the factory. It is recommended that calibrations of the laser triangulation sensor and the Z-sensor be repeated during installation and compared to the factory calibrations. This section details the procedure for obtaining laser triangulation sensor and Z-sensor calibrations in the field.

4.2.1. Requirements

In order to obtain a good calibration, it is estimated that a two hour window of time is required with the scanner head parked in the offset position.

Required hardware:

- two 10.16 mm (0.4 in.) spacer bars
- two C-clamps, large enough to clamp the top and bottom heads together
- The smooth, thin white plastic target provided with the system. The target dimensions are approximately 5 cm x 8 cm x 250 microns (1.97 in. x 3.15 x 0.010 in.) thick. The target can be cleaned with a lint free cloth dipped in optical grade isopropyl alcohol.

4.2.2. Stabilize Platform Temperature

Stable platform, head, laser triangulation sensor, and Z-sensor temperatures are required to perform a calibration.

The mechanical case of the laser triangulation sensor is temperature controlled (the temperature is listed as *LAS Temp*). The LAS setpoint is approximately 36 °C (96.8 °F). The Z-sensor ceramic temperature (Z-Temperature) is controlled by two TECs. The Z-sensor setpoint is approximately 40 °C (104 °F).

Head temperature stability of better than ± 0.1 °C (0.2 °F), and laser triangulation sensor and Z-sensor temperature stability of better than ± 0.01 °C (0.2 °F) over a 10 minute period must be achieved before attempting to calibrate the sensor. The platform temperatures must also be stable during calibration.

Figure 4-1 shows expected temperatures and temperature ranges required for calibration.

Figure 4-1 Da Vinci PM 10 - Trend plot Display

1. Set a trend plot showing the laser triangulation sensor, Z-sensor, and head temperatures as per Figure 4-1. The paths are as follows:

   upper head temperature: *frame list/scanner 1/measurements/upper head temp/objects/periodic/value*

   lower head temperature: *frame list/scanner 1/measurements/lower head temp/objects/periodic/value*

   Z-coil temperature: *frame list/scanner 1/measurements/lcl sta Z-coil temp/objects/periodic/value* laser temperature: *frame list/scanner 1/measurements/lcl sta laser temp/objects/periodic/value*

2. Put the scanner offsheet.

3. Note the average upper head and bottom head temperatures. Verify that the Z-coil and laser case temperatures are close to their operating setpoints of 40 °C (104 °F), and 36 °C (96.8 °F) respectively.

4. Wait until all the temperatures have met the specifications of ± 0.1 °C (0.2°F) and ± 0.01 °C (0.02 °F) in 10 minutes for head and device temperatures, respectively, before proceeding with sensor calibration.

4.2.3. Field Calibration Overview

Before proceeding with sensor calibration, make sure that you are familiar with the **LCL Calibration** display as detailed in Section 2.4.

If this is the first calibration on a new system, ensure that the LVDT LUT is loaded into the system. See Section 6.4 for procedures for loading the LVDT LUT into the Experion MX system. After this is done, follow the detailed instructions to perform a calibration and save the results to disk (see Section 4.2.5).

To calibrate the sensor, the stainless steel dome is stepped through the measurement ranges of the laser triangulation sensor and the Z-sensor. The signals are measured with reference to the LVDT voltage. A calibration file is generated which consists of the voltages from each device, the displacement of the LVDT calculated from its LUT, and the displacements of each device calculated from the LUTs currently in working memory. This procedure is initiated from the **LCL Calibration** display.

The calibration can be used by Experion MX only after the calibration table is converted to individual LUTs for each device. This procedure can be initiated from the **LCL Calibration** display, or the **LCAL Calibration Maintenance** display.

See Table 4-2 for recommended initial settings for calibration, and Subsection 4.2.5 for the recommended procedure for performing the calibration and generating LUTs.

4.2.4. Setup

Table 4-2 provides a list of suggested parameters for calibrations. Generally, the values indicated should be modified at each installation. See Section 2.4 for a detailed description of the **LCL Calibration** display.

Table 4-2 Recommended Initial Settings for Calibrations and LUT Generation

Display	Selection	Entry	Value	Comments
LCAL Setup (Figure 2–2)	Lookup Table Setup	LUT volts interval	0.002	Each device must be selected individually. The settings do not automatically work on all devices
	> Input Signal >	Lwr Limit for fit (microns)	-1200.00	
	LVDT	Upr Limit for fit (microns)	1200.00	
	Laser Top	Smooth data?	True	
	Z	Smoothing Parameter	0.05	
LCL Calibration (Figure 2–11)	Full Calibration Setup	Master	LVDT	
		Lowest LVDT reading (volts)	9.800	
		Highest LVDT reading (volts)	-9.800	
		Interval (microns)	20	
		# of Full Calibration	1	
		Pause between Operations (minutes)	0	

4.2.5. Calibration

To calibrate the laser caliper:

1. Perform stability check (see Subsection 6.3.4).
2. Stabilize platform temperature (see Subsection 4.2.2).
3. Install the thin smooth target on top of the air clamp.
4. Adjust the vacuum if necessary so the sample is held solidly in place. The vacuum cannot be so great that the target is substantially pulled into the vacuum slots.

5. Install 10.16 mm (0.4 in.) bars in the gap and clamp the top and bottom heads together using a minimum of two C-clamps.

6. Load the LVDT LUT if necessary. This must be loaded if this is the first calibration on a new system (see Section 6.4).

7. Enter maintenance mode from the **Scanner/Sensor > Sensor Maintenance** tab.

8. Select **Calibration** from the **Laser Caliper** display.

9. Select **Start calibration**, observe the calibration proceeding on the screen.

10. Click **Save Sensor Data to File**, and save the file with an appropriate filename and header. This step only has to be done once for each calibration.

11. For each of the sensor devices selected from the **Calibration Selection** drop-down arrow, click **Print Report** to print a copy for future reference.

12. Verify from the **LCL Calibration** display that all direct device graphs show a signal-to-displacement response, and that this response is smooth and continuous within the selected LUT fit limits. If this is not the case, it may be necessary to adjust the limits, to adjust the scanner head spacing, or to do sensor troubleshooting.

13. Review the slopes (A1) for the laser triangulation sensor and the Z-sensor in the **LCL Calibration** display (see Figure 4-2). The offsets, (A0) can depend on the thermo-mechanical breathing of the scanner heads and will be somewhat arbitrary. Expect slopes like: laser triangulation sensor (500 ± 5) m/V; Z-sensor (475 ± 50) m/V.

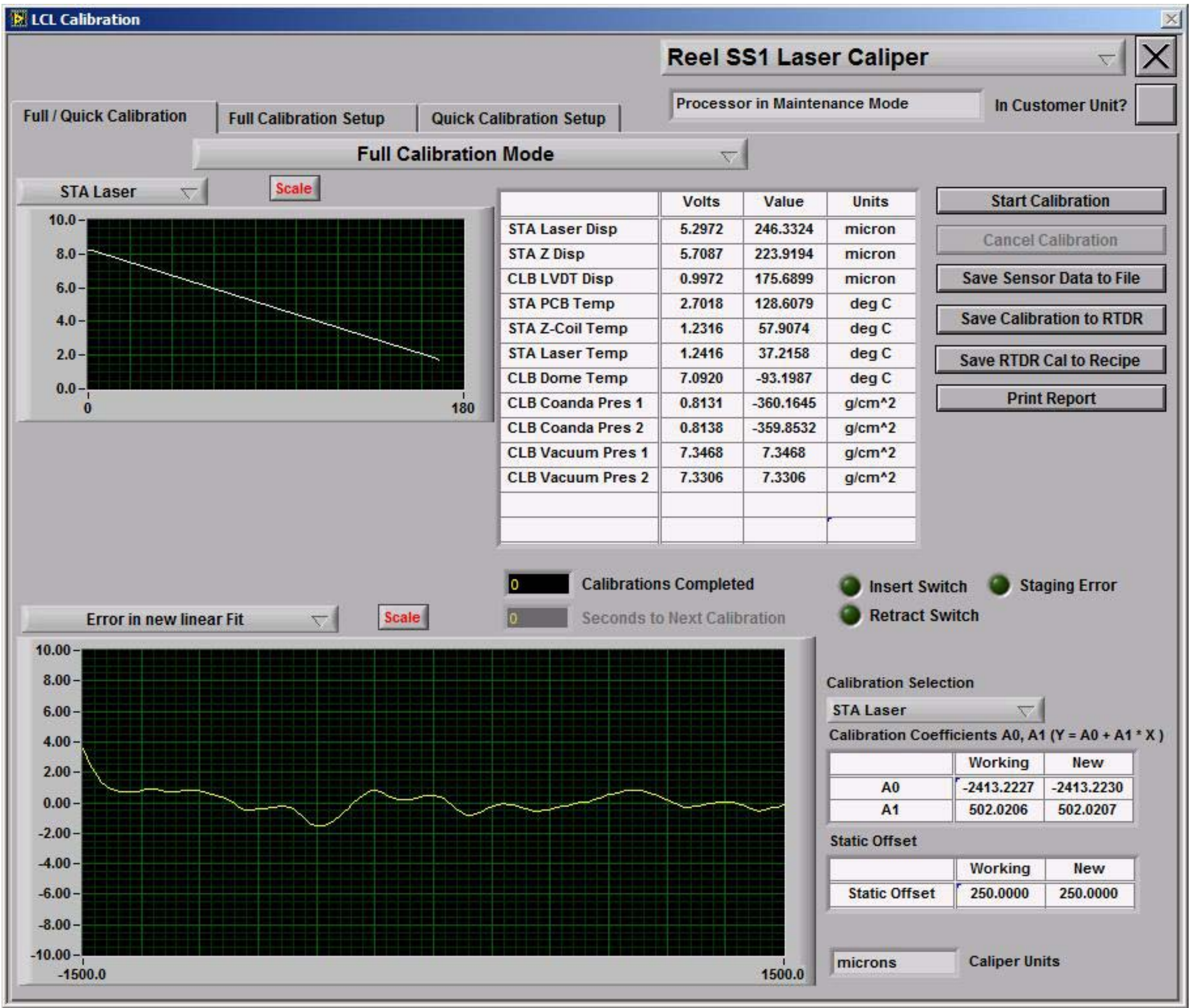


Figure 4-2 LCL Calibration Display

14. If the calibration seems good, proceed to Step 15. If the calibration does not seem good, check temperature stability, inspect and clean the target if necessary, then repeat Steps 8–12.

15. Split heads and move the target to a slightly difference position, then repeat Steps 8–12.

16. After a minimum of three calibration curves with a minimum of two target positions are obtained, proceed to Step 17.

17. Navigate to the **LCAL Compare Calibrations** display (Figure 4-3).

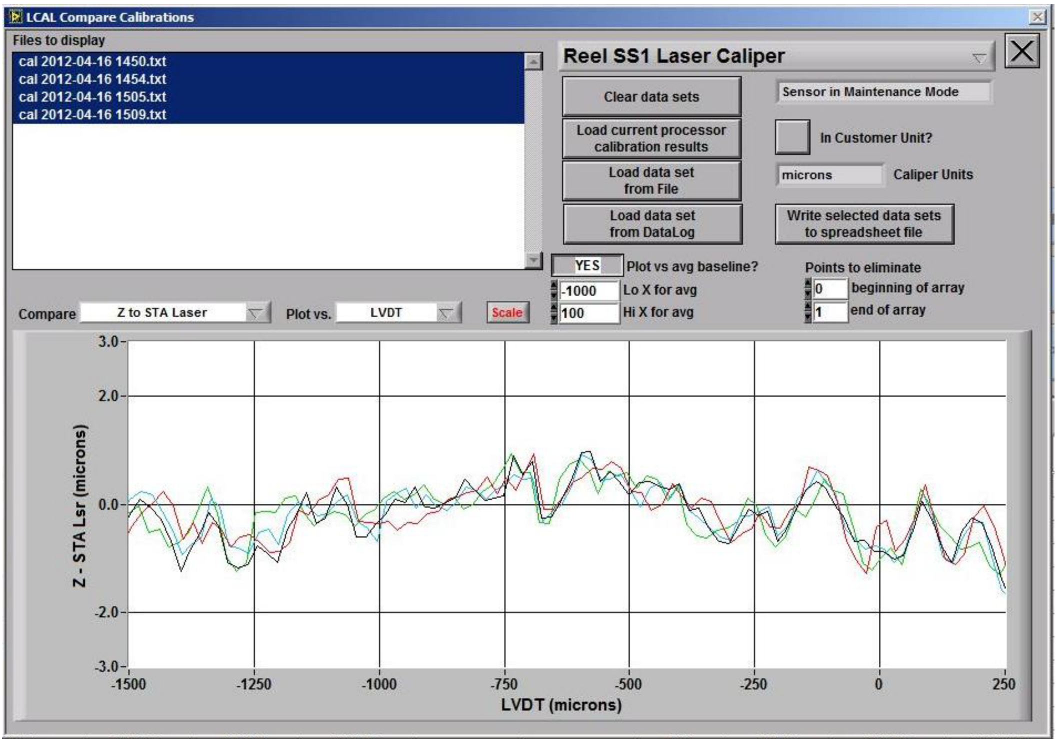


Figure 4-3 LCAL Compare Calibrations Display

18. Load the calibration files using the **Load data set from File** button. Note that Experion MX must be in maintenance mode.

19. After the files are loaded, highlight the file names in the **Files to display** text box (see Figure 4-3).

20. Set the plot options so that **Compare Z to STA Laser** and **Plot vs. LVDT** is displayed on the graph. Set the X- and Y- scales so the difference between the curves can be evaluated (zoom on the flat region of the calibration curves).

21. The calibrations can be considered satisfactory if the following criteria are all met (criteria for acceptable calibrations over a minimum LVDT range of 1500 microns):

    peak to peak variation within one calibration: < 2 microns

    maximum difference between two calibrations: < 1 micron

22. If the criteria are not met, repeat calibrations starting at Step 1. Pay special attention to the Z-coil, laser, and head temperatures stability.

23. The last calibration step is the generation of the device LUTs. Pick a median calibration and use it to generate the device LUTs (see Subsection 6.4.2).

24. At this point it is convenient to set **Static Offset** on the **Laser Caliper Setup** display to be the thickness of the calibration target.

4.3. Optimize X-Y Correction

It is expected that scanning on a smooth target clamped to the bottom head yields flat profiles with a spread below 1 micron (trended profile with a filter factor of 0.2). If this is not the case, and the profile error resembles the X- or Y-profile, an X-Y correction might be necessary.

4.3.1. Overview

The laser caliper sensor has a well-defined sensitivity to lateral motions of the top and bottom scanner heads with respect to each other. This sensitivity is caused by the Z-sensor only. The laser light reflects from the top few microns of the paper surface, and is therefore not affected by the position of the bottom head. In contrast, the Z-sensor relies on the eddy currents generated in the air clamp central piece that sits in the center of the dome in the bottom head. The exact positioning of this metallic piece, with respect to the Z-coil, is critical to the stability of the Z-sensor measurement, and therefore to the stability of the caliper measurement.

Lateral motions of the bottom head with respect to the top head are seen by the Z-sensor as a change in gap. The latter translates directly into a caliper error.

The error in the Z-sensor (ΔZ) as a function of the CD (X) and MD (Y) motions is as follows:

$$\Delta Z = 0.55\left(X - X_{offset}\right)^2 + 2.85\left(Y - Y_{offset}\right)^2$$

where the units of X and Y are mm and those of ΔZ are microns.

The values for X and Y are measured by the X and Y sensors in the scanner head; however, the offsets must be determined through a calibration procedure. The need for offsets comes from the fact that the top and bottom heads are not exactly aligned at X=Y=0.

Using the Experion MX variable names, this equation is written as follows:

$\Delta Z = XCorrQuadratic\,(X - XCorrOffset)^2 + YCorrQuadratic\,(Y - YCorrOffset)^2$,
XCorrQuadratic is 0.55, *YCorrQuadratic* is 2.85.

Equation 4-1

To determine the offsets, this equation must be differentiated with respect to *X* and *Y*:

$$\frac{\partial \Delta Z}{\partial X} = 2 \cdot XCorrQuadratic \cdot (X - XCorrOffset)$$

Equation 4-2

and

$$\frac{\partial \Delta Z}{\partial Y} = 2 \cdot YCorrQuadratic \cdot (Y - YCorrOffset).$$

Equation 4-3

In order to determine the corrector offsets we compare ΔZ to *X* and *Y* and determine the best-fit slopes (*XSlope* and *YSlope*) which we equate to Equation 4-1 and Equation 4-3 respectively which we evaluate at their mean values ($\bar{X}$ and $\bar{Y}$).

$$XCorrOffset = \bar{X} - \frac{XSlope}{2 \cdot XCorrQuadratic}$$, and

$$YCorrOffset = \bar{Y} - \frac{YSlope}{2 \cdot YCorrQuadratic}$$

Use the procedure in Subsection 4.3.2 to determine the correct values for ***X Corr Offset*** and ***Y Corr Offset***.

The X-Y Corrector in Experion MX is expected to have a scan average value of zero. As well, its sign must be appropriate to cancel the error (Equation 4-1). Therefore, *XYCorrector = -ΔZ + ScanAverage(ΔZ).*

4.3.2. Determine X_{offset} and Y_{offset}

ATTENTION

Adjust the X_{offset} and Y_{offset} only after the gauge has been calibrated (see Subsection 4.2.4).

Do as follows to determine the X-Y corrector parameters:

1. Set the datalogger so, at a minimum, the following profiles are recorded:

   X: *frame list/scanner 1/measurements/x/last scan/now/array*. Name the alias *x_ls*.

   Y: *frame list/scanner 1/measurements/y/last scan/now/array*. Name the alias *y_ls*.

   Caliper: *frame list/scanner 1/measurements/laser caliper/last scan/now/array*. Name the alias *lcal_ls*.

2. Send the scanner offsheet.
3. Install the smooth target on top of the air clamp. Adjust the vacuum if necessary so the sample is held solidly in place.
4. Disable the X-Y correction. This can be done temporarily on the **Laser Caliper Setup** display, or on the **Calibration Maintenance** display**,** and permanently on the **Recipe Maintenance** display**.**
5. Press the **Scan** button.
6. Wait a couple of scans and enable data logging.
7. Log a minimum of 10 scans.
8. Convert the datalog to ASCII (TXT) format and export the file.
9. Open the MS Excel worksheet *XY Corrector Calculator* which is located on the CD shipped with the sensor.
10. Copy all the data in the text file and paste it into the *data log data* sheet of the spreadsheet.

11. The data transferred will have all of the logged data. Populate the *Laser Caliper Data*, *X data*, and *Y data*, sheets with the appropriate data. Ensure that the first two rows are the time and date entries.

12. Go to the sheet *Chart data to edit*. There will be rows that have cell entries *Delete this row* (see Figure 4-4). Select these rows and delete them. Note that these rows may appear at both the top and the bottom of the sheet.

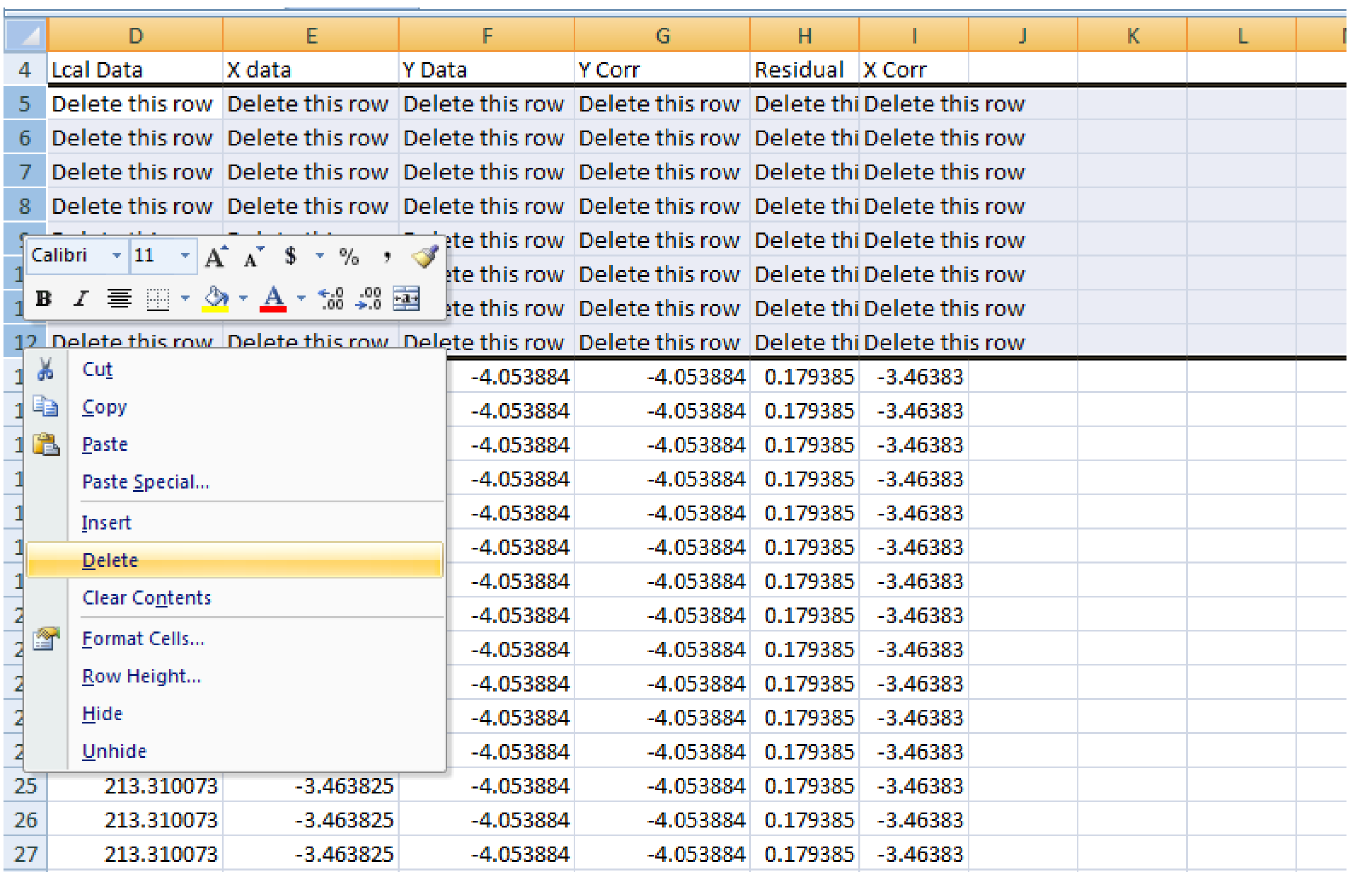


Figure 4-4 *Chart data to edit* sheet of *XY Corrector Calculator*

13. *Chart 1* and *Chart 2* should now show the correlation of the laser caliper to the X Y position of the heads. Note the values for the goodness of fit, R^2.

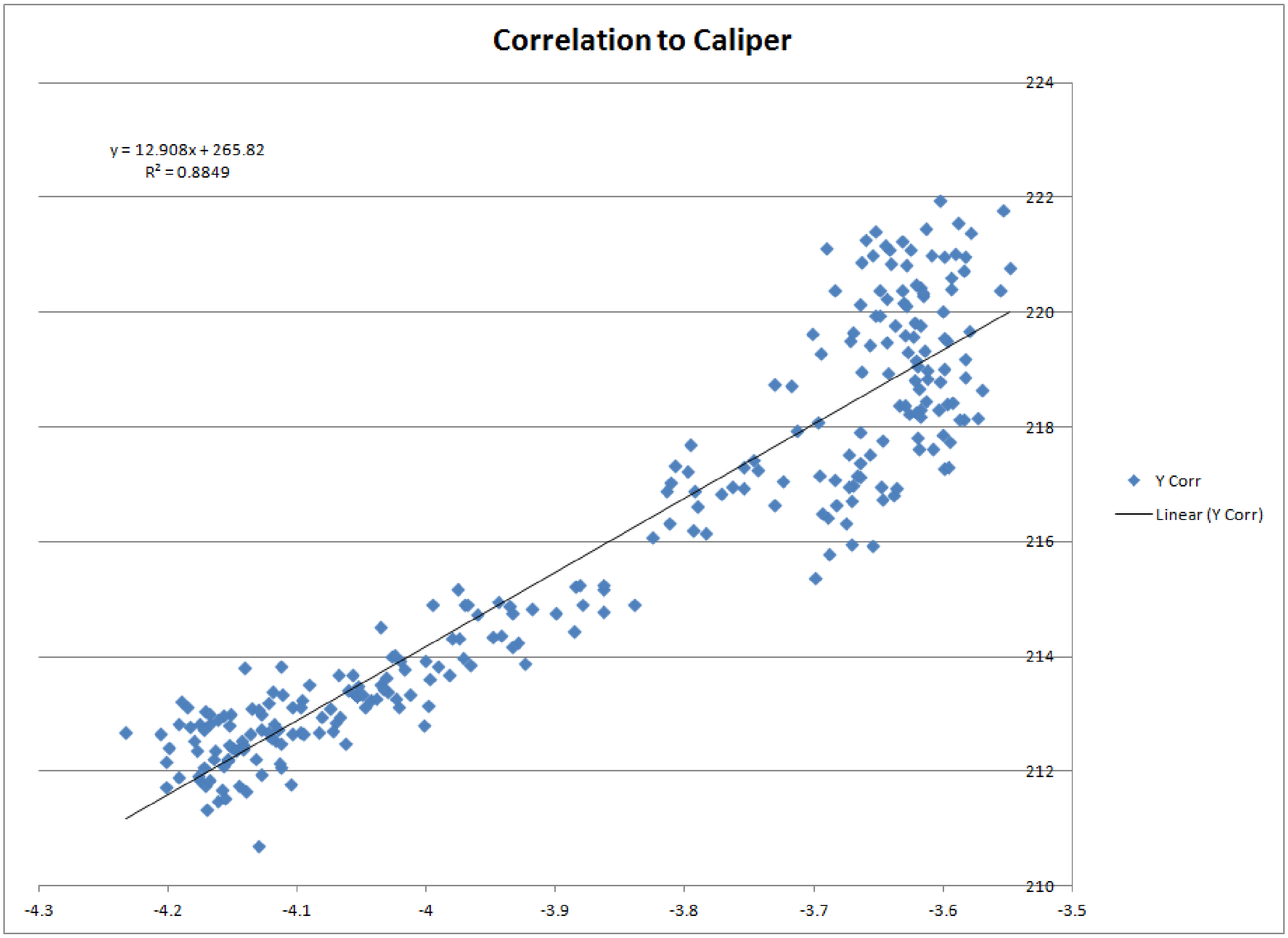


Figure 4-5 ***Chart1*** **of** ***XY Corrector Calculator*** **(apparent caliper as a function of Y is shown)**

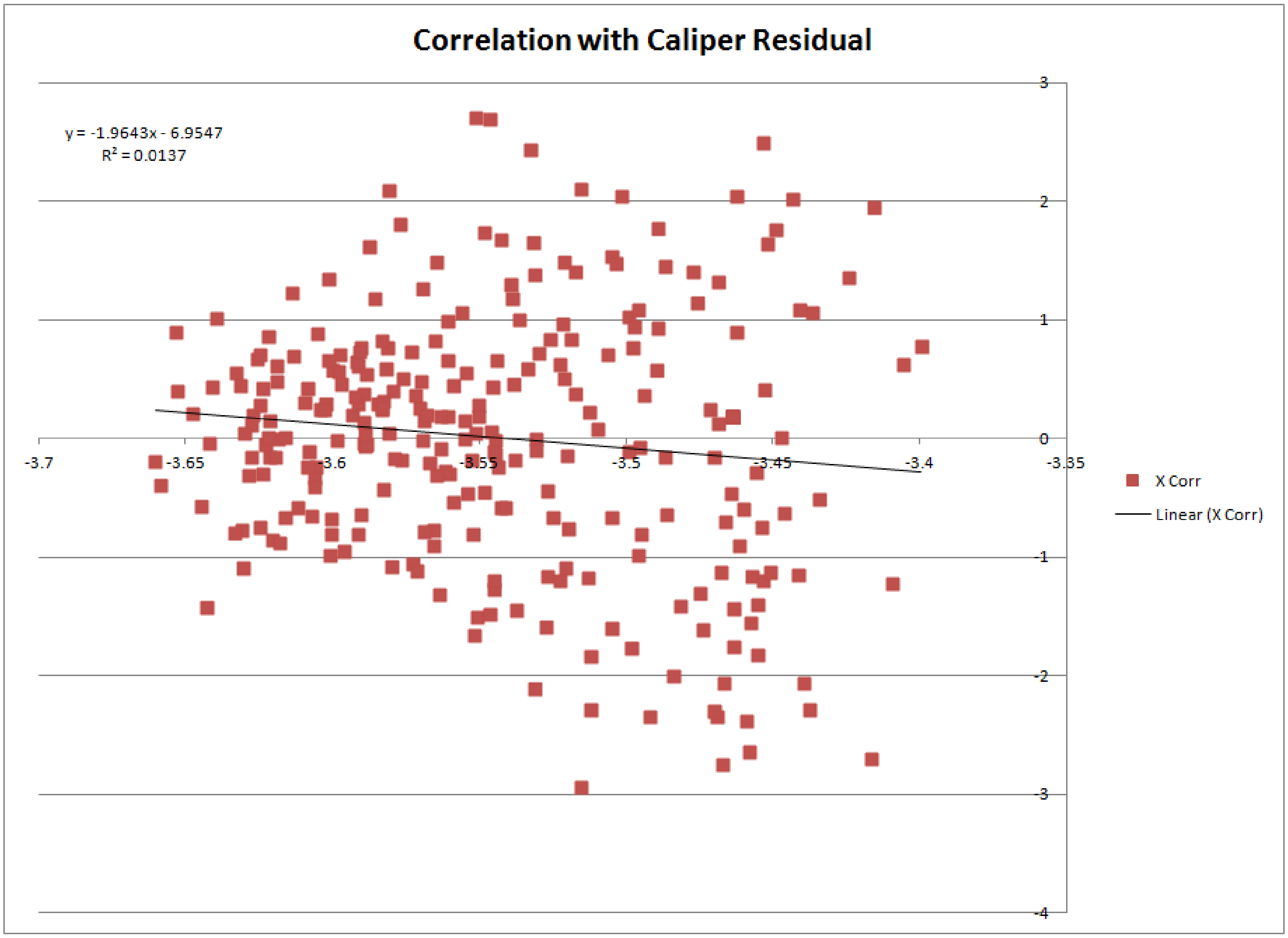


Figure 4-6 *Chart2* of *XY Corrector Calculator* (apparent caliper residual as a function of X, after the presumed Y correlation has been subtracted, is shown)

14. The offset values are displayed on the *Instructions* tab. In the **Sensor Maintenance** display, set X_{offset} = -$slope_x$ and Y_{offset} = -$slope_Y$. However, if the R^2 values associated with one of the offsets is less than 0.3, it is better to set the offset value to zero.

15. Enable the X-Y correction.

16. Profile errors with a spread below 1 micron should be observed on trended profiles (with a filter factor of 0.2). If this is not the case, repeat this activity starting at Step 4, and doubling the number of scans logged. If, after this, the criteria is still not met, you need to build a profile corrector (see Section 4.4).

4.4. Profile Correction

After the laser caliper sensor has been calibrated, and the X-Y corrector has been optimized, it is expected that the profile on the smooth target should be essentially flat. If systematic profile errors with a spread larger than 1 micron are still observed on trended profiles (with a filter factor of 0.2), you might need to build a profile corrector.

ATTENTION

Adjust the dome position only after the gauge has been calibrated (see Subsection 4.2.5) and the X-Y correction has been optimized (see Section 4.3).

To build the profile array:

1. Send the scanner offsheet.
2. Install the white calibration target on top of the air clamp. Adjust the vacuum if necessary so that the sample is held solidly in place.
3. On the horizontal dispatcher, choose the **Profile Correction** display.
4. In the **Profile Correction** display, select **Maintenance Mode**.

5. The instructions for building the profile array are provided in the left side of the **Profile Buildup** display. Figure 4-7 shows the **Profile Buildup** display for the laser caliper sensor.

Figure 4-7 Profile Buildup Display

6. Under **Select sensor processor**, select **Reel Laser Caliper Sensor Processor** (see Figure 4-7).

7. Under **Select Sensor Measurement**, select **Laser Caliper**.

8. Under **Commands**, select **Enable build profile corr**.

9. The green button lights up, indicating that build profile correction has been enabled.

10. Perform a reference and sample by selecting **Reference** and **Sample** under **Commands**.

11. Under **Options**, in the **# of Scans to Do** text box, enter the applicable number.

12. Under **Options**, in the **Smoothing Width mm** text box, enter the applicable number.

The scanner is now ready to build the profile.

1. Press **Scan**.

   The utility builds the caliper profile. Profiles are plotted both in forward and reverse direction. After completion, the average profile of the number of scans is displayed.

2. Save this array by clicking **Save Arrays to Recipe** (under **Retrieve from/Save to Recipe**).

   The **Select ID and groups to apply** dialog appears (see Figure 4-8).

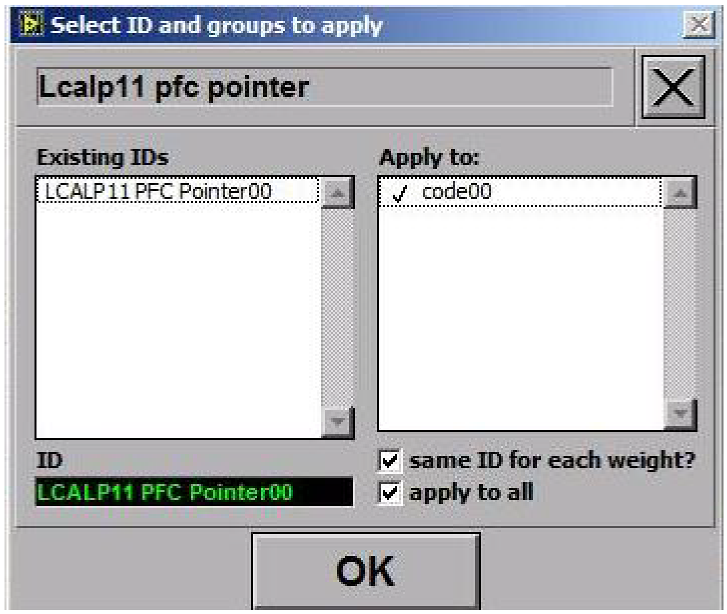


Figure 4-8 Select ID and groups to apply Dialog

3. Name the pointer. In the **Select ID and groups to apply** dialog, name the profile array that has been built as, for example, *LCALP11 PFC Pointer 00*.

4. Select the **apply to all** checkbox, because the profile correction is built from scanning on a target and not on a specific paper grade, and press **OK**.

The system is now ready to perform the profile correction when you enable it. To check how the profile correction is applied to the given scanning profile:

1. Go to the profile and select the profile of the laser caliper sensor as shown in Figure 4-9.

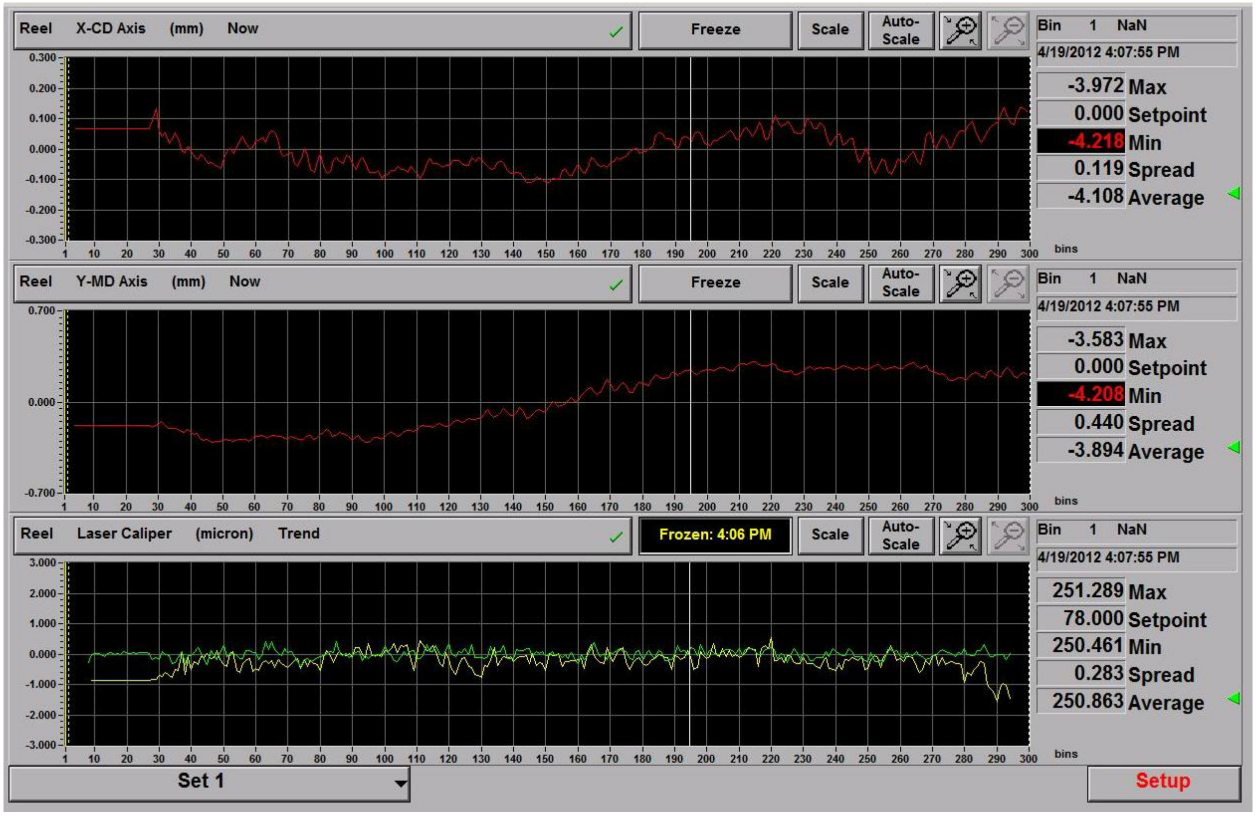


Figure 4-9 Profile-Corrected Caliper versus Uncorrected Caliper Display

2. While scanning, watch the caliper profile and freeze it by clicking **Freeze**.

3. Enable the profile correction and watch the corrected profile. For example, Figure 4-9 displays the profile-corrected caliper versus the uncorrected caliper.

   The profile-corrected caliper should be flat and have a lower spread than the uncorrected caliper.

4.5. Determine the Optimum Onsheet Position

The dome position may affect the accuracy of the gauge if it forces the Z-sensor and/or the laser triangulation sensor to not operate in their optimal range.

The dome position is adjusted at each standardize so that the scan-average reading of the Z-sensor stays constant. This section details a procedure for finding the optimum onsheet dome position.

ATTENTION

> Adjust the dome position only after the gauge has been calibrated (see Subsection 4.2.5) and the X-Y correction has been optimized (see Section 4.3).

ATTENTION

> Ensure that the automatic dome control is turned off, or that the sensor does not standardize during this activity.

1. Navigate to the **LCAL Compare Calibrations** display (see Figure 4-3) in the **Laser caliper** display.

2. Load the calibration file and plot **Z to STA Laser** versus **LVDT** as shown in Figure 4-3.

3. Find the center of the flattest region (1500-micron wide minimum), and note the LVDT position.

4. Send the scanner offsheet.

5. Install the white calibration target on top of the air clamp. Adjust the vacuum pressure if necessary so that the sample is held solidly in place.

6. Use dome control in the **Laser caliper\Dome control** display to move the dome to the LVDT position noted in Step 3.

7. Perform a minimum of four sample scans, and note the average 2-sigma spread.

8. Send the scanner offsheet.

9. Move the dome up or down by 250 microns, and repeat Steps 7–8.

10. Repeat Steps 7–9 so that the effect of the dome position is mapped out over a ± 500 micron region around the value noted in Step 3.

11. Identify the optimum dome position by plotting the 2-sigma spread versus the dome position (LVDT value), and selecting the dome position with the lowest spread. In a well calibrated system it is possible that the difference between the spreads will not be statistically significant. In that case, keep the dome position as noted in Step 3.

12. Send the scanner offsheet.

13. Move dome to the optimized position and record the Z-sensor reading. Enter the optimum Z-voltage for the onsheet and standardize position in the **LCAL Setup** display (ensure that **Z** is selected as the onsheet master).

4.6. Optimize Profile Correction

Where reliable laboratory profile data are available, it might be advantageous to build a profile correction that minimizes the error between the laser caliper and the laboratory profiles.

This section describes the off-line utility, *CorrectorUtility*, which is used to generate a profile correction using online and laboratory data.

4.6.1. Using CorrectorUtility

CorrectorUtility is a program for use on a laptop or PC running Windows 2000 or later. It assists in making profile correctors which can be loaded into the model 4213 laser caliper sensor processor to compensate for systematic shape differences between laboratory profiles and online profiles. This document describes version 1 of CorrectorUtility.

Installation of CorrectorUtility is described in Appendix E.

4.6.1.1. Overview

There are two cases for using CorrectorUtility:

- Estimating profile correctors for forward and backward traverses from laboratory measurements of a cross direction strip, and from online measurements taken around the same time that the strip was taken.

- Combining a number of profile correctors made at different times or in different process situations to make a composite profile corrector of presumably greater reliability.

The work-flow is depicted in Figure 4-10. Note that there are five steps needed in making a corrector, but a single step suffices for combining existing correctors.

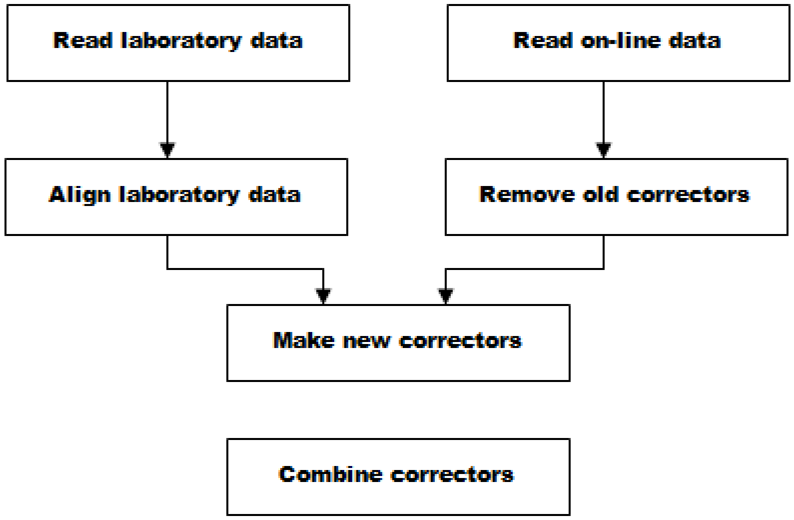


Figure 4-10 Making Correctors Workflow

CorrectorUtility software can be started from the program menu, and is usually in a group by itself, as shown in Figure 4-11.

Figure 4-11 CorrectorUtility (in the Start menu)

When started, the **CorrectorUtility** display shows the **Instructions** tab selected with **Overview** selected from the **Procedure** drop-down menu (see Figure 4-12).

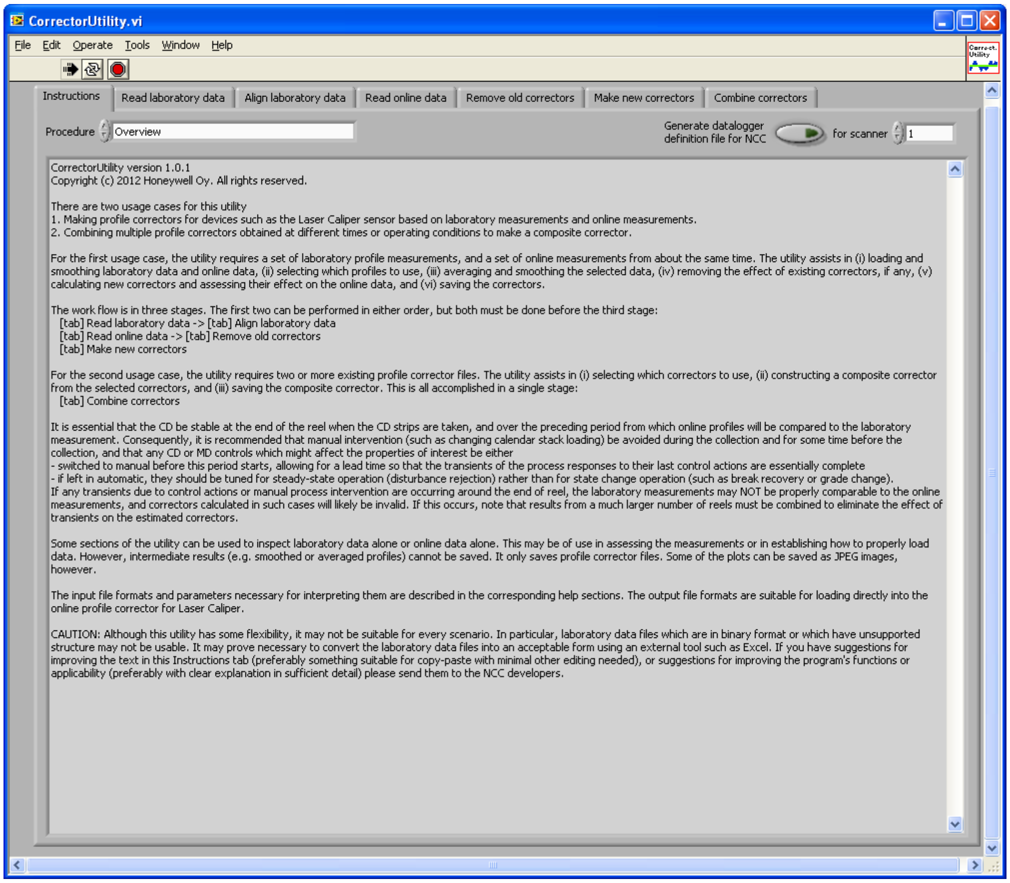


Figure 4-12 CorrectorUtility Display: Instructions Tab Display

Scrolling through the items listed in the **Procedure** drop-down menu provides instructions for using the other six tabs shown in the **CorrectorUtility** display.

The **Instructions** tab display also provides the **Generate datalogger definition file for NCC** button to create a datalogger configuration file.

When you click **Generate datalogger definition file for NCC**, the **Datalogger definition file** save dialog appears (Figure 4-13). Choose a suitable name for the datalogger definition file (there is no default filename, but *NCConly.dat*, or something similar would be suitable).

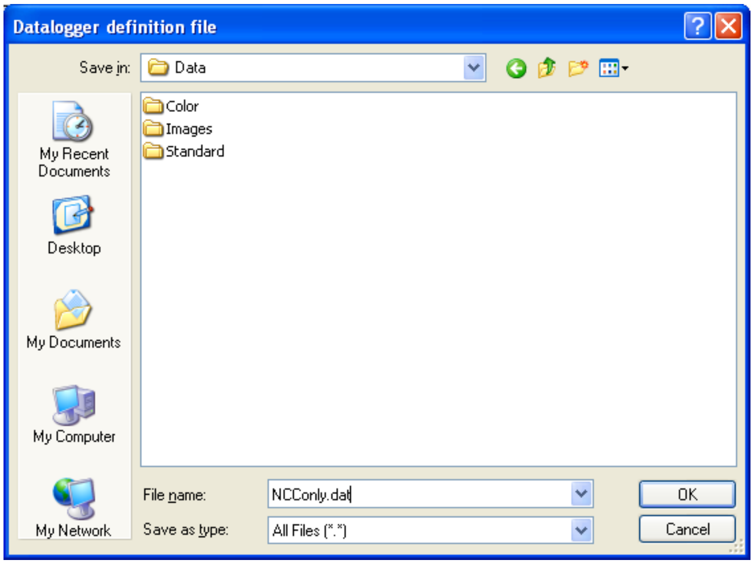


Figure 4-13 Datalogger definition file Save Dialog

The datalogger definition file will define a data collection for the laser caliper profiles at the end of each scan. The scanner number must be set to match the scanner number where the laser caliper sensor exists before the file is generated. This file can be copied to the datalogger directory on the RAE server and used for collecting caliper profiles suitable for use with this utility. An example of the contents of the file is shown in Figure 4-14.

```
V3
TrapDelay= "0" "0"
Event="log event 1" "end of scan 3" "end of scan 3" "1" "Off"
Record1 1 once ./system/system number{SystemNumber}
Record2 1 continuous ./scanner 3/measurements/nc caliper/last scan/now/array{lcal_ls}
```

Figure 4-14 Datalogger Definition File Contents

4.6.1.2. Making Correctors

To make correctors, you must have online data *and* laboratory data from the same time period. The data must be in a format which is acceptable to the utility, or must be externally converted to such a format (using Microsoft Excel, for example).

Laboratory data must be in one or more text files (ASCII or extended ASCII), which can have DOS, Unix, or Mac style line terminators, and use periods or commas as the decimal delimiter. Numeric profiles must be in columns in the files, and an arbitrary number of lines of header can be discarded. One or more designated columns can be included from one or more such files.

Online data must be in one of either:

- a single Honeywell datalogger file containing a known number of instances of a single collected profile, converted to delimited ASCII format
- a single text file containing a number of lines of header followed by several numeric profiles, each in a column of the file

Honeywell datalogger files always use a period as the decimal delimiter, but in the latter case, the decimal delimiter can be a period or a comma. In both cases, the file must have DOS style line termination.

The online data must always contain an uninterrupted series of alternating forward and backward traverses. The direction of the first traverse in the file must also be known.

Ideally, the machine direction and cross direction controls that might affect caliper are switched to manual before the relevant data are collected, and no manual interventions occur in the process during or just before the relevant data collection. In practice, it might not be acceptable to the mill to switch controls to manual, so the alternative is that if controls are in automatic, the tuning should be for steady-state operation (disturbance rejection), rather than for state-change operation (break recovery, grade change, and so on). In particular, if the cross direction control activity appears to decline only gradually after a sheet break, then it is best to use the second or subsequent reel after a sheet break or grade change for calculating correctors. The process is more likely to be stable with less control activity; manual interventions are also less likely. It is not advisable to use any reels in the first several hours after a machine startup or other extended interruption to production.

There are five procedures (in three sets) involved in making profile correctors as depicted in Figure 4-10. One of two sets of two procedures (loading laboratory data and smoothing and aligning laboratory data, *or* loading and smoothing online data and removing existing correctors) must be sequentially executed to load and process laboratory or online data. These data loading sets of two procedures can be performed in either order, but both of them must be completed before new correctors can be made in the final procedure, making new correctors. The five procedures (in three sets) are:

Procedure Set 1

1. Loading Laboratory Data
2. Smoothing and Aligning Laboratory Data

Procedure Set 2

1. Loading and Smoothing Online Data
2. Removing Existing Correctors

Procedure Set 3

1. Making New Correctors

1. Loading Laboratory Data

Laboratory data must be loaded from ASCII files. Select the **Read laboratory data** tab (see Figure 4-15).

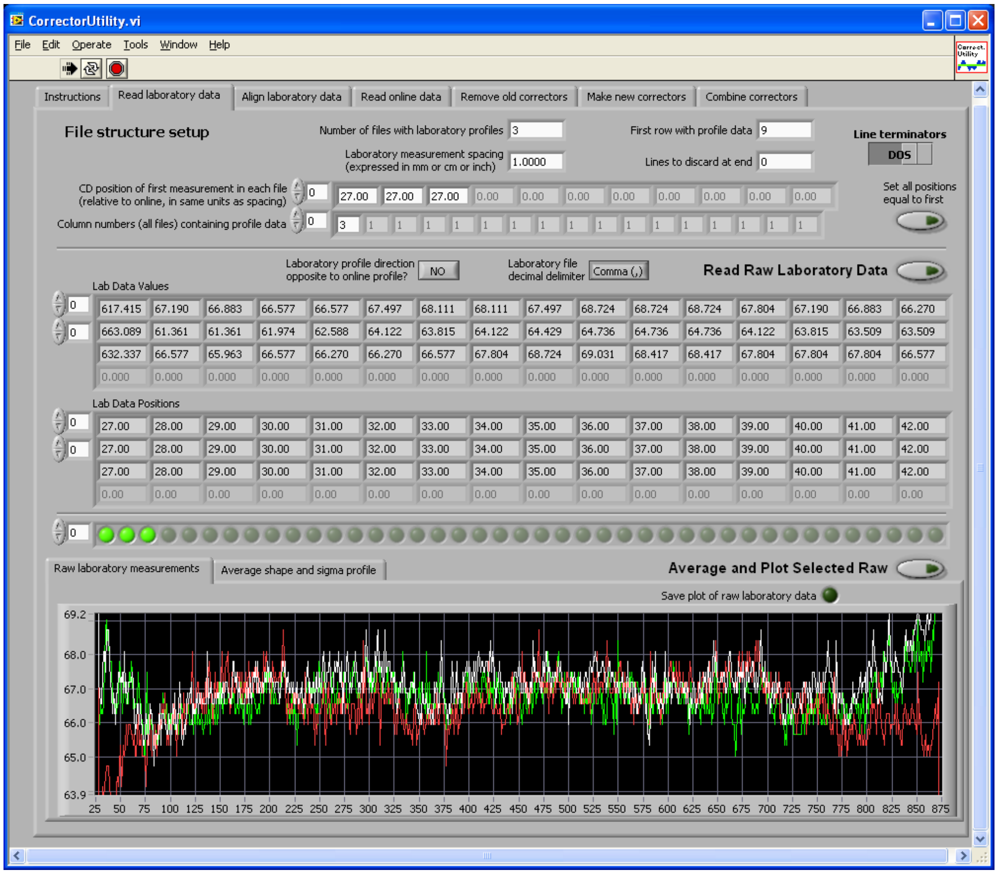


Figure 4-15 CorrectorUtility Display: Read laboratory data Tab Display

First, the slider in the upper right must be set to match the file line terminators in the laboratory files (either DOS or Unix style). Note that files made in Windows or OS/2 will generally have DOS line terminators, but files made in Linux, BSD, and Mac OSX generally have Unix line terminators. While Mac OS9 and earlier employ a different termination, it is handled in the same way as Unix line termination.

Next, the decimal delimiter should be set using the pushbutton to indicate either a comma or a period as the delimiter.

If the laboratory measures profiles in the opposite direction to the online system, the corresponding pushbutton should be set to **YES**. Normally, the laboratory measures profiles in the same direction as the online system, and this can be left at **NO**.

It is necessary to understand the layout of the files produced by the laboratory measurement. Typically, each file contains one or more profiles, and also contains a number of lines of header material, which is to be discarded. Several fields govern this:

- **First row with profile data**: indicates the first row after the header. If this is a 1, then the profile data begins in the very first line in the file, and there is no header to skip. If this is a 9, then eight lines of header are skipped.

- **Lines to discard at end**: indicates how many trailer lines exist after the profile data. This is usually zero.

- **Laboratory measurement spacing**: this should be set to be the cross direction interval between measurement points. It can be expressed in any suitable units (such as cm or in.), but should be given in sufficient precision that the total span from first to last measurement point agrees with the number of points times the spacing to within less than the spacing value. Note that only equispaced measurements are supported.

- **Number of files with laboratory profiles**: this should be set appropriately. Typically, each cross direction strip will result in a separate file from the laboratory (this is not always the case, of course).

- **CD position of first measurement in each file**: this will automatically be given a zero value corresponding to each file. These values should be set to match the position of the first actual laboratory measurement, relative to the online profile. For example, assuming spacing measurements in centimeters, if the online profile indicated the sheet edge was at 25 cm, and the first laboratory measurement was at 2 cm in from the edge, then the corresponding value would be 27. Clicking the **Set all positions equal to first** button will copy the value entered for the first file into the values for all other files. This is useful if there are many files, and most of them have the first measurement in the same place. Only those which differ from the others need to have values set individually.

- **Column numbers (all files) containing profile data**: this should indicate which columns in the files contain caliper profiles. If this is set to 1, then the first column in every file contains a caliper profile. If several columns of each file contain caliper profiles, then the appropriate column numbers should be set here.

After the above items have been set correctly, click the **Read Raw Laboratory Data** button. That will cause the **Laboratory data file** dialog to appear, once for each file with laboratory profiles (see Figure 4-16). Only a single file can be loaded on each instance of the dialog (selection of multiple files in a single dialog is not supported).

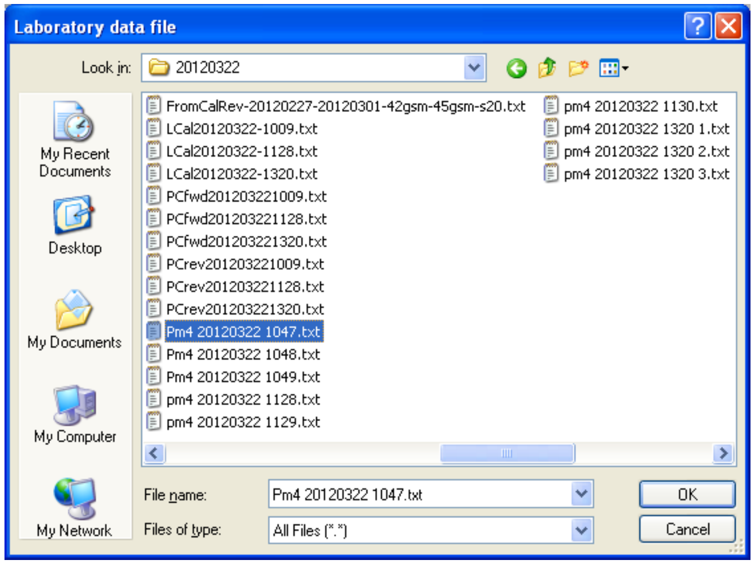


Figure 4-16 Laboratory data file Dialog

After the data files have been read, the profiles will be displayed in the graph at the bottom of the tab. The array of green balls above the graphs indicates that all of the loaded profiles are selected for display and averaging. If some profiles look implausible, the corresponding green ball can be clicked (turning it dark) to deselect that profile.

Switching sub-tabs will display a graph of the average shape of the laboratory profiles, and the 1-sigma profile for those shapes (Figure 4-17).

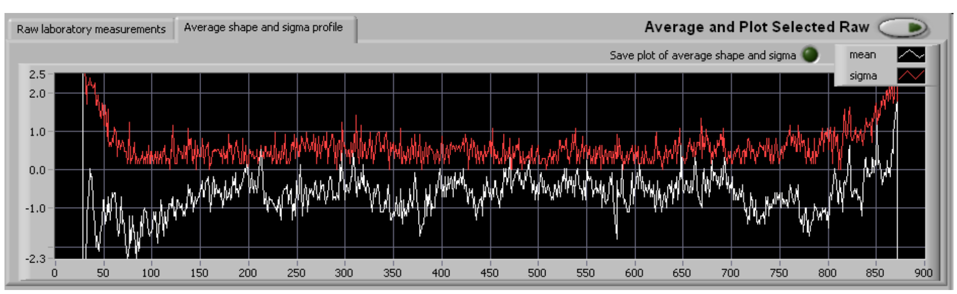


Figure 4-17 Average raw shape and sigma profiles Sub-tab Display

When the sub-tab is changed, or when the selection of profiles is changed, you need to click **Average and Plot Selected Raw**.

It is possible to inspect and manipulate the laboratory caliper measurements using the upper table of data values. It is also possible to inspect and manipulate the positions at which laboratory measurements were made in the lower table of data values. In each of these tables, a profile is a row. Note that it is generally not recommended that any data be manipulated. If a profile appears to be unacceptable, it should be excluded.

Click the round dark green **Save plot** button in each of the graph sub-tabs to save the currently displayed graph as a JPEG file. A file save dialog will appear, and it is necessary to enter the file extension as well as the file name.

2. Smoothing and Aligning Laboratory Data

After a satisfactory selection of profiles is reached (often all of the profiles are used), the data must be smoothed and aligned with the online measurement extents. The applicable tab for this is shown in Figure 4-18.

Figure 4-18 CorrectorUtility Display: Align laboratory data Tab Display

The profiles are smoothed first, then aligned by interpolation with the online measurement positions. The parameters governing the smoothing and alignment are:

- **Smoothing**: this is the wavelength for a low-pass filter which is to be applied to the laboratory profiles. It is expressed in the same units as the spacing of the profiles. It is recommended that this be approximately 20 cm (8 in.) as a first estimate.

ATTENTION

> The smoothing to be applied to the laboratory profiles should generally be quite similar to the smoothing to be applied to the online profiles. Differences should be small, and should exist only if it is known that the effective bandwidth of the measurements differ and the smoothing wavelength is close to the limiting bandwidth of one of them.

- **Ignore at start**, and **ignore at end**: indicate the number of values which should be ignored at either end of the profile. Often, the first and last laboratory measurements are unreliable because a sheet transport attachment (such as tape) is fixed to the ends of the cross direction strip. A typical value is 1.

- **Scanner profile length**: should indicate the number of cells which are in an online profile, including all offsheet cells.

- **Spacing of scanner points**: should indicate the distance between scanner cells, expressed in the same units as the spacing of the laboratory profile. It should be given with sufficient precision that the number of onsheet cells times the spacing is within one cell of the sheet width.

After suitable values have been entered for the parameters, click **Smooth and Align Data**. That will cause the data displayed, and the graphs at the bottom of the tab, to be updated. The **Average shape and sigma profile** sub-tab display shown in Figure 4-19 shows the selected smoothed individual profiles. The other graph sub-tab, **Selected smoothed profiles**, shows the average of the selected smoothed profiles and the 1-sigma profile of those profiles.

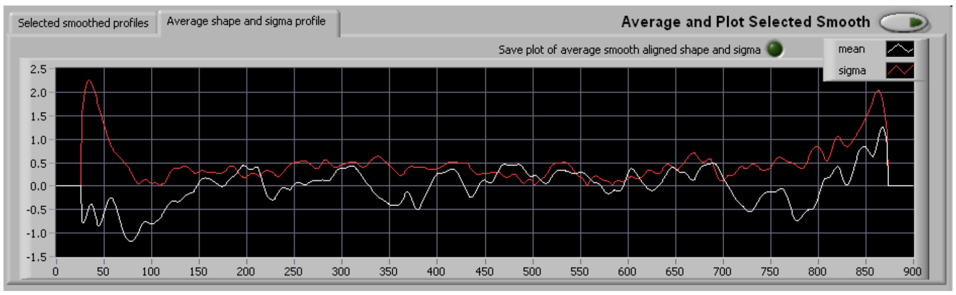


Figure 4-19 Average shape and sigma profile Sub-tab Display

The selection of profiles is shown as an array of green balls just above the graphs. This is set to be all of the profiles when **Smooth and Align Data** is clicked, but can be changed afterwards. If the selection is changed, click **Average and Plot Selected Smooth** to update the graphs.

It is possible to inspect and manipulate the smoothed laboratory caliper measurements using the upper table of data values. It is also possible to inspect and manipulate the smoothed and aligned laboratory caliper measurements in the lower table. In each of these tables, a profile is a row. Note that it is generally not recommended that any data be manipulated; if a profile appears to be unacceptable, it should be excluded.

Click the round dark green **Save plot** button in each of the graph sub-tabs to save the currently displayed graph as a JPEG file. A file save dialog will appear, and it is necessary to enter the file extension as well as the file name.

At this point, the laboratory data has been loaded and processed.

3. Loading and Smoothing Online Data

Online data must be loaded from a single ASCII or extended ASCII file with DOS line terminators. The applicable tab for doing this is shown in Figure 4-20.

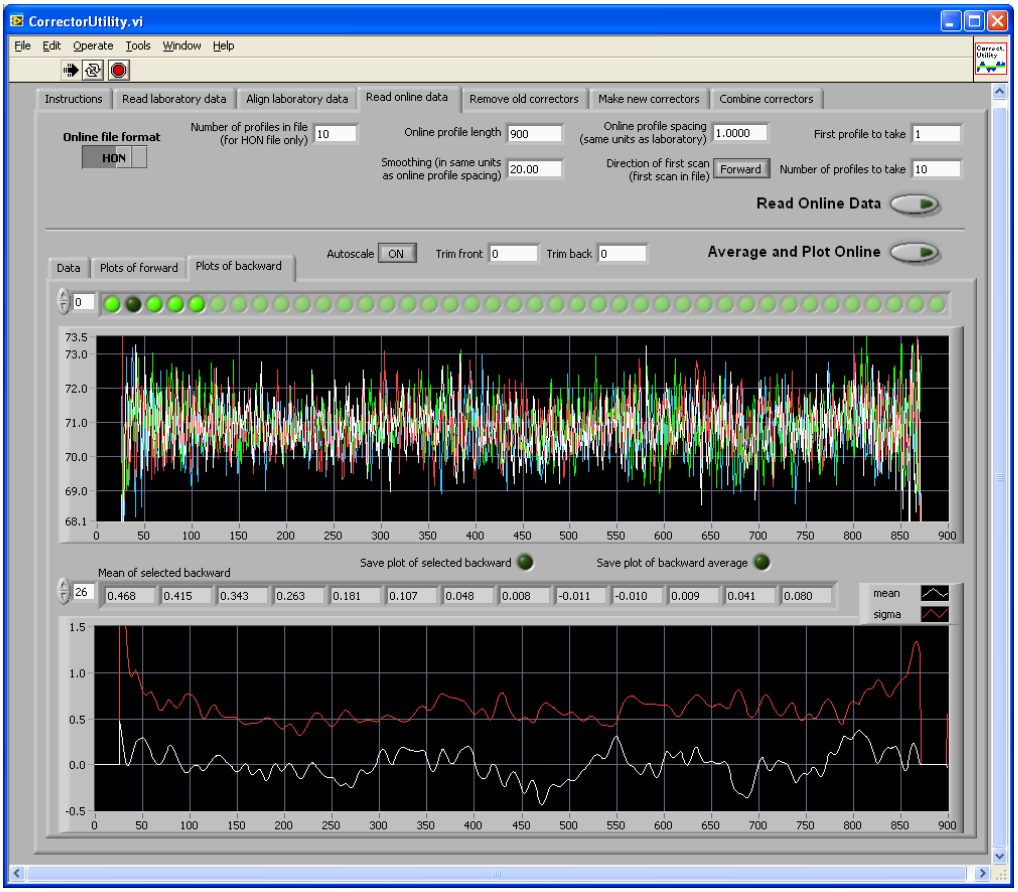


Figure 4-20 CorrectorUtility Display: Read online data Tab; Plots of backward Sub-tab Display

Two file formats are supported. The slider at the upper left of the tab is used to select either **HON** for a file converted from Honeywell datalogger format, or **Other** for a set of profiles as a rectangular array of numbers with profiles in columns.

The parameters shown beside the slider depend on the slider setting, as shown in Figure 4-21.

Figure 4-21 Parameters

The format-specific parameters to enter for loading and smoothing the online profiles are:

- **Number of profiles in file**: The total number of profile records in a data collection file, including profiles which are not of interest. Only valid/needed for **HON** files.
- **Header lines to skip**: Number of header lines before data. Only valid/needed for **Other** files.
- For **Other** files, the decimal delimiter may be set as either a comma or a period via pushbutton.

The parameters which are needed for both formats are:

- **Online profile length**: should indicate the number of cells which are in an online profile, including all offsheet cells.
- **Online profile spacing**: should indicate the distance between scanner cells, expressed in the same units as the spacing of the laboratory profile. It should be given with sufficient precision that the number of onsheet cells times the spacing is within one cell of the sheet width.
- **Smoothing**: this is the wavelength for a low-pass filter which is to be applied to the online profiles. It is expressed in the same units as the spacing of the profiles. It is recommended that this be approximately 20 cm (8 in.) as a first estimate.

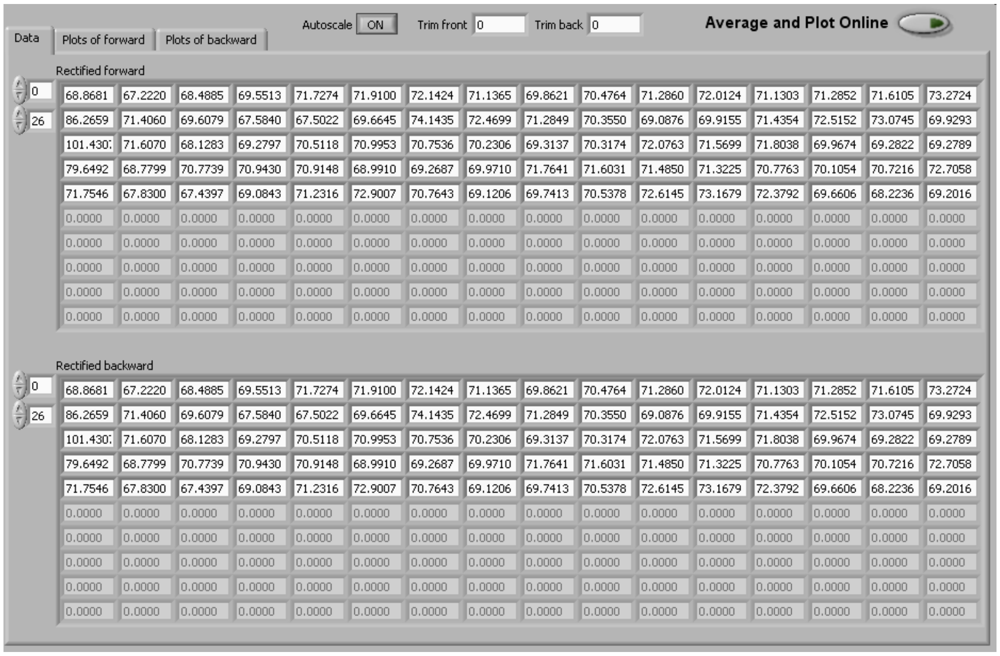
ATTENTION

> The smoothing to be applied to the online profiles should generally be quite similar to the smoothing to be applied to the laboratory profiles. Differences should be small, and should exist only if it is known that the effective bandwidth of the measurements differ and the smoothing wavelength is close to the limiting bandwidth of one of them.

- The direction of the first scan in the file must be known in order to properly separate the scans into forward and backward traverses (different correctors may be needed for each scan direction). It is set using the pushbutton as either forward or backward.
- **First profile to take**: should be set to the index of the first profile to load from the file. Putting 1 in this field means the first profile in the file will be taken.

- **Number of profiles to take**: should be set to the number of consecutive profiles to take, including the first profile. For example, if the file contains 40 profiles, then setting **First** to 21 and **Number** to 10 will take profiles 21 to 30 from the file. Similarly, if it contains 20 profiles, and all of them are to be taken, then **First** would be 1 and **Number** would be 20.

- There are three sub-tabs, the one labeled **Data** contains numeric values of the loaded profiles (see Figure 4-22). The two tables contain the loaded profiles separated into forward traverses and backward traverses.



Rectified forward

68.8681	67.2220	68.4885	69.5513	71.7274	71.9100	72.1424	71.1365	69.8621	70.4764	71.2860	72.0124	71.1303	71.2852	71.6105	73.2724
86.2659	71.4060	69.6079	67.5840	67.5022	69.6645	74.1435	72.4699	71.2849	70.3550	69.0876	69.9155	71.4354	72.5152	73.0745	69.9293
101.430	71.6070	68.1283	69.2797	70.5118	70.9953	70.7536	70.2306	69.3137	70.3174	72.0763	71.5699	71.8038	69.9674	69.2822	69.2789
79.6492	68.7799	70.7739	70.9430	70.9148	68.9910	69.2687	69.9710	71.7641	71.6031	71.4850	71.3225	70.7763	70.1054	70.7216	72.7058
71.7546	67.8300	67.4397	69.0843	71.2316	72.9007	70.7643	69.1206	69.7413	70.5378	72.6145	73.1679	72.3792	69.6606	68.2236	69.2016
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Rectified backward

68.8681	67.2220	68.4885	69.5513	71.7274	71.9100	72.1424	71.1365	69.8621	70.4764	71.2860	72.0124	71.1303	71.2852	71.6105	73.2724
86.2659	71.4060	69.6079	67.5840	67.5022	69.6645	74.1435	72.4699	71.2849	70.3550	69.0876	69.9155	71.4354	72.5152	73.0745	69.9293
101.430	71.6070	68.1283	69.2797	70.5118	70.9953	70.7536	70.2306	69.3137	70.3174	72.0763	71.5699	71.8038	69.9674	69.2822	69.2789
79.6492	68.7799	70.7739	70.9430	70.9148	68.9910	69.2687	69.9710	71.7641	71.6031	71.4850	71.3225	70.7763	70.1054	70.7216	72.7058
71.7546	67.8300	67.4397	69.0843	71.2316	72.9007	70.7643	69.1206	69.7413	70.5378	72.6145	73.1679	72.3792	69.6606	68.2236	69.2016
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Figure 4-22 Data Sub-tab Display

- The **Plots of forward** and **Plots of backward** sub-tabs show graphs of profiles from the forward and backward traverses. In these latter two sub-tabs, the upper graph shows the individual selected profiles, while the lower graph shows the smoothed average of those profiles and the sigma profile.

Figure 4-20 shows the sub-tab for backward traverses, while the sub-tab for forward traverses is shown in Figure 4-23.

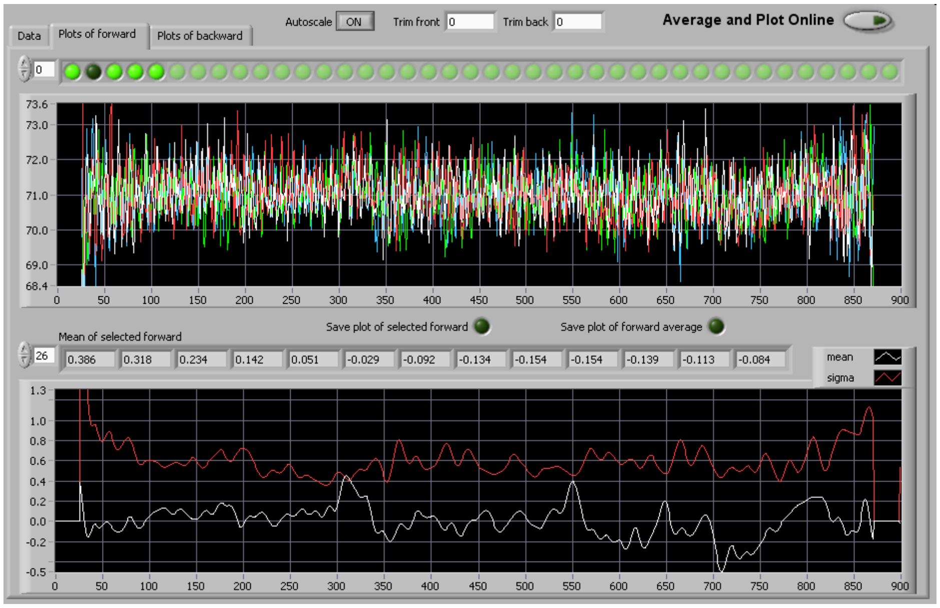


Figure 4-23 Plots of forward Sub-tab Display

- The **Autoscale** button controls whether the graph scales are recalculated when **Average and Plot Online** is clicked.

- **Trim front** and **Trim back** allow edge values to be left out of the average. This is not usually needed.

The selection of profiles is shown as an array of green balls just above the graphs. This is set to be all of the profiles when **Read Online Data** is clicked, but can be changed afterwards. If the selection is changed, click **Average and Plot Online** to update the graphs.

It is possible to inspect and manipulate the loaded profile data in the tables of values in the **Data** sub-tab. Each profile is a row in its respective table. It is also possible to inspect and manipulate the smooth average of selected online profiles using the array of data values above the lower plot under the **Plots of forward** and **Plots of backward** sub-tabs. Note that it is generally not recommended that any data be manipulated; it is preferred that profiles be excluded from the average instead.

Click either of the two round dark green **Save plot** buttons between the two graphs in under the **Plots of forward** and **Plots of backward** sub-tabs to save the corresponding displayed graph as a JPEG file. In each sub-tab, one button is for the graph of selected online profiles, and the other is for the graph of the smooth average profile and sigma profile. A file save dialog will appear, and it is necessary to enter the file extension as well as the file name.

4. Removing Existing Correctors

Because there may be old correctors already in use and biasing the online profiles, it may be necessary to remove them. The applicable tab for doing this is shown in Figure 4-24.

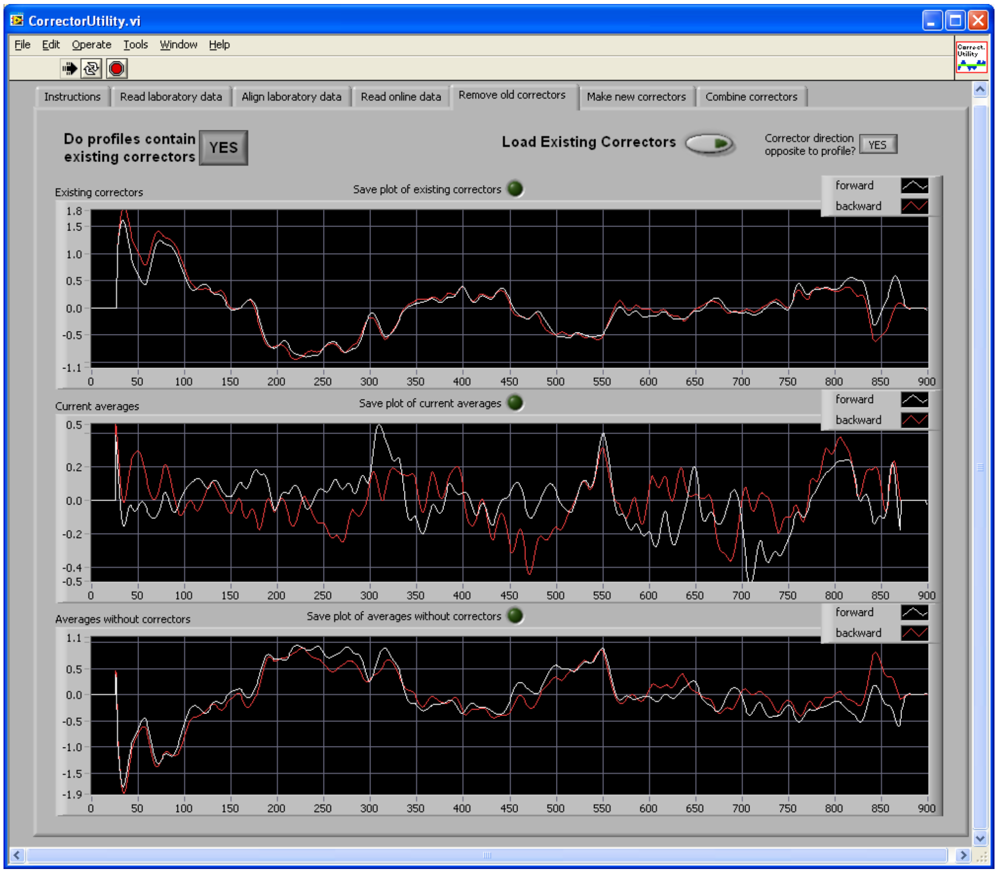


Figure 4-24 CorrectorUtility Display: Remove old correctors Tab Display

There is one primary parameter to set:

- **Do profiles contain existing correctors**: should be set to **YES** or **NO** using the large pushbutton. If it is set to **NO** (the default), then the corrector profiles will contain only zeroes. If it is set to **YES**, then the corrector profiles are initialized to zeroes, and two additional controls appear in the upper right of the tab.

The pushbutton in the upper right should be used to indicate whether the corrector direction is reversed compared to the profile direction. Normally, this is **YES**.

Clicking **Load Existing Correctors** will provide two file dialogs for opening corrector files. The dialog name will indicate whether it is for the forward or backward corrector. For example, Figure 4-25 shows the dialog for loading a corrector for the backward traverse direction. The files loaded must be in Honeywell profile corrector format, which is extended ASCII text with DOS line terminators and period as decimal delimiter.

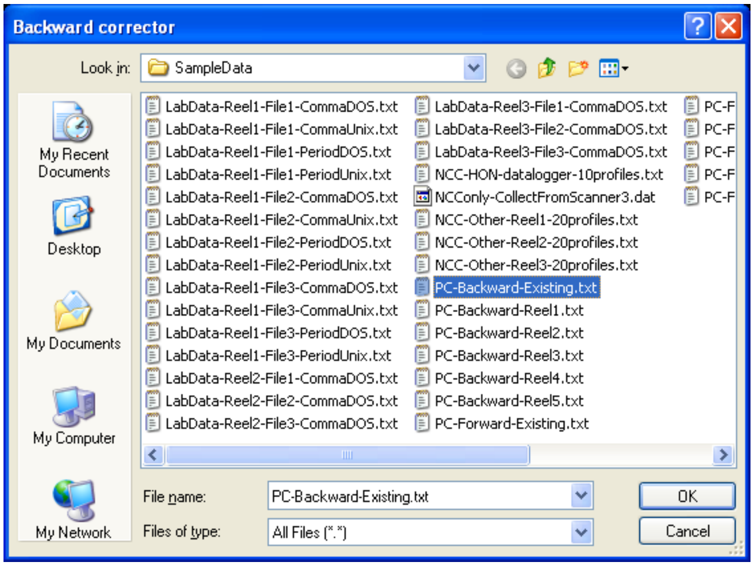


Figure 4-25 Backward corrector Dialog

There are three graphs in the tab, as shown in Figure 4-24, each with two traces:

- forward traverses
- backward traverses

The top graph shows the existing profile correctors, the middle graph shows the existing online profile averages, and the bottom graph shows the online profile averages without the profile correctors.

Click the round dark green **Save plot** button above each graph to save the corresponding displayed graph as a JPEG file. A file save dialog will appear, and it is necessary to enter the file extension as well as the file name.

ATTENTION

It is necessary to enter this tab after loading the online data, even if there are no existing correctors in use.

At this point, the online data has been loaded and processed.

5. Making New Correctors

After the laboratory data has been loaded and processed, and the online data has been loaded and processed, it is possible to make new correctors. The applicable tab for this is shown in Figure 4-26.

Figure 4-26 CorrectorUtility: Make new correctors Tab; Backward corrector and effect Sub-tab Display

Correctors are made for both traverse directions simultaneously. Figure 4-26 shows the **Backward corrector and effect** sub-tab selected.

The pushbutton in the upper left should be used to indicate whether the corrector direction is reversed compared to the profile direction. Normally, this is **YES**.

Click **Make Correctors** to update the graphs.

Under each sub-tab, the upper graph shows the new corrector and the existing corrector for the appropriate traverse direction. Optionally (depending on the setting of the **Show changes** button), it will also show the change in correctors from existing to new. The middle graph shows the individual online profiles for the same traverse direction including the effect of the existing corrector. The bottom graph shows the same individual online profiles as they would be with the new corrector instead of the existing corrector. The set of online profiles is selected using the green balls in the same sub-tab. An example of the top graph with **Show changes** ON is shown in Figure 4-27. If the selection of profiles is changed, or if the **Show changes** setting is changed, you will need to click **Update plots** button to update the graphs displayed.

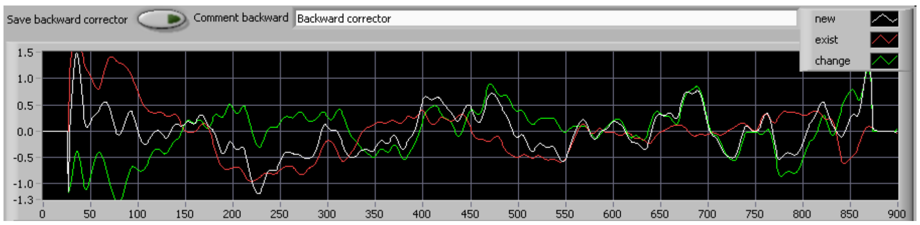


Figure 4-27 New and Existing Corrector With Change Plotted Display

It is possible to inspect and manipulate the corrector in each sub-tab using the array of data values above the lower plot under the **Plots of forward** and **Plots of backward** sub-tabs. Note that it is generally not recommended that any data be manipulated.

In each sub-tab, the **Comment** text field is used to insert a suitable comment into the corrector file. It is recommended that information such as the date and time of the reel and basic grade information be inserted, as well as the traverse direction.

In each sub-tab, click **Save corrector** to call up a file save dialog for the corresponding profile corrector, either for forward traverse or for backward traverse.

The units string defaults to microns, but can be changed to whatever units are used locally for measurement of caliper. This string is common to both traverse directions.

Click either of the round dark green **Save plot** buttons under each sub-tab to save the upper graph displayed in the sub-tab as a JPEG file (the graph with the correctors). A file save dialog will appear, and it is necessary to enter the file extension as well as the file name.

At this point, making new correctors is completed.

4.6.2. Combining Correctors

To combine correctors, it is necessary to have saved two or more correctors into files. Ideally, a fairly large number of correctors should be available from different reels, both for forward and backward traverses. That will improve the statistical reliability of the combined corrector. Note that only the Honeywell corrector file format is supported.

This operation is normally carried out independently of the steps for making correctors, and only after a number of acceptable correctors have been made. It is generally performed for forward and backward correctors separately, although it can be used to combine a mixture of forward and backward correctors. The correctors being combined should have received the same amount of smoothing. The applicable tab for this step is shown in Figure 4-28. The number of corrector files to read must be specified in the text box at the upper left.

Figure 4-28 CorrectorUtility Display: Combine correctors Tab Display

Reversed direction for storing data in the corrector (relative to the data in online profiles) is set using the **Corrector direction** button. Normally, this is **YES**.

Click **Read corrector files** to call up a file open dialog, once for each file with a corrector profile. Note that only a single file can be loaded on each appearance of the dialog (selection of multiple files in a single dialog is not supported).

It is possible to inspect and manipulate the numerical corrector data in the tables of values under the **Corrector data** sub-tab (see Figure 4-29). Each profile is a row in the displayed table, and the index will be set so that the first non-NaN value is shown. Note that it is generally not recommended that any data be manipulated; it is preferred that corrector profiles be excluded from combination in their entirety instead.

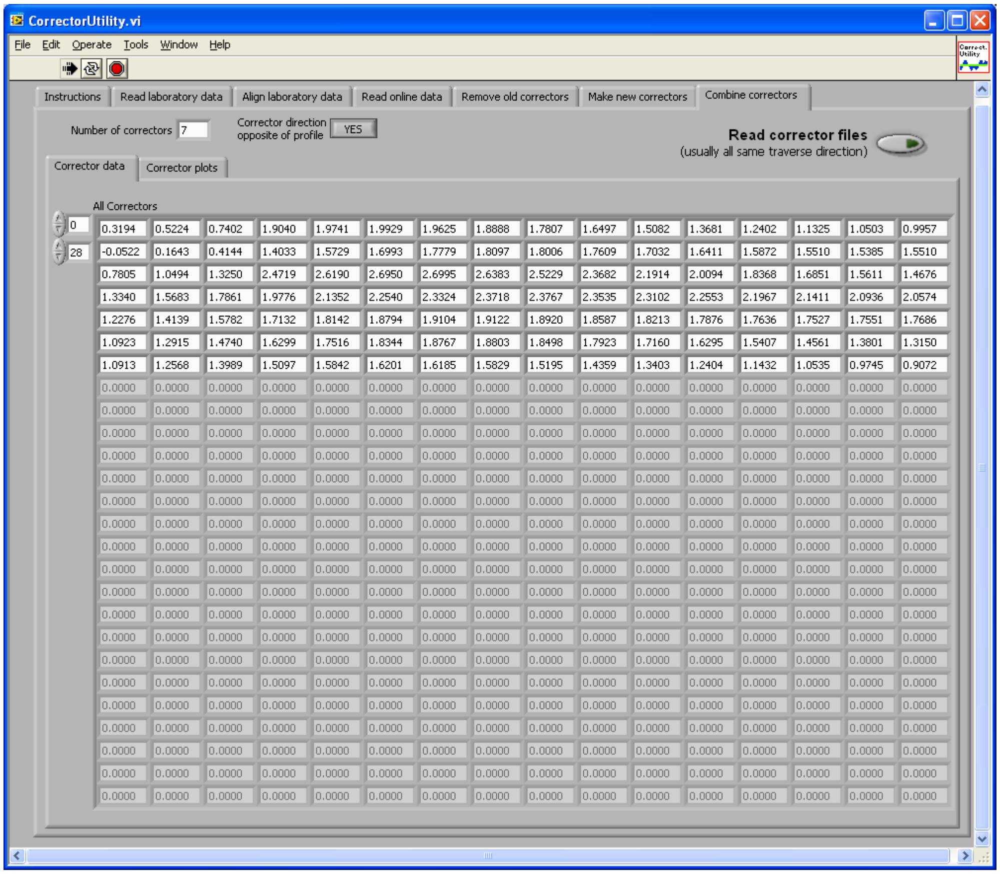


Figure 4-29 Combine Correctors Tab: Corrector data Sub-tab Display

Under the **Corrector plots** sub-tab, the set of selected correctors can be manipulated using the array of green balls. This is initialized to select all of the loaded correctors, but can be changed after they are loaded.

It is also possible to specify a smoothing wavelength for combining correctors, but this should not be needed in most cases, as suitable smoothing should already have been applied to the individual correctors being combined.

The **Autoscale correctors** button (Figure 4-28) controls whether the graph scales are recalculated when you click **Combine and plot selected correctors**.

A number of composition methods are supported, and can be selected using the **Combination method** drop-down menu, as shown in Figure 4-30. The methods are:

- **Average**
- **Median**
- **Center** (selects the average of the highest and lowest value at each point)

The default is to use **Average**.

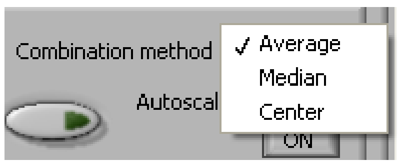


Figure 4-30 Combination method

If there are sufficient correctors loaded, it is also possible to exclude one or more extrema (both upper and lower) from the combination using the **Omit extrema** value. This is advantageous when several of the correctors contain local anomalies, and excluding all of such correctors in their entirety is not desirable. The default for **Omit extrema** is zero, and it is limited to ensure at least one value remains at each point.

Click **Combine and plot selected correctors** to update the graphs using current parameters. This must be done to update the graphs whenever changes are made to the selection of correctors, or **Omit extrema**, **Smoothing**, or **Combination** method.

Click **Save composite as new corrector** to call up a file save dialog for the combined corrector. It is necessary to specify the entire file name, including extension.

The **Comment** text field is used to insert a suitable comment into the file for the combined corrector. It is recommended that information such as the range of dates and range of grades of the selected correctors be inserted, as well as the traverse direction.

The **Units** string defaults to microns, but can be changed to whatever units are used locally for measurement of caliper.

Click either of the round dark green **Save plot** buttons above each graph under the **Corrector plots** sub-tab to save the corresponding displayed graph as a JPEG file. In this sub-tab, one button is for the graph of selected correctors as displayed and the other is for the graph of the combined corrector and its sigma profile as displayed. A file save dialog will appear, and it is necessary to enter the file extension as well as the file name.

4.7. Set Air Pressures

Recommended initial pressures for the air clamp (as viewed on the module pressure gauges) are 5 psi for both Coanda slots, 15 psi for the outer vacuum slot, and 7.5 psi for the inner slot. Note that these are the pressure settings. The vacuum readings are displayed on the **Laser Caliper** display. The vacuum readings vary depending on the porosity and surface properties of the paper. A sample sheet of paper should be placed on the air clamp and compared to Figure 4-31.

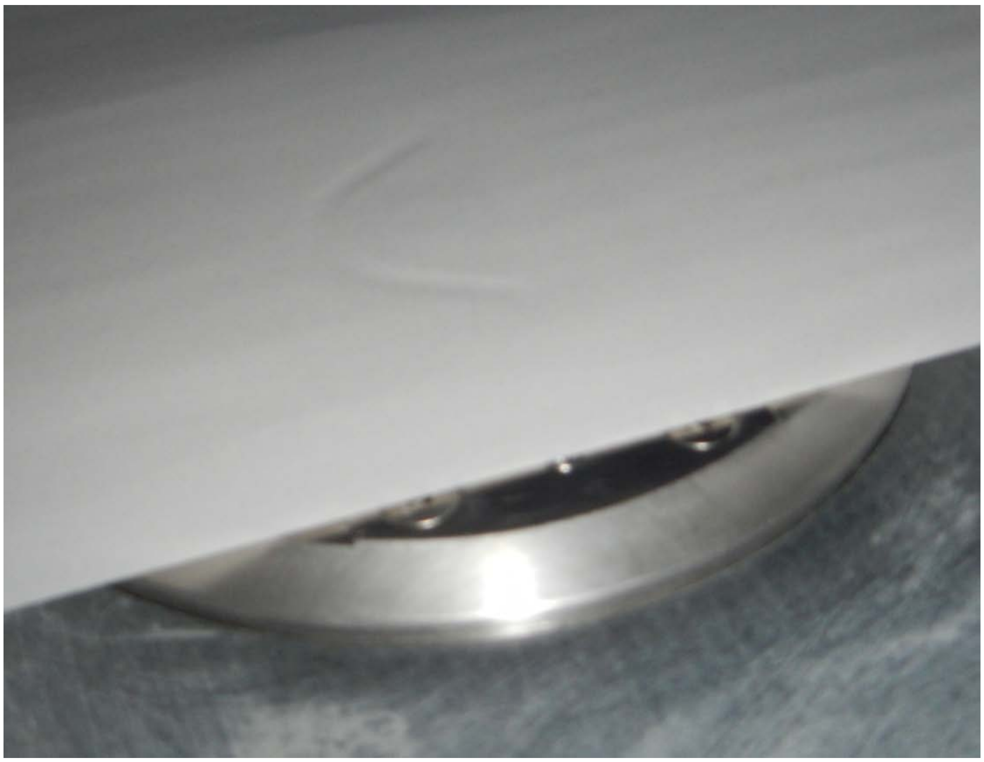


Figure 4-31 Stationary Sheet

Adjustments to the vacuum should be made until the sheet is seen to be slightly pulled in by the outer vacuum slot and minimally pulled in by the inner. As the scanner is put on sheet, it may be necessary to re-evaluate these settings based on performance. The vacuum should be set so that moving or stationary sheet looks like it does in Figure 4-31.

After the scanner starts scanning, it is important to quickly check for sheet lift-offs. Most commonly, these appear at the edges as the air clamp is moving on sheet (see Figure 4-32). If such profiles are seen, increase the flow to the Coanda slots so that the lift-offs are suppressed.

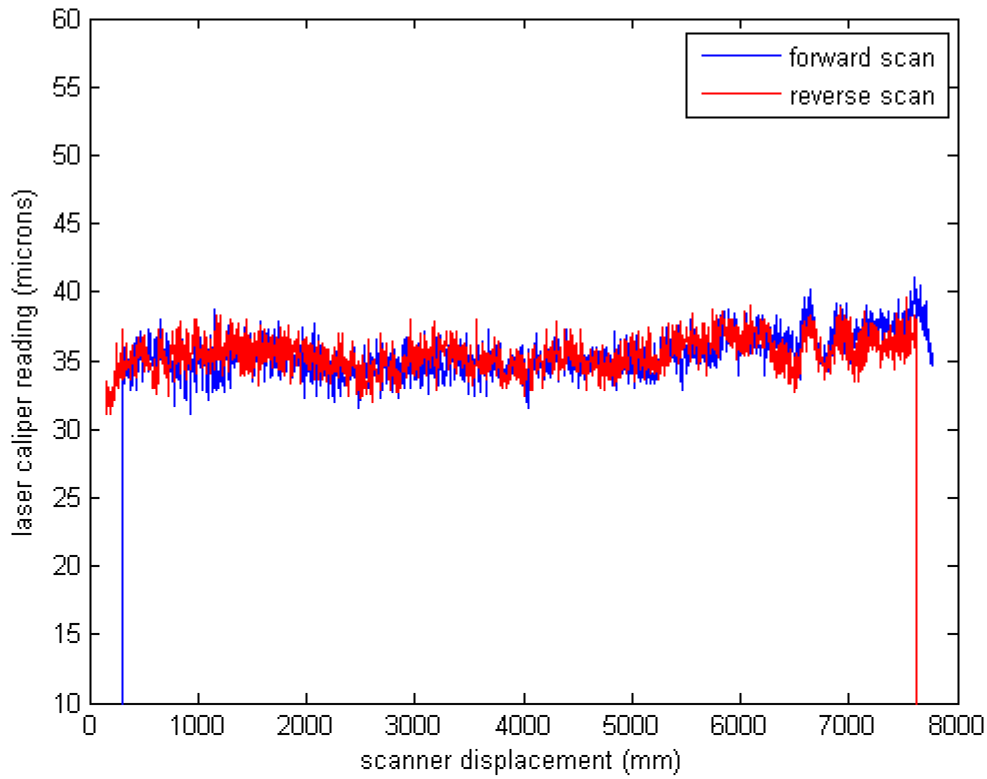


Figure 4-32 Insufficient Air Flow Through Air Clamp

The sheet is not held as the scanner moves onto the sheet. Increased pressure on the Coanda slots will improve the measurement.

4.8. Setting Static-offset to Report the Absolute Value

While the initial caliper value should be within ~10 µm of the true sheet caliper, the optical properties of the sheet might require an adjustment to the dynamic or static offset values. The best source for a true caliper reading is a quality measurement from the mill lab using the TAPPI 411 standard. When this is obtained, adjust the static offset in the **Laser Caliper Setup** display so the onsheet absolute caliper value is correctly reported.

Use this formula to adjust the offset:

New static offset = Current static offset - Laser Caliper Reading + True caliper.

Alternatively, if many grades are run which are significantly different, it might be desirable to set dynamic offsets for each grade group, and then enable the Dynamic offset corrector.

4.9. Additional Sensor Setup

As with all sensors, the MSS Job Set (see Figure 4-33) has to be configured properly for laser caliper. The **Beam Offset mm** has to indicate the physical position of the sensor. It is recommended that **Beam Half Width mm** be set to 25 for the **STA Laser Displacement** as shown in Figure 4-33. The **Beam Half Delay ms** is an advanced setting and should have non-zero values only if field testing has been done on fixed samples while scanning. Because the laser caliper measurement can use X and Y correction, the offset of these sensors must be set to the same value as that used for laser caliper.

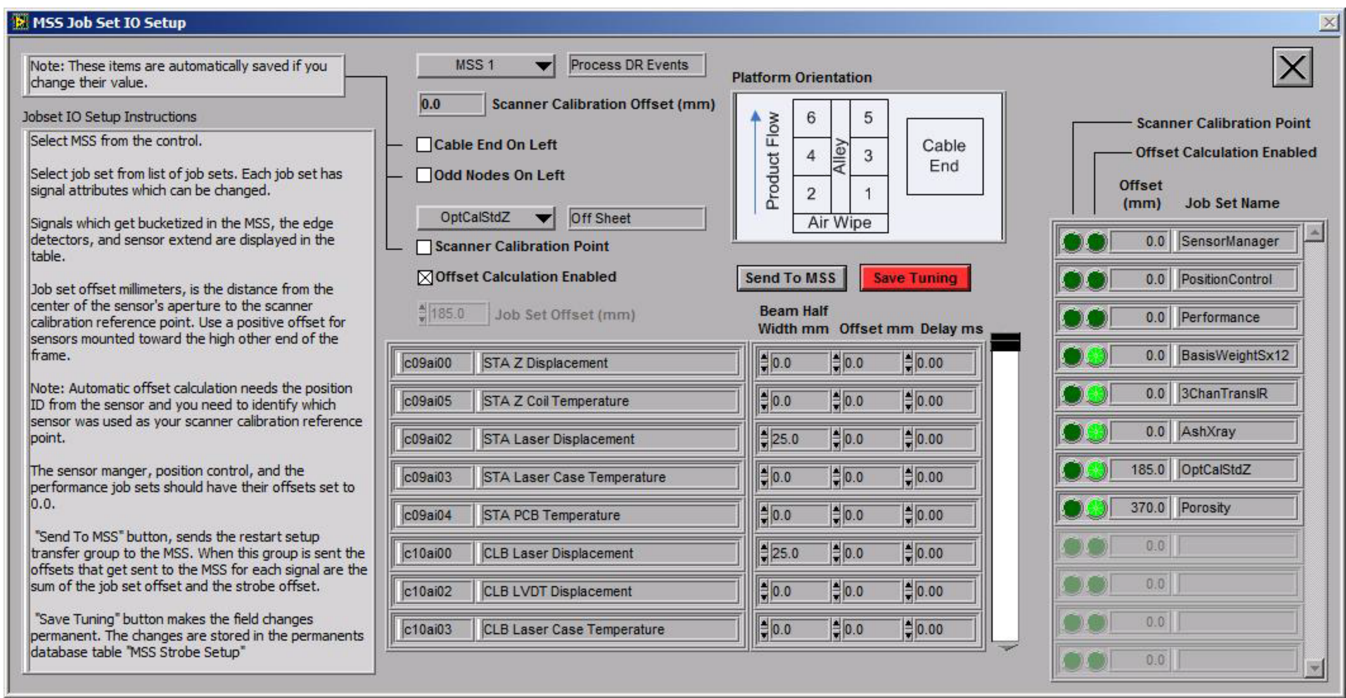


Figure 4-33 MSS Job Set IO Setup Display (laser caliper: OptCalStdZ)

Under **Performance**, the **X CD** and **Y MD** axes **Beam Offset mm** must be set to be the same as for laser caliper (see Figure 4-34).

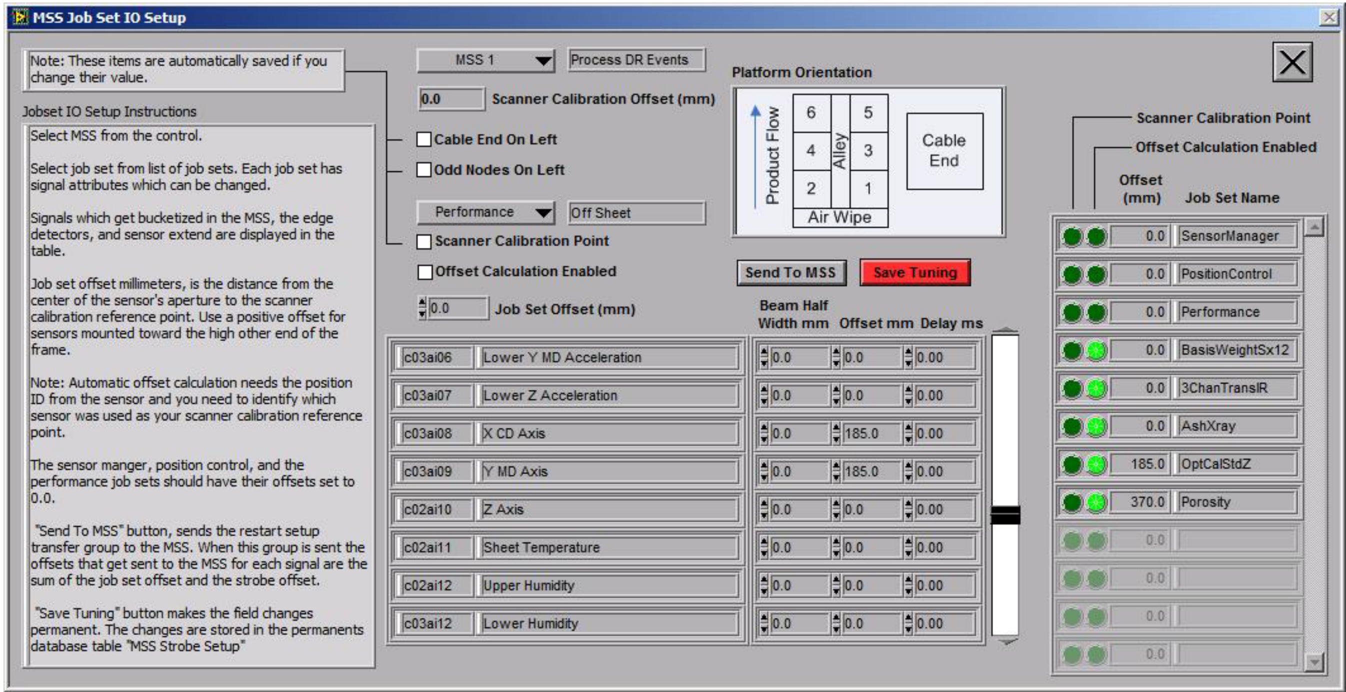


Figure 4-34 MSS Job Set IO Setup Display (laser caliper: Performance)

Additionally, Table 4-3 lists some parameters which should be checked in order to avoid errors. These are shown in Figure 4-35.

Table 4-3 Sensor Maintenance Settings

Setting	Display	Value	Comments
Phase Setup > Bkgd phases Phase Setup > Support Sensor Monitor> Bkgd phases	**Sensor Maintenance**	0	Laser caliper does not use a background phase. If one is requested an error will be produced.
Phase Setup > Check Limits, offsheet when bad, check drift limit Phase Setup > Support Sensor Monitor> Check Limits, offsheet when bad, check drift limit	**Sensor Maintenance**	Unchecked	At least during sensor set up these should remain unchecked to avoid problems. Once the sensor has been running stably for a period of time, it may be acceptable to check limits for the laser temperatures. It is unlikely that these temperatures would be driven too high by the temperature control circuit.

Figure 4-35 shows an example location of *Bkgd phase* and *Check limits* flags for laser caliper.

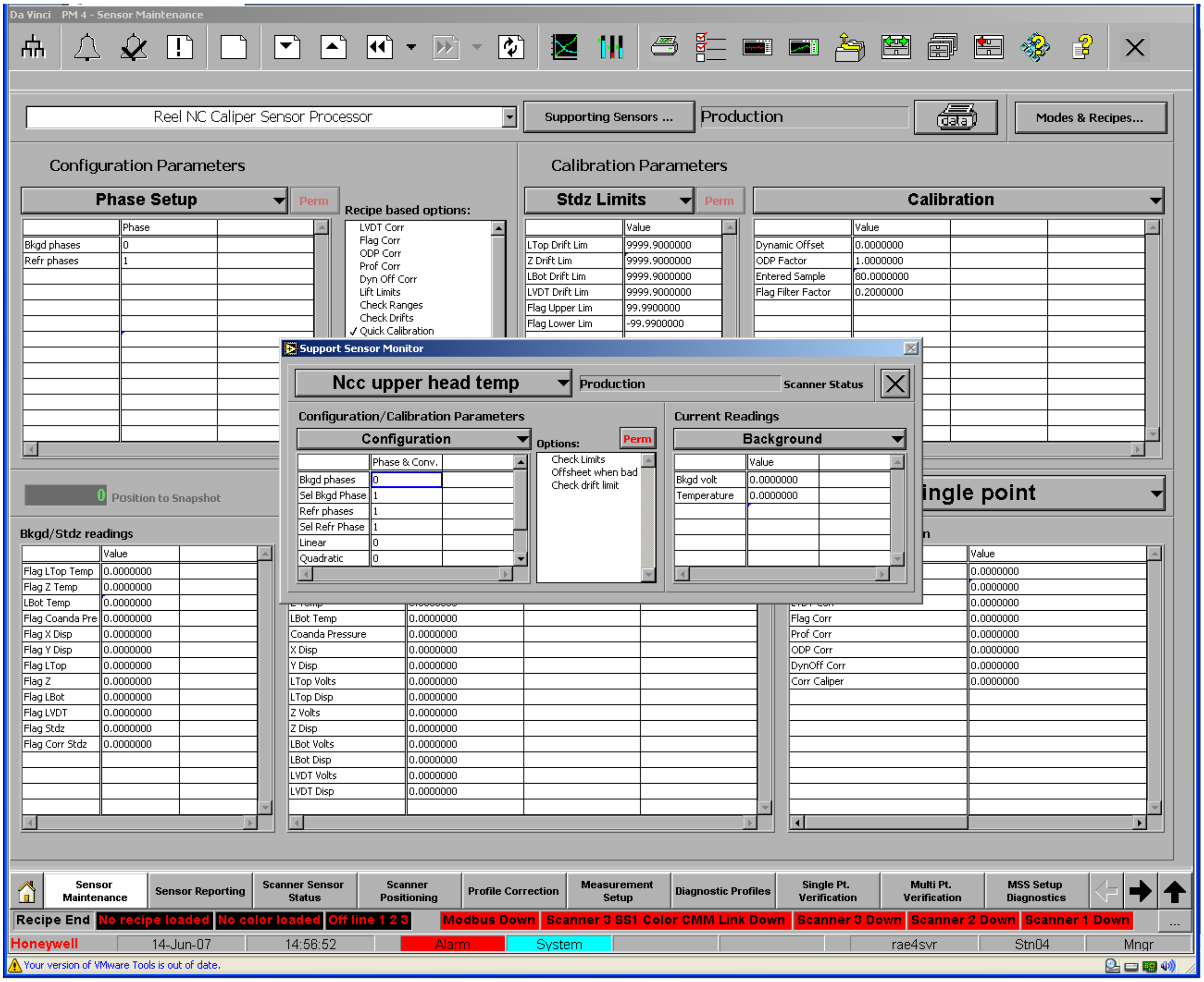


Figure 4-35 Da Vinci PM 4 - Sensor Maintenance Display: Support Sensor Monitor Dialog

4.9.1. Set Standardize and Alarm Limits

Recommended limits are listed in Table 4-4. The Coanda pressure alarm should be set after the Coanda flow has been optimized on-sheet for the alarm to indicate that flow has failed. It is difficult to set vacuum limits because the vacuum is only generated when the sheet is being drawn onto the vacuum slots.

Table 4-4 Recommended Limits

Signal	Standardize Limit	Offsheet When Bad
Lcl Coanda pressure x	2–10 psi	No
Lcl vacuum pressure x	Not applicable	No
Lcl sta pcb temp	10–65 °C (50–149 °F)	No
Lcl sta Z-coil temp	35–50 °C (95–122 °F)	No
Lcl sta laser temp	20–40 °C (68–104 °F)	Yes (high temperature will damage laser)
Lcl clb dome temp	Do not check range limits	No

Table 4-5 lists actions, time, and materials required to install and optimize the sensor.

Table 4-5 Installation Steps and Time Estimates

Step	Section	When	Time	Parts	Comments
Mechanically install gauge	4.1.2	Gauge arrival	1 hour	5 mm Allen key	Requires offsheet time for duration of action
Power-up and initial commissioning	4.1.3	Gauge arrival	0.5 hour	N/A	Requires offsheet time for duration of action
Check factory calibration	4.2	Gauge arrival	2 hours	White calibration target provided with system	Requires offsheet time for duration of action
Optimize XY corrector	4.3	Gauge arrival	2 hours	White calibration target provided with system	Requires 30 minutes of scanning on target then time for data analysis
Build profile correction	4.4	Gauge arrival	0.5 hour	White calibration target provided with system	Requires 15 minutes of scanning on target
Optimize dome position	4.6	Gauge arrival	0.5 hour	White calibration target provided with system	Requires 30 minutes of scanning on target
Air clamp flow optimization	4.7	First scans after install	0.5 hour	N/A	
Set static offset	4.8	First scans after install	2 hours	Paper sample	
Profile correction to lab data	4.6	At reel turn up	2 hours	Paper samples	Need lab analysis
Set limits and alarms	4.9.1		0.5 hours		

5. Preventive Maintenance

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

In Table 5-1, *X* indicates recommended maintenance intervals.

Table 5-1 Preventive Maintenance Internal Checklist

Procedure	Daily	Weekly	Months		Years			Task Details
			1	6	1	2	5	
Verify Head split Switch Functionality			X					Section 6.1.2
Clean Exterior Surfaces of STA and CLB Modules		X						Section 6.2.1
Clean Triangulation Laser			X					Section 6.2.2
Clean the Air Clamp Coanda Slots			X					Section 6.2.3
Clean the Vacuum Hardware			X					Section 6.2.4
Inspect Standardize Report		X						Section 6.3.1
Check Calibration			X					Section 6.3.2
Check Air Tubes and Air Pressures			X					Section 6.3.3

6. Tasks

This chapter contains procedures for maintaining optimal caliper function or troubleshooting issues with the sensor.

ATTENTION

Activity numbers that appear in the task description tables are for use on the **Sensor Diagnostics** display only and do not reflect model numbers for the tasks. To determine whether the task applies to your sensor, check *Applicable Models*.

If a value in the task description table is blank, that means it is not applicable to that task.

6.1. Interlock Related Tasks

6.1.1. Verify laser off

For most maintenance procedures the scanner heads must be split. While there is an interlock present, some precautions should be taken to ensure that there is no danger.

Activity Number:	Q4213-52-ACT-001	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	1 minute	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	

	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	Head split switch key		

WARNING

Do not look into the laser hole until it has been verified that there is no emission.

1. Turn off the laser key switch on the endbell and remove the key. See Figure 1-16.
2. Split the scanner heads. Check to ensure that there is no red emission from the laser triangulation sensor when a piece of paper is held in front of it. If emission is observed, put the heads back together. It is not safe to work on the split heads, and TAC should be contacted for assistance.
3. If there was no emission observed in Step 2, it is safe to proceed with the maintenance procedures.

6.1.2. Verify head split switch functionality

The scanner laser key switch is usually used to turn the laser off before splitting the heads. Periodically, it should be verified that the head split switch will also turn the laser off.

Activity Number:	Q4213-52-ACT-002	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	1 minute	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			

	Part Number	Quantity	Lead Time
Required Tools:	Head split switch key		

WARNING

Do not look into the laser hole until it has been verified that there is no emission.

1. Split the scanner heads without turning the laser keyswitch off.
2. Check to ensure that there is no red emission from the laser triangulation sensor when a piece of paper is held in front of it. If emission is observed, put the heads back together. It is not safe to work on the split heads, and TAC should be contacted for assistance.

6.1.3. Diagnose interlock open circuit

If the laser will not turn on as expected, the cause will either be a laser hardware issue or an interlock issue.

Activity Number:	Q4213-52-ACT-003	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	15 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	• White calibration target (6581100066) or piece of paper for scattering laser beam • digital multimeter (DMM)		

See Figure 1–13, a schematic of the interlock circuit.

1. Check that the scanner heads are aligned, the laser keyswitch is on, and the laser button has been pressed. If the pushbutton light does not remain on after having been pressed, there is an interlock issue.

2. On the **MSS Card IO Point Monitor** display, under **Job Set**, check that the **STA Laser Power** is shown as in Figure 6-1, or check the **Laser Power on** LED on the **Laser Caliper** display (both must indicate the same). If these lights are on, the issue is with the Q4000 side of the interlock; see Step 4.

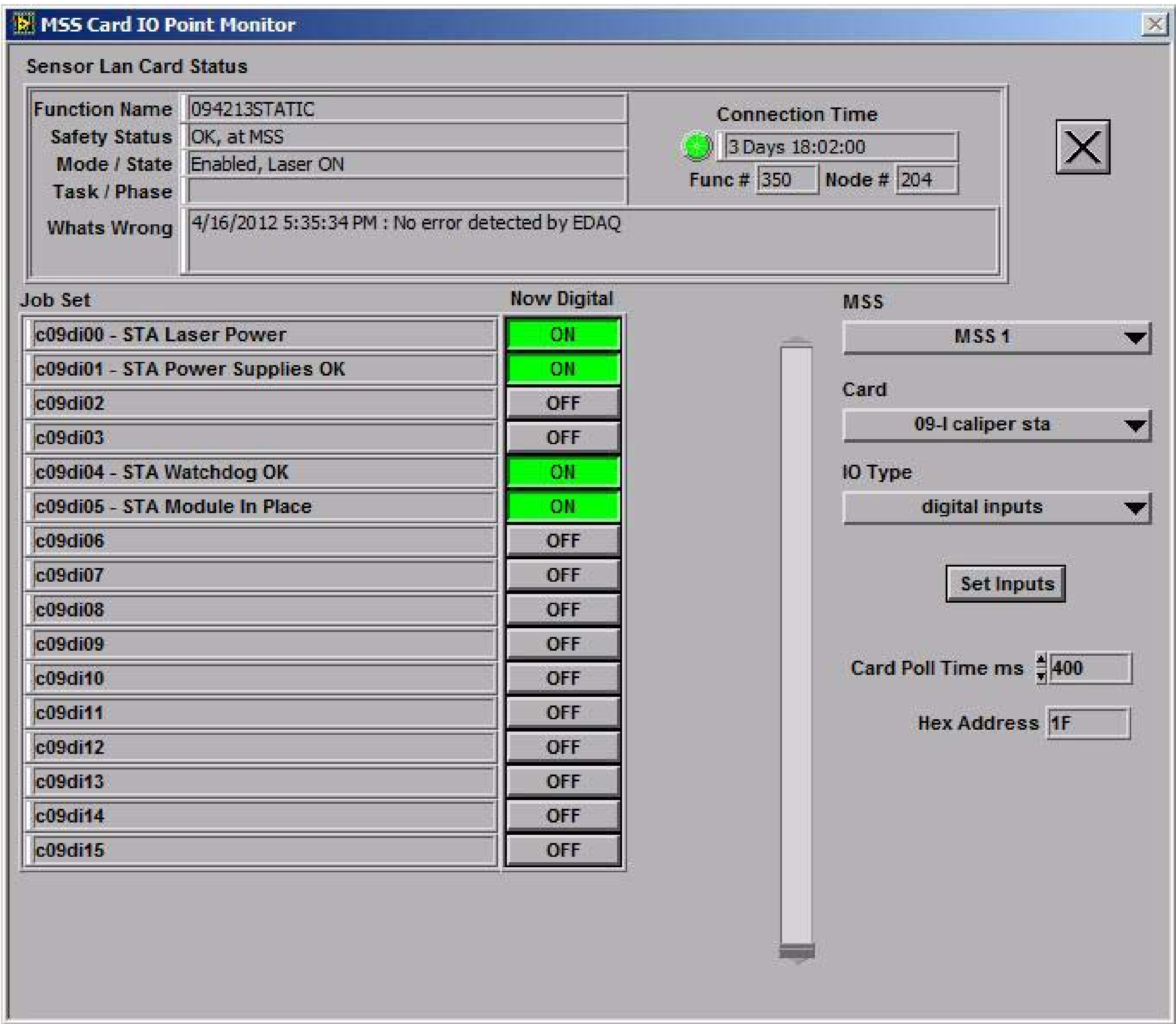


Figure 6-1 MSS Card IO Point Monitor

3. If the light is off, the issue is with the laser caliper side of the interlock. Check the **MSS IO Card Point Monitor** display, looking at the laser triangulation sensor digital input. The indicator for the head split switch **cxxdi05 - STA Module in place** must be on for the laser to go on. If it is not on:

   Ensure that the electrical harness is properly connected (the socket locking arms are engaged) and not damaged.

   Check that there is a jumper on J5 of the unused in-place switch of the STA interface PCBA (the jumper may be hardwired to the PCBA). J5 is beside J,1 which is the connector for the Z sensor.

   Ensure that there is a jumper on J8 of the CLB module interface PCBA (6581500046).

   Unplug the head split switch from STA module interface PCBA J7, and measure the resistance (when the heads are together). If it is > 50 Ω, the problem is that this switch is not being closed by the magnet. Insert the dome to LVDT ~ 0 V (the middle of the gap). If the switch still has a high resistance, replace it (see Replace head split switch).

   If these steps do not fix the problem, replace the interface PCBA (see Replace the Interface PCBA).

4. The Q4000 checks all the individual parts of the interlock before allowing the interlock PCBA to supply 24 V to the laser. This part of the system is most easily checked by clicking **What's Wrong** on the **MSS Monitor** display (see Alarm Based Troubleshooting). Re-initializing the MSS may be necessary to get the laser to power on.

5. If it seems that the interlock is fully functional, but the laser will not turn on (check with paper or target on the zirconia button), it is likely that the laser has to be replaced (see Replace laser triangulation unit).

6. If after following all these steps an *Interlock Board* error is still indicated by the MSS, inspect the harnesses to the Interlock PCBA (658080109) and replace if necessary. If this still doesn’t work, replace the Interlock PCBA, and then replace the EDAQ.

6.1.4. Diagnose laser that will not turn off

A laser that will not turn off is a serious safety problem. This is most likely to occur when the heads are split.

Activity Number:	Q4213-52-ACT-004	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	Head split switch key		

WARNING

If it is known that the laser does not turn off when the heads are split, only move the heads with respect to each other a small amount so that the laser is always projected onto the lower sheetguide.

Observe D4 on the STA module PCBA while moving the heads from the heads-aligned position to approximately 10 cm (4 in) split. It should toggle as the heads are split and re-aligned. Alternatively, unplug the head split switch from J7 and measure the resistance as the heads are split approx 10 cm (4 in) and put back together. When the heads are more than a few centimeters apart, the resistance should be > 100 kΩ. If the switch has failed, replace it (see Confirm Z-sensor failure). If the switch is functional, inspect all cable harnesses and PCBAs for damage, especially one that could cause a short circuit. If no obvious solution can be found, replace the STA module PCBA (see Diagnose dome movement problems).

6.2. Cleaning Tasks

6.2.1. Clean exterior surfaces

Contact between the air clamp of the CLB module and the sheet can cause the release of ash from the sheet, which can build up on the CLB module dome and the STA module dust cover. The buildup should be removed weekly at a minimum, or as required. Different environments in different mills can increase the frequency of cleaning required.

Activity Number:	Q4213-52-ACT-005	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Maintenance	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	none
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	Weekly
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:	Verify laser off before maintaining heads	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	Compressed air supply		

WARNING

Do not look into the laser hole until it has been verified that there is no emission.

Brush accumulated dust away from the keyhole of the STA module. Then use a compressed air supply held a minimum of 15.5 cm (6 in) away to blow the loose dust off of the CLB module dome and the STA dust cover. Use a dry cloth to wipe away the remaining dust.

ATTENTION

Be careful to not blow dust into the keyhole, if dust is inadvertently blown onto the laser window. If the window is dusted, it must be cleaned. When covering the exhaust, ensure the heads are first split.

6.2.2. Clean triangulation laser

Activity Number:	Q4213-52-ACT-006	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Maintenance	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	none
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:	Verify laser off Clean exterior surfaces Clean triangulation laser	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	• Allen key 1/8 and 5/64 in., • cotton-tipped swabs, • clean isopropanol		

WARNING

Do not look into the laser hole until it has been verified that there is no emission.

The laser window should be cleaned at every maintenance shutdown. First, split the scanner heads while following the laser safety precautions. To access the laser triangulation sensor window:

1. Remove the dust cover using a 1/8 in. Allen key.

2. Remove the three screws securing the centre keyhole insert using a 5/64 in. Allen key. Be careful to not drop the screws, they will affect the Z-sensor calibration if lost.

3. Carefully remove the insert.

To clean the optics:

ATTENTION

The window can be scratched or otherwise damaged if cleaned too frequently or if cleaning supplies are not completely dirt-free.

1. Blow dust off optics with clean compressed air (canned air is best).
2. Moisten a cotton-tipped swab with distilled water, shake off the excess, and gently roll over the window. Try to roll in a smooth motion so only the clean part of the swab is in contact with the window. A back-and-forth motion may push dirt around the surface or even scratch the window rather than cleaning it.
3. Repeat with isopropanol. Different solvents (water and alcohol) dissolve different contaminants. A combination is often best.
4. Inspect the surface to ensure there is no remaining dust.
5. Clean the keyhole insert before replacing it.
6. Carefully replace the keyhole insert.

6.2.3. Clean air clamp coanda slots

In some dirty mill environments, the slot can become partially obstructed. Aside from a visual inspection, this may be evident from an upwards drift in the plenum pressure.

Activity Number:	Q4213-52-ACT-007	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Maintenance	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:	Verify laser off	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			

	Part Number	Quantity	Lead Time
Required Tools:	Feeler gauge 50–100 µm (0.002–0.004 in.)		

WARNING

Do not disassemble the air clamp without instructions from Honeywell Engineering.

The simplest way to clean the slot is to use a feeler gauge (also called a gap gauge). A gauge in the range of 50 to 100 µm (0.002 to 0.004 in.) can be used. The gauge should be inserted into the slot and gently moved along the slot until it is clean. If it is particularly dirty, isopropanol may be used to dissolve any contaminants.

6.2.4. Clean vaccuum hardware

In some mill environments, ash or coating can be easily removed from the sheet by the air clamp. While the vacuum hardware is quite robust with respect to dust build-up, it is prudent to periodically clean it.

Activity Number:	Q4213-52-ACT-008	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Maintenance	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:	Verify laser *off*	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

WARNING

Do not reverse flow through the vacuum without splitting the scanner heads first. Failure to do so may result in dirt being deposited onto the laser triangulation sensor window. Do not apply more than 350 kPa (50 psi) air to the vacuum exhaust. If working with pressurized air, take appropriate safety precautions, including using eye protection.

1. Place a paper sample (or similar) on the air clamp and note the level of vacuum generated. Note the same with the sample removed. Dust buildup will either reduce the maximum vacuum that can be generated with the sample on the clamp, or it will increase the vacuum reading with no sample on the air clamp. The measurement can either be done looking at the Experion MX screen, or by measuring the PCBA test points. It should be possible to compare these values to earlier ones taken during sensor installation, or during previous shutdowns. If the values are not the same, cleaning should improve the vacuum levels.

2. Split the heads sufficiently that there is no hardware above the air clamp.

3. Block the vacuum exhaust. Ejected dust should be evident.

4. Re-measure the maximum and minimum vacuum levels. If the levels are not close to expected levels, it may be necessary to take further steps.

5. Note the pressure applied to the vacuum ejector at the vacuum manifold. Increase the pressure to maximum while periodically removing and replacing the sample from the air clamp, then turn the pressure off.

6. Apply pressurized air of no more than 350 kPa (50 psi) to the vacuum exhaust. Reset the pressure supply line to the original settings and again measure the maximum and minimum vacuum levels. If they are not as expected, partial disassembly of the pressure and vacuum tubing may be necessary for further cleaning.

6.3. Long-term Device Monitoring

6.3.1. Inspect standardize report

Inspect standardize reports weekly. Information that will be obtained includes the thermal stability of the temperature controlled devices, effects of build-up in the Coanda slots and the vacuum hardware, and drift issues with the displacement sensors. Print out and save reports, or use the HMX SQL utility to export them.

Activity Number:	Q4213-52-ACT-009	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	
Availability Required:	None	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	Weekly
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	Temperature-related Troubleshooting; Check air pressure and fittings Clean air clamp coanda slots Check calibration
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

Table 6-1 lists the important quantities in the standardize report. Additionally, it may be useful to use an external spreadsheet or mill information system to plot these values and graph them over time. Note that when the sensor is in the offsheet position, the vacuum should read close to zero. An upwards drift will indicate dirt build-up in the air clamp or the vacuum line.

Table 6-1 Expected Standardize Values

Standardize Report Item	Expected Value	Expected 2σ	Follow-up Tasks
Z Temp	(42 ± 2) °C	0.2 °C (0.4 °F)	Temperature-related Troubleshooting
STA Lsr Case Temp	(37.5 ± 2) °C	0.2 °C (0.4 °F)	
Coanda Pres 1	(40 ± 28) kPa (6 ± 4) psi	7 kPa (1 psi)	Check air pressure and fittings Clean air clamp coanda slots
Coanda Pres 2	(40 ± 28) kPa (6 ± 4) psi	7 kPa (1 psi)	
Vacuum Pres 1	(0 ± 3) kPa (0.0 ± 0.5) psi	1 kPa (0.2 psi)	Check air pressure and fittings
Vacuum Pres 2	(0 ± 3) kPa (0.0 ± 0.5) psi	1 kPa (0.2 psi)	
Uncorrected Flag	(0 ± 100) µm	20 µm	Clean triangulation laser Check calibration

6.3.2. Check calibration

Activity Number:	Q4213-52-ACT-010	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:	4.2.5 Calibration	**Post Procedures:**	Clean triangulation laser
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	Calibration target		

Calibrate regularly (see Section 4.2.5) to see if there are any device changes.

Alternately, calibrations can be performed if performance issues are noted as a troubleshooting measure. The calibrations can be easily checked to see if there has been a change in the device response. At a basic level, the slope and offset may exhibit a change. These changes can be examined more closely with the **LCal Compare Calibrations** display.

After each calibration has been performed, select **save sensor data to file**, but do not save the new calibrations to the recipe.

The slope from the new calibration should be compared to the calibration slope of the current and past calibrations. The slope should not change by more than 1 µm/mV. More detailed comparison can be made using the procedure described in Subsection 4.2.5.

If there are large changes, first ensure that the sensor temperatures at the time of calibration has not changed. If the laser calibration has changed, clean the laser triangulation sensor (see Clean triangulation laser).

If the Z-sensor calibration has changed, ensure that no changes have been made which might affect the Z-sensor reading. Anything conductive within approximately 50 mm (2 in) of the coil can affect the measurement.

Wire orientation, screw location, or dust cover changes or orientation can result in a changed measurement. Other changes, such as a change in electronics or a big change in scanner head temperatures, will also affect measurements.

You will need to decide whether to change the calibration or to reverse the changes made which affected the calibration. If it is necessary to change calibrations more than a few times without any apparent reason, it is a good idea to schedule a laser- or Z-sensor replacement.

6.3.3. Check air pressure and fittings

Problems with air fittings are most likely to be seen as a loss of air pressure or vacuum. Also, if a vacuum exhaust line leaks, ash will be visible inside the scanner head. If the pressure or vacuum readings drift, the issue is most likely dirt build-up; however, it is possible that a regulator could be faulty, or that the interface PCBA has failed.

Activity Number:	Q4213-52-ACT-011	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Maintenance	**Expertise Level:**	Technician
Priority Level:	Medium	**Cautions:**	
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time

Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

Check the air fittings, tubes, and pressures at every shutdown.

1. Visually inspect all of the tubing to ensure that there is no damage or evidence of pinching. Replace all damaged tubing.
2. Inspect the purge air flow. It should be possible to feel the air flowing from the keyhole slot, yet the flow should not be so high that the air flow can reduce the temperature of the laser or the Z coilform.
3. Inspect the fittings for evidence of air leakage.

6.3.4. Check gauge stability

Check the gauge stability regularly to confirm proper operation of the sensor. A noisy sensor can lead to increased measurement profile spreads.

Gauge stability must also be checked before attempting to calibrate the sensor.

Activity Number:	Q4213-52-ACT-012	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	1 month
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	Calibration Target (6581100066)		

To verify gauge stability, execute an appropriate number of repeated standardizes to ensure device measurement is sound:

1. Bring the scanner offsheet.
2. Check that the head, laser triangulation sensor, and Z-sensor temperatures are stable, at least ± 0.2 °C (1 °F) and ± 0.1 °C (0.5 °F) in 10 minutes for head and device temperatures, respectively.
3. Install the white calibration target, supplied with the system, on top of the air clamp. Adjust the vacuum pressure if necessary so that the sample is held solidly in place but not so much that it visibly drawn into the vacuum slots.
4. Place the scanner in maintenance mode, and do the repeatability test using the **Sensor Maintenance** display as shown in Figure 6-2.

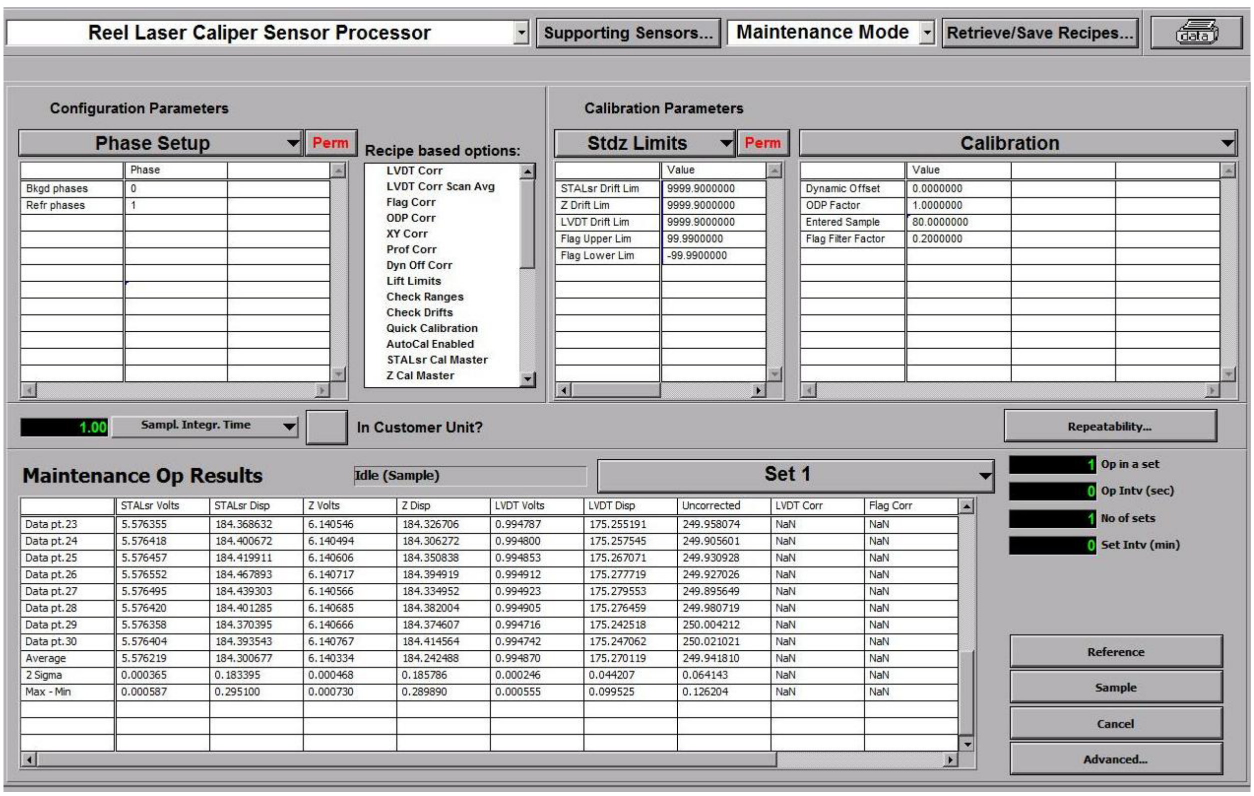


Figure 6-2 Repeated Sample Setup

5. Perform the test with the following parameter assignments:

Field	Value
Sampl. Integration time	1.0 seconds
Op in a set	30
Op Intv	0 seconds
No of sets	5
Set Intv	0 minutes

6. After the sampling is complete, verify that the 2-sigma repeatability of the LCAL (**Uncorrected**) measurement is 0.25 microns or better.

7. If the repeatability does not meet the criteria, repeat the test, paying special attention to the Z-sensor, laser, and head-temperature stabilities (to troubleshoot problems with these, see Temperature-related Troubleshooting). If the test fails repeatably, the cause may be due to a calibration which has changed (see Check calibration) or a noisy device (compare the spread of the laser to that of the z sensor, if one has a significantly larger spread, it may be failing) or PCBA (see Inspect PCBAs and harnesses).

8. It is useful to keep track of repeatability with time. If the repeatability is getting worse with time, it may mean that hardware is beginning to fail. The components most likely to cause bad repeatability are the laser displacement sensor and the PCBA.

The sensor repeatability depends on the integration time. Table 6-2 lists expected repeatability values for the sensor at various integration times from 50 ms to 16 seconds. Note that at short integration times, the repeatability is affected by electronic noise. At longer integration times the measurement is affected by thermal drift effects. Since most systems are set up to scan in times less than 30 seconds, repeatabilities of sampling on the order of (30 × 1 s) is the most important for measurement.

Table 6-2 Repeatability Criteria

Integration times (seconds)	0.05	1	16
2-sigma repeatability (µm)	0.30	0.25	0.35

6.4. Calibration and LUT Tasks

6.4.1. Install LVDT LUT file

In a new system, or in the event that an LVDT is replaced on-site, the corresponding LUT needs to be entered into Experion MX. The LVDT comes with a calibration LUT from the factory. Perform this task if an LVDT replacement occurred, or if you need to change the LVDT LUT for some other reason.

Activity Number:	Q4213-52-ACT-013	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Setup	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	Gauge Calibration – see Chapter 4
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Copy the LUT file, delivered with the LVDT, to the Experion MX server.

2. Navigate to the **Laser Caliper → LCAL Calibration Maintenance** display.

CAUTION

Check that there is a backup copy of the LUT currently being used. If there is not, create one using the **Store Trial Cal to Disk File** option.

3. Select **LVDT** as the signal, and select **Read Trial Cal from Disk File** from the **Source for Trial Cal** drop-down arrow (see Figure 6-3).

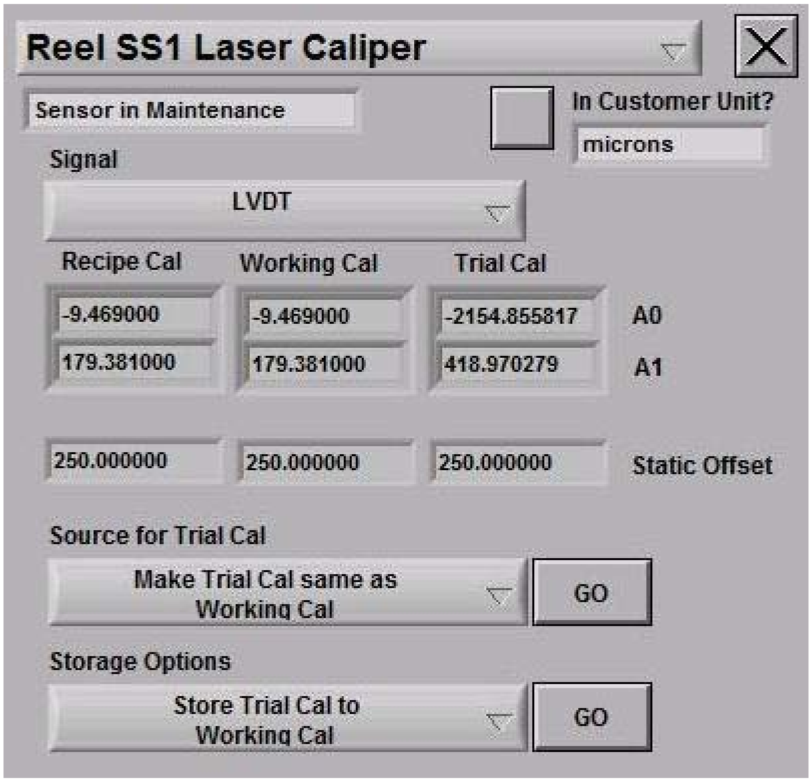


Figure 6-3 Entering an LUT for LVDT

4. In the **Trial Cal** column, new **A0** and **A1** that appear as the contents of the text file are read into the RTDR. At this point, the calibration is not yet active, it is a trial for review.

5. To use the calibration, it must be stored in the system. Under **Storage Options**, select the appropriate storage locations, typically **Store Trial Cal to Working & Recipe Cal**. Be aware that an LUT stored only to **Working** will be overwritten by the contents of the recipe if the grade is reloaded.

ATTENTION

> If the LVDT was replaced, and the LVDT LUT changed, it is strongly recommended that the gauge be re-calibrated (see Chapter 4).

6.4.2. Create new Z-sensor and Laser Triangulation Sensor LUTs

After a satisfactory gauge calibration is obtained, it is necessary to create and store, in the recipe, the LUT files for the Z-sensor and the laser triangulation sensor.

Activity Number:	Q4213-52-ACT-014	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Setup	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	10 min	**# of People Required:**	1
Prerequisite Procedures:	Gauge calibration (see Chapter 4)	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

To create and load an LUT for the Z-sensor or the laser:

1. Put the scanner in maintenance mode to ensure that the calibration update will apply to all relevant grades (after the grade is re-loaded).
2. Navigate to the **Laser Caliper → LCAL Calibration Maintenance** display.
3. Select the signal (Z or laser) for the calibration update. After a calibration has been performed, the operations to load individual device calibrations into the RTDR have to be repeated for each device. The reason for this is that if only a single device is thought to require updating, the calibration for that device can be updated without forcing an update for the other device.

4. Under **Source for trial cal,** select **Generate Trial Cal from Raw Data File**. The dialog box shown in Figure 6-4 appears.

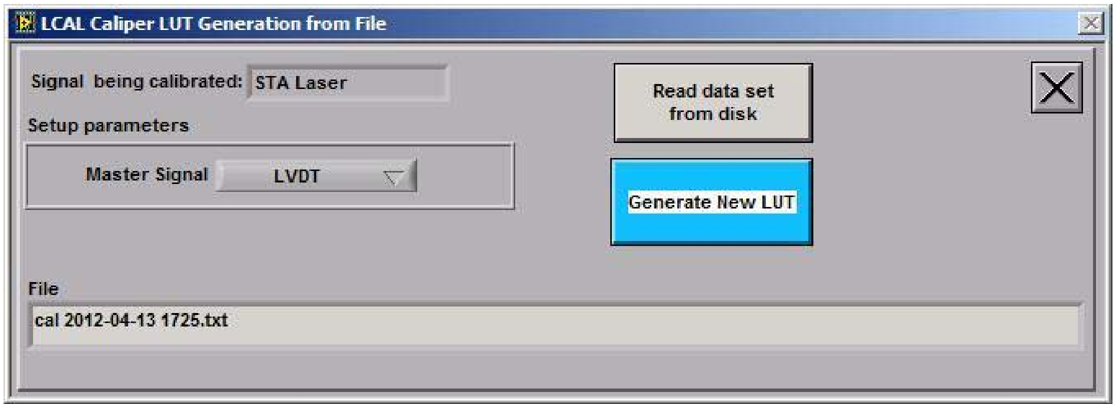


Figure 6-4 LCAL Caliper LUT Generation From File

5. Selecting **Read data set from disk** opens a dialog box from which raw calibration files can be identified. The selected file appears in the **File** field.

6. Select the correct **Master Signal** from the drop-down arrow. This is usually the LVDT.

7. Click **Generate New LUT**. A graph appears similar to the one in Figure 6-5. The graph expresses the nonlinearity of the device (not the error, as labeled in the image). If the nonlinearity is very large, adjust the limits for the calibration fit (see Chapter 4).

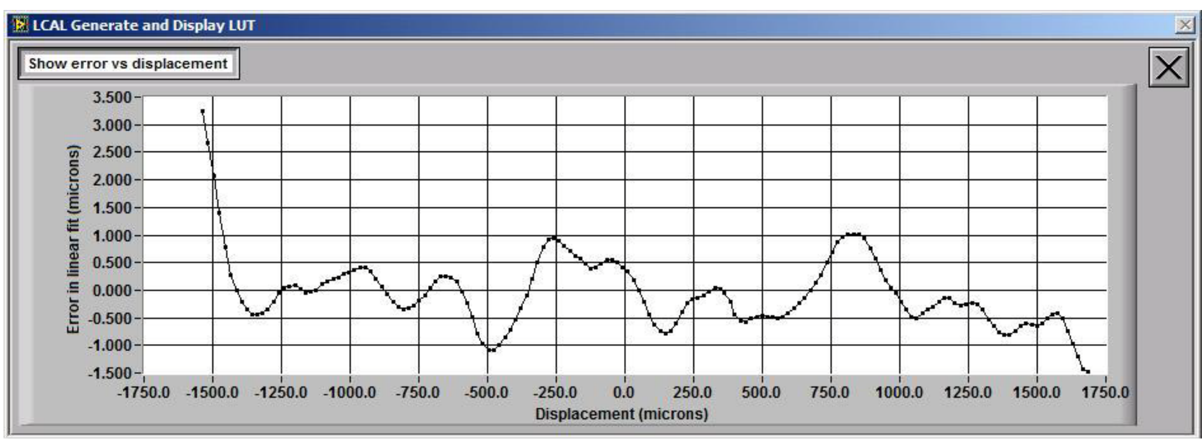


Figure 6-5 LCAL Generate and Display LUT

8. Entering new calibrations will affect the absolute caliper readings. Pressing the **Auto-adjust Trial Cal** offset button will make the new average caliper value agree with the existing one. If an additional change is required, the adjustment can be entered in the additional offset to apply to the **Trial Cal** box.

9. In the **Trial Cal** fields in the upper right corner of the display, the **A0** and **A1** constants are updated (see Figure 6-6). To accept these constants for measurement, under **Storage Options** select the appropriate storage locations, typically **Store Trial Cal to Working & Recipe Cal**. Be aware that an LUT stored only to **Working** is overwritten by the contents of the recipe if the grade is reloaded.

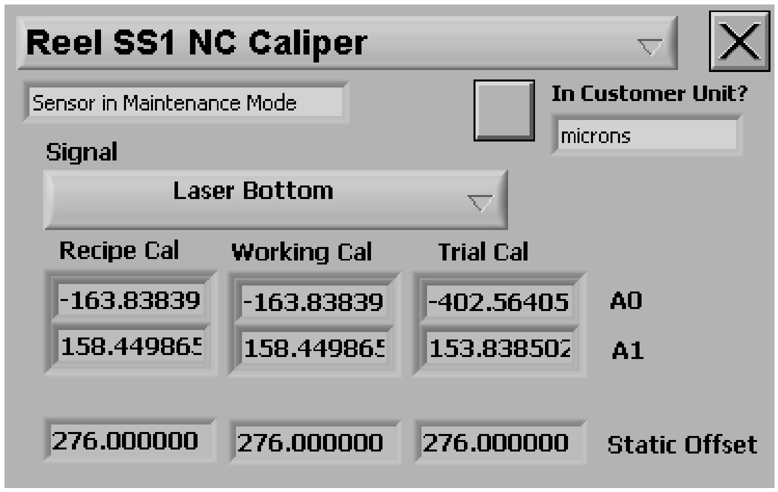


Figure 6-6 Trial Cal Fields Updated

10. If storage to the recipe is included in the selection, a prompt appears to select which pointers should be associated with this LUT. If the calibrations are grade independent as is usually the case, select the **apply to all** check box, otherwise, select the appropriate pointers (see Figure 6-7).

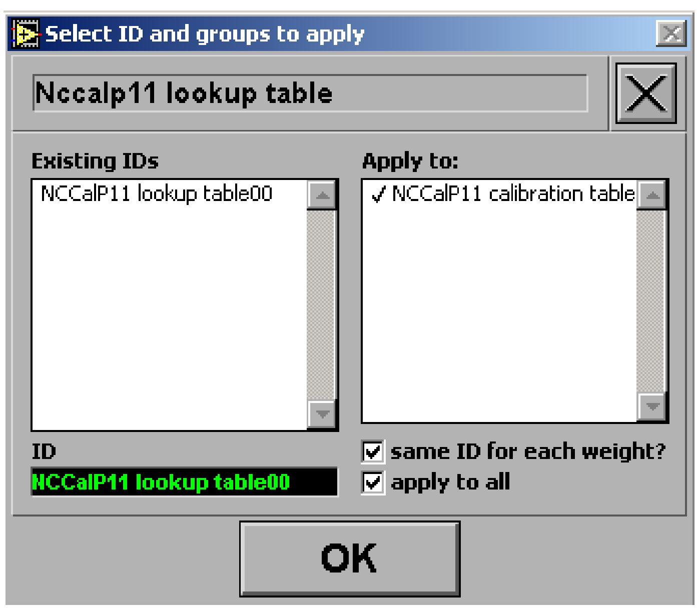


Figure 6-7 Select ID and groups to apply

11. After the LUT has been entered into the recipe, the **A0** and **A1** parameter fields also reflect the update.

12. Return the scanner to production mode, and re-load the grade. Verify that the proper A0 and A1 appear in both the **Recipe Cal** and **Working Cal** fields. **Working Cal** fields are what the sensor will use when it is making production measurements. If the working values are not the expected A0 and A1, repeat Steps 3–11, but this time in production mode. This will update the working values.

6.5. Diagnose Alarms

6.5.1. Diagnose MSS alarms

Activity Number:	Q4213-52-ACT-015	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	None	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

A brief description of the error appears on the **Alarm** page, or by going to the **MSS Monitor** display and clicking on the **What's Wrong** button (see Figure 6-8). This message can also be seen on the **MSS Summary** page.

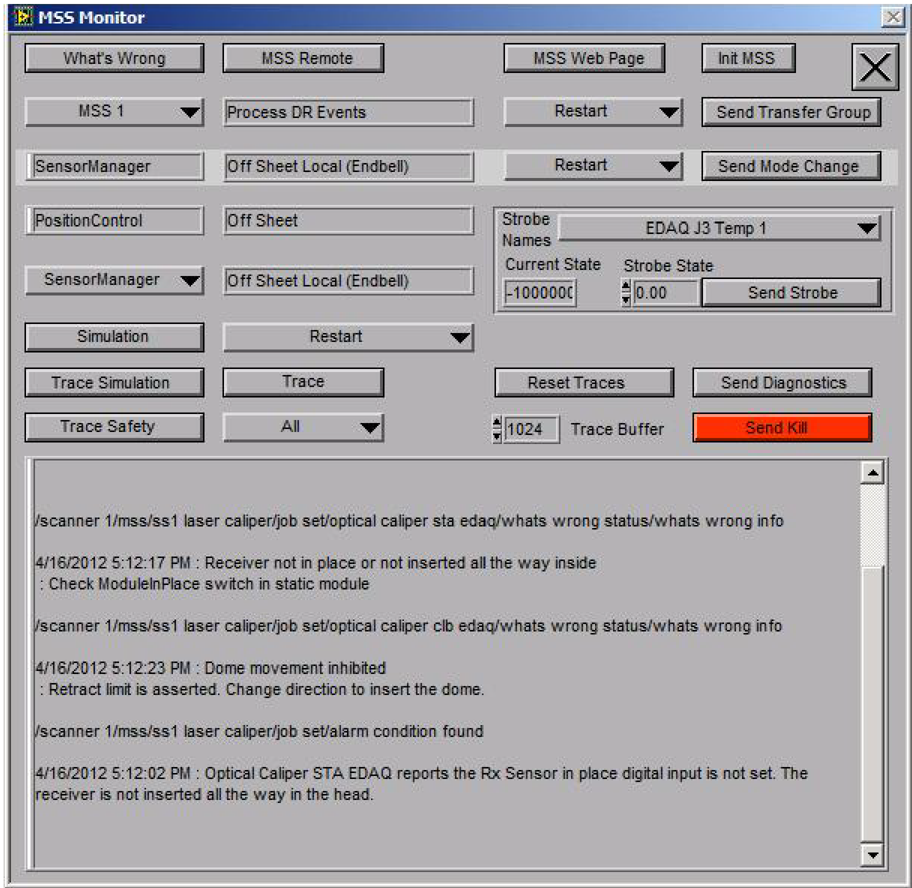


Figure 6-8 MSS Monitor Display

The possible alarms and associated troubleshooting are described in Section 7.1.

6.6. Temperature-related Troubleshooting

6.6.1. Check laser temperature control

Activity Number:	Q4213-52-ACT-016	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	5 minutes	**# of People Required:**	1

Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	DMM		

The laser case temperature is held at approximately 36 °C (97 °F) by a TEC (see Subsection 1.2.2.2). A signal level of 1.22 to 1.26 V is expected. Field site stabilities have been demonstrated to better than ± 0.05 °C (< 0.5 °F) for this control system. Up to ± 0.1 °C (0.5 °F) is acceptable.

Troubleshooting can be performed using the LEDs, and the indicators on the **MSS IO Point Monitor** display. You can see if the power supplies are generating enough voltage. One or both of the heating/cooling LEDs should be on.

1. Examine the power supply LED on the PCBA D5. If it is not fully on, it is likely that the PCBA should be replaced (see Replace the Interface PCBA), or that there is a short circuit which may be diagnosed through inspection. If D11 and D12 are periodically flashing in unison, this is also an indicator that the PCBA should be replaced.

2. Verify that the TEC and the thermistor are properly connected to the PCBA, then unplug them and, using a DMM, ensure that there is not an open or short circuit when measuring across the connector pins (J8 and J10). Power to the control circuit will be cut off when the thermistor is unplugged.

3. If both the heating and cooling LED indicators are off, disconnect the power cable to the PCBA and re-power it. This circuit has an emergency power off. If the thermistor is unplugged or short-circuited, the power to the TEC circuit will be cut off. Re-powering will re-initialize the circuit (disconnect and re-connect J2).

6.6.2. Check Z-sensor temperature control

Activity Number:	Q4213-52-ACT-017	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	

Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

The Z-coil temperatures are held at approximately 40 °C (104 °F) by a pair of TECs connected electrically in series. The TECs are sandwiched between the Z-coil and an aluminum heat sink. Field site stabilities have been demonstrated to better than ± 0.1 °C (0.2 °F) for this control system. The most common cause for failure is a broken TEC.

Troubleshooting can be performed using the LEDs, and the indicators on the **MSS IO Point Monitor** display. It can be observed if the power supplies are generating enough voltage. One or both of the heating and cooling LEDs should be on.

1. Examine the power supply LED on the PCBA D13. If it is not fully on, it is likely that the PCBA should be replaced (see Replace the Interface PCBA), or that there is a short circuit which may be diagnosed through inspection. If D19 and D20 are periodically flashing in unison, this is also an indicator that the PCBA should be replaced.

2. Verify that the heater and thermistor are properly connected into the PCBA, then unplug them and, using a DMM, ensure that there is not an open or short circuit when measuring across the connector pins (J3 and J6). Note that power to the control circuit will be cut off when the thermistor is unplugged. Also note that there are two thermistors on the Z-coil, and they should have similar resistances. Use Table C-1 (in Appendix C) to calculate if the voltage outputs indicate similar temperatures. If a thermistor is damaged, the Z-coil should be replaced (see Replace Z-sensor). However, it is possible to operate the sensor by exchanging the wires for the two identical thermistors (the thermistor used for temperature control is connected to J3, pins 3 and 4).

3. Verify that the thermistor and TEC leads are in proper condition. If a wire is damaged it can be easily fixed by soldering on a bypass wire.

4. If both the heating and cooling LED indicators are off, disconnect the power cable to the PCBA and repower it. This circuit has an

emergency power cutoff. If the thermistor is unplugged or short circuited, the power to the TEC circuit will be cut off. Re-powering will fix the issue.

5. Try reducing or eliminating the laser triangulation sensor air purge flow temporarily. An instance has been found of there being too much cold air flow for the coilform to reach its setpoint.

6. Measure the voltage applied to the TECs. This should be in the range of 2–10 V. The maximum voltage is 11.5 V, which would indicate maximum (probably uncontrolled) heating or cooling.

6.7. Diagnose and Replace Failed Hardware

6.7.1. Replace laser thermistor

Activity Number:	Q4213-52-ACT-018	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner Power Off	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	• Thermistor Ass'y, 30 K • Static Module p/n 6581800233 • Thermal Joint Compound p/n 6530200009		
	Part Number	Quantity	Lead Time
Required Tools:	• Allen keys: 9/64, 1/8, 3/32, and 1/16 in. • Phillips Screwdriver: #1 • Wrench: 7/16 in.		

CAUTION

The laser triangulation device is static-sensitive. Adequate anti-static precautions must be taken before disconnecting the laser from the interface PCBA. A properly grounded conductive wrist strap must be worn.

1. See Appendix D assembly drawing.
2. Turn scanner power off. Disconnect the Z-sensor electronics control box (item 48 Figure D-5) from static module interface PCBA (item 31) and remove the connector leading from the coilform to the electronic box.
3. Loosen the two 1/4 in. bolts (item 38) using a 7/16 in. wrench, and remove the Z-sensor electronics box and bracket.
4. Using a 1/16 in. Allen key, remove the 4-40 button screw (item 15) and the retainer clip (item 11) from the laser cover.
5. Disconnect the two TEC connectors, two thermistor leads, and the laser connector from the static module interface board (item 31).
6. Disconnect the 4-mm tube from the purge block assembly (item 29).
7. Using a 3/32 in. Allen key, remove the four 4-40 socket head cap screws holding the laser cover (item 10) to the sensor baseplate (item 33).
8. Carefully pull the cover up, and thread the wires passing through its openings until it clears the laser (item 41) and the thermal insulation (item 8).
9. Unscrew the damaged thermistor (item 51) from the heat sink (item 5). Replace with new thermistor after applying thermal joint compound to the threads.
10. Repeat Steps 1–8 in reverse order to re-assemble the sensor.
11. As the true control temperature will change with thermistor, re-calibrate the sensor (see Chapter 4).

6.7.2. Replace dome thermistor

Activity Number:	Q4213-52-ACT-019	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner Power Off	**Reminder Lead Time:**	

Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	Thermistor Ass'y, 30 K, Cal Module p/n 6581800232 Thermal Joint Compound p/n 6530200009		
	Part Number	Quantity	Lead Time
Required Tools:	Allen keys and Adjustable Wrench		

1. See Appendix D assembly drawing.
2. Unplug the damaged thermistor assembly from the PCBA.
3. Remove the dome (item 6) from the dome body (item 9) by removing the three socket head screws (item 39).
4. Unscrew the damaged thermistor (item 38) and replace after applying thermal joint compound to the threads.
5. Replace the dome and plug the connector into the PCBA.

6.7.3. Check laser operation

Activity Number:	Q4213-52-ACT-020	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:	Verify laser *off*	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

If the laser caliper sensor produces a constant reading, or if the laser displacement sensor reading is always 0 or 10 V:

1. Check that the laser power head split LED (D4) is lit on the interface PCBA. If not, see Section 6.1.

2. Verify the Experion MX measurement by measuring the appropriate test point (TP6) on the interface PCBA. If the signals do not correspond, investigate the electrical connections and the EDAQ.

3. Remove the keyhole plate, clean the optics, and inspect for dirt. If there is no obvious dirt, check if there is a normal signal when the sensor is reassembled with the keyhole removed. If removing the keyhole fixes the problem, this may be an indication that the laser power may be dropping and that a complete failure is imminent. If this does not fix the problem, go to Step 4.

4. Check that there is laser emission. Split the scanner heads and put the calibration target or piece of white paper on the zirconia button and ensure that it is held in place with the vacuum. Put the heads back together, and ensure that the endbell laser indicator is lit. Look in the gap for the red laser emission.

5. If none of these steps solve the problem, the laser should be replaced.

6.7.4. Replace laser triangulation unit

Activity Number:	Q4213-52-ACT-021	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner Power Off	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	30 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	• Laser Assembly p/n 6581800245 • Thermal Joint Compound p/n 6530200009		

	Part Number	Quantity	Lead Time
Required Tools:	• Allen keys: 9/64, 1/8, 3/32, and 1/16 in. • Phillips Screwdriver: #1 • Wrench: 7/16 in.		

CAUTION

The laser triangulation device is static-sensitive. Adequate anti-static precautions must be taken before disconnecting the laser from the interface PCBA. A properly grounded conductive wrist strap must be worn.

1. See Appendix D assembly drawing.

2. Turn scanner power off. Disconnect the Z-sensor electronics control box (item 48) from static module interface board (item 31) and remove the connector leading from the coilform to the electronic box.

3. Loosen the two 1/4 in. bolts (item 38) using a 7/16 in. wrench, and remove the Z-sensor electronics box and bracket.

4. Using a 1/16 in. Allen key, remove the 4-40 button screw (item 15) and the retainer clip (item 11) from the laser cover.

5. Disconnect the two TEC connectors, two thermistor leads, and the laser connector from the static module interface board (item 31).

6. Disconnect the 4 mm tube from the purge block assembly (item 29).

7. Using a 3/32 in. Allen key, remove the four 4-40 socket head cap screws holding the laser cover (item 10) to the sensor baseplate (item 33).

8. Carefully pull the cover up, and thread the wires passing through its openings until it clears the laser (item 41) and the thermal insulation (item 8).

9. Using a 9/64 in. Allen key, remove the two 8-32 socket head cap screws (item 26), and the heat sink (item 9) from the sensor baseplate (item 33).

10. Using a #1 Phillips screwdriver, remove the two 2-56 machine screws (item 44) from the side of the laser insulation (item 8).

11. Using a 1/8 in. Allen key, remove the four 10-32 socket-head flat screws (item 19) holding the dust cover in place (item 13).

12. Using a #1 Phillips screwdriver, remove the three 2-56 screws (item 3) that hold the laser cooling bracket (item 5) to the ceramic Z-coilform (part of item 48).

13. Carefully remove the laser (item 41), and the laser cooling bracket (item 5), from the assembly.

14. Using a 3/32 in. Allen key, remove the two 8-32 shoulder bolts (item 6) holding the laser (item 41) to the cooling bracket (item 5).

15. Remove the old laser assembly.

16. Prepare to install the new laser assembly (item 41) by removing any stickers that may be present on the side that will mate to the cooling bracket. Insure that the surface is clean prior to applying a thin layer of thermal joint compound (item 47) to each of the mating surfaces.

17. Repeat Steps 1–14 in reverse order to re-assemble the sensor.

18. Re-calibrate the sensor (see Chapter 4).

6.7.5. Confirm Z-sensor failure

Activity Number:	Q4213-52-ACT-022	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Sensor offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	5 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

A Z-sensor failure would be evidenced by lack of sensible signal from the Z-sensor. Verify all connectors from the Z-coil to the electronics box to the STA PCBA are properly connected.

Visually inspect the device, paying particular attention to where the electrical connections emerge from the Z-coil. Ensure that the cable is intact. Ensure that there are no cracks in the coil. The coil is brittle and could be broken by over-tightening the screws, or by dropping it.

A sample calibration can be performed to examine Z-sensor performance (compare it against historical data).

6.7.6. Replace Z-sensor

Activity Number:	Q4213-52-ACT-023	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Sensor offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	45 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	• Terminated Z-sensor assembly p/n 6581800226 • Shim Guide, Static Module p/n 6581700326 • Thermal Joint Compound p/n 6530200009		
	Part Number	Quantity	Lead Time
Required Tools:	• Allen keys: 9/64, 1/8, 3/32, and 1/16 in. • Phillips Screwdriver: #1 • Wrench: 7/16 in.		

1. See Appendix D assembly drawing.
2. Disconnect the Z-sensor electronics control box (item 48) from the STA module interface board (item 31), and remove the connector leading from the coilform to the electronics box.
3. Loosen the two 1/4 in. bolts (item 38) using a 7/16 in. wrench, and remove the Z-sensor electronics box and bracket.
4. Using a 1/16 in. Allen key, remove the 4-40 button screw (item 15) and the retainer clip (item 11) from the laser cover.

5. Disconnect the two TEC connectors, two thermistor leads, and the laser connector from the STA module interface board (item 31).

6. Disconnect the 4-mm tube from the purge block assembly (item 29).

7. Using a 3/32 in. Allen key, remove the four 4-40 socket head cap screws holding the laser cover (item 10) to the sensor baseplate (item 33).

8. Carefully pull the cover up, and thread the wires passing through its openings until it clears the laser (item 41) and thermal insulation (item 8).

9. Using a 9/64 in. Allen key, remove the two 8-32 socket head cap screws (item 26) and heat sink (item 9) from the sensor baseplate (item 33).

10. Using a #1 Phillips screwdriver, remove the two 2-56 machine screws (item 44) from the side of the laser insulation (item 8).

11. Using a 1/8 in Allen key, remove the four 10-32 socket head flat screws (item 19) holding the dust cover in place (item 13).

12. Using a #1 Phillips screwdriver, remove the three 2-56 screws (item 3) that hold the laser cooling bracket (item 5) to the ceramic Z-coilform (part of item 48).

13. Carefully remove the laser (item 41) and the laser cooling bracket (item 5) from the assembly.

14. Remove the four 6-32 machine screws (item 22) sandwiching the Z-coilform (part of item 48), the Z-coil TECs (item 32), the coilform spacer (item 4), the four flat washers (item 2), and the shim guide (item 1) between the coilform ring (item 20) and the sensor baseplate (item 33).

15. Remove the ceramic coilform assembly and replace it with the new assembly.

16. Attach the new shim guide (item 1) to the new coilform. Use the old coilform as an example.

17. Apply thermal joint compound to each of the mating surfaces of both the TECs (item 32) and the new coilform, as well as the mating surfaces on the sensor baseplate (item 33).

ATTENTION

Orientation of the TECs must be with the smaller side in contact with the coilform.

18. Repeat Steps 1–14 in reverse order to re-assemble sensor.

19. Re-calibrate the sensor (see Chapter 4).

6.7.7. Replace the Z sensor TEC assembly

Activity Number:	Q4213-52-ACT-024	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Sensor offline	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	45 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	• Thermoelectric cooler assembly p/n 6581800242 • Thermal Joint Compound p/n 6530200009		
	Part Number	Quantity	Lead Time
Required Tools:	• Allen keys: 9/64, 1/8, 3/32, and 1/16 in. • Phillips Screwdriver: #1 • Wrench: 7/16 in.		

1. See Appendix D assembly drawing.

2. Disconnect the TEC connector J6 from the STA module interface board (item 31).

3. Using a 3/32 in. Allen key, remove the four 4-40 socket head cap screws holding the laser cover (item 10) to the sensor baseplate (item 33).

4. Carefully pull the cover up, and thread the wires passing through its openings until it clears the laser (item 41) and thermal insulation (item 8).

5. Using a 1/8 in. Allen key, remove the four 10-32 socket head flat screws (item 19) holding the dust cover in place (item 13).

6. Loosen the four 6-32 machine screws (item 22) sandwiching the Z-coilform (part of item 48), the Z-coil TECs (item 32), the coilform spacer (item 4), the four flat washers (item 2), and the shim guide (item 1) between the coilform ring (item 20) and the sensor baseplate (item 33).

7. Apply thermal joint compound to the mating surfaces of both the new TECs (item 32).

8. Remove the TEC assembly and replace it with the new assembly.

ATTENTION

Orientation of the TECs must be with the smaller side in contact with the coilform.

9. Repeat Steps 1–14 in reverse order to re-assemble sensor.

6.7.8. Replace head split switch

Activity Number:	Q4213-52-ACT-025	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	Head split switch, static module p/n 6581800244		
	Part Number	Quantity	Lead Time
Required Tools:	• Phillips screwdriver: #1 • Allen keys: 1/8, and 3/32 in.		

1. See Appendix D assembly drawing.

2. Using a 1/8 in. Allen key, remove the four 10-32 socket head flat screws (item 19) holding the dust cover in place (item 13).

3. Using a 3/32 in. Allen key (or #1 Phillips screwdriver, depending on hardware used), remove the two 4-40 screws holding the head split switch (item 27) in place.

4. Disconnect the switch from the STA module interface board (item 31), and feed the cable through the opening in the laser cover (item 10)

5. Replace the old switch with the new one, and repeat Steps 1–3 in reverse order.

6.7.9. Diagnose dome movement problems

Symptoms of stepper motor damage can be erratic dome movement, an inability to reach the home position, repeated staging errors, or a complete inability to move. An inability to move can also be caused by an interface PCBA failure, a bad harness connection, bad values in the database, or a physical obstruction.

Activity Number:	Q4213-52-ACT-026	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:	Verify laser *off*	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

If the stepper motor does not run, the dome cannot move. This will cause MSS errors on the **Experion MX** display because the software will not be able to retract the dome to satisfy the retract switch at startup. To test the ability of the stepper motor to move, control the motor through the **MSS Setup Diagnostics** display, the **MSS IO Point Monitor** display, or the **LCAL Dome Contol** Display (see Section 2.6).

One way to confirm that the dome is actually moving is to verify that the signals of the laser triangulation sensor, the Z-sensor, and the LVDT all react, simultaneously, in a sensible fashion. Be sure to be outside the device deadbands to properly interpret signal levels.

Another way to diagnose dome movement issues is to physically examine the CLB Module at the scanner:

1. Inspect the sensor to ensure that there is nothing physically obstructing the movement of the dome or the translation stage (see Figure 1-5). Inspect the translation stage for signs of corrosion and wear. Also, ensure that the dome movement is not obstructed by the sheet guide by running a feeler gauge around dome, between the sheet guide and the dome. If the dome does not seem to be centered, loosen the four baseplate screws and re-center it. It is likely that before a mechanical issue causes a complete failure of dome movement, the issue will first be seen as calibration problems or staging errors.

2. Retract the dome using the **LCAL Dome Control** display. The **Stepper Motor Retract Limit** should indicate ON.

   If the retract switch never engages even if the dome is at the end of its physical travel range, the stepper motor should be replaced (see Replace the stepper motor).

3. Verify as well that the dome can travel out of this position by using the **LCAL Dome Control** display to send ten thousand upward steps to the stepper motor. The **Insert Limit** should eventually display ON, and on physical inspection the dome should appear to be extended into the gap.

4. If dome motion was not observed during these attempts, verify that the stepper motor connector is firmly connected into J7 on the interface board.

5. If the dome moves but repeated staging errors are seen, then it is possible that component wear may be an issue (mechanical hardware or PCBA).

   It is possible to temporarily avoid staging errors by adjusting the dome movement database items.

   Increase the RTDR settings for *Max iterations to find position* and *position tolerance volt (./Mss/Ssx Laser Caliper/Setup/Staging iterations max* and */iterations).*

If the stepper motor does not move out of its home position on start up, or cannot find its staging voltage, or ends up at the insert limit, the problem may also be that the *../steps away from home* value is incorrect so that the on-sheet master device is measuring in its deadband, in which case the dome-height control feedback will not work as expected which may cause the dome to not find its target voltage (see Section 2.8.1).

6. Verify that the harness linking the interface board to the EDAQ PCBA (6580801795) is properly installed by ensuring that the locking arms of the connectors are fully engaged. Dome motion requires a combination of functions from both the EDAQ PCBA and the interface card.

7. If the sensor does not pass all these tests, it is likely that the stepper motor or the interface PCBA has failed. Some troubleshooting of the CLB interface PCBA can be done by observing the LEDs during requested dome movement (see Table 1-1).

ATTENTION

It is not considered a large problem if staging errors are seen only occasionally, especially during calibration. However, if these errors are seen repeatedly, it may be a sign that hardware will fail. The exact cause should be determined and part replacement scheduled.

6.7.10. Replace the stepper motor

Activity Number:	Q4213-52-ACT-027	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Honeywell Expert
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner power off	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	20 minutes	**# of People Required:**	1
Prerequisite Procedures:	Diagnose dome movement problems	**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	Stepper motor assembly Laser caliper sensor–comprehensive gauge test		

	Part Number	Quantity	Lead Time
Required Tools:	Allen keys: 5/32 in. Wrench: 11/32 in.		

1. See Appendix D assembly drawing while removing and replacing the stepper motor.
2. Disconnect the stepper motor and stepper motor home switch from the calibration module interface board (item 42).
3. Remove the hex nut (item 33) that secures the stepper motor shaft to the connector plate (item 4).
4. Using a 5/32 in. Allen key, remove the four 10-32 socket head cap screws holding the stepper motor bracket (item 41) to the laser caliper slide mount (item 1).
5. Remove the four 4-40 socket head cap screws (item 28) holding the stepper motor (item 23) to the stepper motor bracket (item 41).
6. Replace the stepper motor assembly and repeat Steps 1–4 in reverse order.
7. Re-set the home switch while referring to Section 4.5 of *Laser Caliper Sensor – Comprehensive Gauge Test*, p/n 6510030134.
8. Re-adjust the *steps away from home* (see Replace LVDT).

6.7.11. Inspect PCBAs and harnesses

It is often necessary to electrically troubleshoot the system. For this reason electrical test points and diagnostic LEDs are provided on the interface PCBAs.

Activity Number:	Q4213-52-ACT-028	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner Offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	20 minute	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	

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

1. Inspect the PCBA LEDs. For the CLB interface PCBA (6581500046), the most likely failures are power supply or stepper motor failures. The relevant LEDs are listed and described in Table 1-1. It may be necessary to have a second person send commands to the stepper motor to diagnose any issues with dome movement. For the STA interface PCBA (6581500045), the most common failures will be the temperature control circuits, and the power supplies. The relevant LEDs are listed and described in Table 1-2. For the temperature control circuits, D5 and D13 should always be on, and either or both of R80 and R81 should be on, and either or both of D19 and D20 should be on. In all cases, rapidly flashing LEDs indicates a failure. Note that if the circuit detects an open or short circuit on J3 or J8, the temperature control circuit will be shut down and the connectors must be detached and reconnected for normal function to resume.

2. Inspect harnesses for damage and for proper connection to the PCBAs.

3. Check jumper settings and connectors. On the STA interface PCBA (6581500045), J5 should have a jumper installed and J11 should not. All other plugs should have a connector installed. On the CLB interface PCBA (6581500046), there should be a jumper on J8 and none on J9 or J10. All other plugs should have connectors installed. There are two vacuum line and two pressure line connectors, the tube should be attached to the sensor nipples and the tubes should be not kinked.

4. If the electrical issues cannot be traced to one of the devices attached to the PCBAs, the non-funtioning PCBA must be replaced (see Replace the Interface PCBA).

CAUTION

There are static-sensitive components on the PCBAs. Adequate anti-static precautions must be taken before touching these boards. A properly grounded conductive wrist strap must be worn, and the PCBAs must be in static bags when being inserted or removed from the scanner heads.

6.7.12. Replace the Interface PCBA

Activity Number:	Q4213-52-ACT-029	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	
Availability Required:	Scanner power off	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	10 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:	• STA interface PCBA p/n 6581500045; • CLB interface PCBA p/n 6581500046		
	Part Number	Quantity	Lead Time
Required Tools:	• 7/16 in. wrench, • small Phillips screwdriver (for the 4-40 screws)		

1. See Appendix D assembly drawings.
2. Power down the sensor, and remove all connectors and tubing. If all the Phillips screws are not immediately accessible, remove the PCBA bracket from the base-plate in order to remove them.
3. Replace the PCBA and reconnect all connectors.

6.7.13. Replace LVDT

Activity Number:	Q4213-52-ACT-030	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Replace	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner power off	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	40 minutes	**# of People Required:**	1

Prerequisite Procedures:		Post Procedures:	
	Part Number	Quantity	Lead Time
Required Parts:	LVDT assembly with LUT p/n 6581800240		
	Part Number	Quantity	Lead Time
Required Tools:	5/8 in. wrench, DMM		

1. Move the dome so that the Z-sensor reads 5 V (the middle of its range).
2. Loosen and remove the existing LVDT. It might be necessary to disconnect the air supply and move some of the tubing if it is in the way. A 5/8 in. wrench is required. Do not turn off power to the sensor.
3. Physically install the new LVDT, but do not tighten the nut. Use a DMM to monitor the LVDT test point on the PCBA. Adjust the LVDT until the reading is 0.0 ± 0.2 V. Tighten the nut.
4. Read the new LVDT LUT into the recipe (see Install LVDT LUT file).
5. The LVDT may have shifted from where it was before. This affects the initialization procedure, and perhaps calibration and onsheet absolute positioning. One adjustment that may have to be made is to the database variable *./Scanner x/Mss/Ssx laser caliper/Setup/Steps away from retract*.

   It should be noted that the LVDT is not well behaved in its deadband outside the normal measurement range. It will usually read ± 10 V, but can also read anywhere in between. If the dome is positioned in the deadband, the behavior can be unpredictable. The *steps away from retract* parameter is used in the initialization to place the LVDT in the middle of its measurement position. If it is suspected that this parameter is incorrect, it is necessary to use the **MSS IO Point Monitor** display to first find the middle of the measurement range, and then to find the number of steps to the home position.

6.8. Address Calibration Issues

6.8.1. Diagnose bad calibration

Bad calibrations can be defined as ones which have bad repeatability or with high non-linearites seen by both the laser and the z sensor.

Activity Number:	Q4213-52-ACT-031	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	40 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:	feeler gauge, 0.050 mm thick.		

1. Ensure proper centering of the dome (Z target) by running a shim or feeler gauge with a thickness of less than 0.125 mm (< 0.01 in.) between the periphery of the dome and the sheet guide. If it does not seem to be centred, loosen the four baseplate thumbscrews (Figure 1-4), centre the dome, and re-tighten.

2. Determine if the dome moves smoothly by commanding large movements and feeling or listening to the movement (second person at the operator station may be necessary). If the dome movement does not seem smooth after this procedure, it may be necessary to replace the stepper motor (see Replace the stepper motor). Alternatively, a loose part in the CLB module may be affecting the calibrations. Examine the fasteners on the module, and inspect the translation stage for corrosion.

6.9. Measurement Improvement

6.9.1. Correct absolute value drift

Absolute value drift can be an early indication that a measurement device is losing its accuracy. In particular, if the device is drifting continuously, it is likely that either dust is accumulating on the laser window, or that there is build-up on the zirconia button. Alternatively, this could indicate non-stable scanner head or sensor temperatures. Debug this effect systematically.

Activity Number:	Q4213-52-ACT-032	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	Scanner offsheet	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	40 minutes	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Ensure that the keyhole insert is held in place with all screws, and ensure that the laser purge is properly plumbed with a clean and dry air supply, and is expelling air through the keyhole insert.

2. See Interlock Related Tasks and Clean triangulation laser.

3. If device temperatures are not stable see Temperature-related Troubleshooting.

6.9.2. Correct profile error

It will often be found that there are some profile errors. These are frequently related to measurement errors of the comparison device, but are sometimes due to the laser caliper sensor and are correctable.

Activity Number:	Q4213-52-ACT-033	**Applicable Models:**	Q4213-02, Q4213-52
Type of procedure:	Inspect	**Expertise Level:**	Technician
Priority Level:	High	**Cautions:**	None
Availability Required:	None	**Reminder Lead Time:**	
Overdue Grace Period:		**Frequency (time period):**	
Duration (time period):	2 hours	**# of People Required:**	1
Prerequisite Procedures:		**Post Procedures:**	
	Part Number	Quantity	Lead Time
Required Parts:			
	Part Number	Quantity	Lead Time
Required Tools:			

1. Most of the profile errors involve a resemblance between the laser triangulation sensor profile and the Z-sensor profile, in which case, examine laser triangulation sensor and Z-sensor calibrations. If field calibrations were used instead of factory calibrations, are the calibrations good?

2. If the calibrations are repeatable, but the calibration still does not seem good, examine the temperature control. Is the device temperature during calibration quite different from the onsheet temperature?

3. Often, the onsheet position found by scanning on the calibration target (or paper–see Section 4.5) is not the best, in which case, move dome until the best position is found.

4. If the error is related to the X and Y profiles, the X-Y corrector constants should be determined again (see Subsection 4.3.2). Note that it is important to have the job set offset for the X and Y sensors be the same as for the laser sensor.

5. It might also be necessary to look at the amount of vacuum. Often, vacuums which are as small as possible without allowing the sheet to

lift off are best. Also, the outer vacuum should be slightly higher than the inner vacuum.

7. Troubleshooting

In this chapter, possible issues with the laser caliper measurement are divided into two sections:

- Section 7.1 Alarm Based Troubleshooting: Troubleshooting steps to be taken in response to a specific alarm generated in the Experion MX system.
- Section 7.2 Non-alarm Based Troubleshooting: Troubleshooting steps that may not be related to a specific alarm in the Experion MX system.

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

7.1. Alarm Based Troubleshooting

7.1.1. Rx Sensor Not in Place

Symptom	Cause	Solution (Tasks)
This alarm indicates an electronics problem since the in-place switch for the receiver is not used in this revision of the sensor.	Jumper for J8 of 6581500046 is not in place.	Verify jumper in place. See Inspect PCBAs and harnesses.
	PCBA or harness failure	See Inspect PCBAs and harnesses.

7.1.2. Interlock Board

Symptom	Cause	Solution (Tasks)
Interlock PCBA is not giving an expected signal.	Failed interlock or EDAQ PCBA, damaged harness or MSS issue.	See Diagnose interlock open circuit (Steps 4-6).

7.1.3. Laser Enabled Status Mismatch

Symptom	Cause	Solution (Tasks)
Laser enabled status on STA interface PCBA does not match the status expected by the Interlock PCBA.	Failure of head split switch	Inspect switch: see Diagnose interlock open circuit (Step 3).
	Failure of Interface PCBA	See Inspect PCBAs and harnesses and Diagnose interlock open circuit (Step 3).
	Failure of Interlock PCBA or EDAQ	See Diagnose interlock open circuit (Steps 4-6).

7.1.4. Retract Limit Not Found

Symptom	Cause	Solution (Tasks)
During dome retraction the retract limit switch was not found	The value of *steps to retract* is too low in the database	See Section 2.8.1.
	The dome movement is being stopped by a physical obstruction	Inspect for and remove any physical obstruction. See Diagnose dome movement problems.
	The home switch is disconnected or has failed	Inspect the motor and harness. See Diagnose dome movement problems.

7.1.5. Move Away still in Retract Limit

Symptom	Cause	Solution (Tasks)
Dome failed to move away from the retract limit switch when requested to move up	Physical obstruction of dome movement.	Inspect for and remove any physical obstruction. See Diagnose dome movement problems.
	Retract limit switch has failed.	Inspect the motor and harness. See Diagnose dome movement problems.

7.1.6. Move Away in Insert Limit

Symptom	Cause	Solution (Tasks)
During the dome initialization sequence the firmware insert switch was unexpectedly triggered.	The value of *steps away from retract* is too high. It must be less than 6000	Ensure the database value of *steps away from retract* is less than 6000. 2000 to 3000 is a more normal value (see Subsection 2.8.1).
	Insert switch contact output erroneously on due to Interface or EDAQ PCBA failure	Inspect PCBAs and harnesses

7.1.7. Staging Voltage Not Found

Symptom	Cause	Solution (Tasks)
The staging voltage for positioning the dome could not be found within a specified number of iterations to the specified accuracy.	Mechanical wear or interference, PCBA degradation, or bad dome-movement RTDR values.	See Diagnose dome movement problems, especially steps 1 and 5 to 7.

7.1.8. Staging in Retract Limit

Symptom	Cause	Solution (Tasks)
While setting the staging voltage, the dome was found to be in the retract limit switch	The database value of *steps away from home* is too small so that the stepper motor is not moved out of the home position, or the master signal is measuring in its deadband causing incorrect feedback signals.	Increase *steps away from home* by 500 and try again (see Diagnose dome movement problems step 5).
	The home switch harness has been damaged.	See Diagnose dome movement problems (step 2).

7.1.9. Staging in Insert Limit

Symptom	Cause	Solution (Tasks)
While the MSS was attempting to find the dome staging voltage, the insert limit was found	The database value of *steps away from home* is too large so that the stepper motor is moved past its measurement range into its deadband causing incorrect feedback signals.	Decrease *steps away from home* by 500 and try again (see Diagnose dome movement problems step 5).
	If problem will not clear, there Is likely a PCBA failure as the limit is set by firmware on the PCBA.	See Replace the Interface PCBA.

7.1.10. Calibration Stepped into Limit

Symptom	Cause	Solution (Tasks)
During calibration, the dome ended up at the insert limit.	The calibration stop voltage, step size, or numbers of steps may be incorrect.	Re-set **Full Calibration Setup** values to those in Table 4-2.
	Faulty LVDT or LVDT was not set up properly in the factory	see Replace LVDT
	The firmware insert limit is within the measurement range of the LVDT.	Decrease *steps away from home* by 500 and try again (see Diagnose dome movement problems step 5).
	LVDT or associated electronics failure.	See Inspect PCBAs and harnesses.

7.1.11. Simple Move in Retract Limit

Symptom	Cause	Solution (Tasks)
During a move, the dome was positioned into the retract limit switch.	This is likely due to an inadvertent action of the operator during a maintainance procedure.	Move the dome away from the home position (see Section 2.6).

7.1.12. Simple Move in Insert Limit

Symptom	Cause	Solution (Tasks)
During a move, the dome was positioned into the insert limit	This is likely due to an inadvertent action of the operator during a maintainance procedure.	Move the dome away from the insert position (see Section 2.6).

7.1.13. STA Laser Power Off

Symptom	Cause	Solution (Tasks)
STA Laser power is off	Laser interlock is not satisfied.	If this is unexpected see Diagnose interlock open circuit.
	Head-split switch or interface PCBA damaged.	See Inspect PCBAs and harnesses.
	Abnormally large scanner head gap can mean that the distance between the magnet and the switch is too large.	Adjust the minimum dome height so the head-split switch can be triggered (see Replace the stepper motor).

7.1.14. CLB Laser Power Off

Symptom	Cause	Solution (Tasks)
CLB Laser Power digital input is off.	There is no CLB laser, so this error can only be caused by an MSS or EDAQ error.	See Chapter 3

7.1.15. STA Power Supplies

Symptom	Cause	Solution (Tasks)
The STA Interface voltages for the temperature control circuits are too low.	TECs are damaged.	Inspect the Z-sensor TEC assembly for damage. Replace if necessary See Replace the Z sensor TEC assembly
	PCBAs are damaged	See Inspect PCBAs and harnesses

7.1.16. LCL STA Z-Coil Temp Processor

Symptom	Cause	Solution (Tasks)
Raw input voltage on analog channel is outside the A/D limits of 0 to 10 volts	Thermistor broken	Repair thermistor wire, or swap thermistor inputs if possible for a temporary fix (see Check Z-sensor temperature control steps 2 and 3). If it is not possible to do either of these, Replace Z-sensor
	Damaged Harness or PCBA	See Inspect PCBAs and harnesses)
Drift Limit Exceeded Reading out of Limit	Failed temperature control circuit.	See Check Z-sensor temperature control.

7.1.17. LCL STA Laser Temp Processor

Symptom	Cause	Solution (Tasks)
Raw input voltage on analog channel is outside the A/D limits of 0 to 10 volts	Thermistor broken	See Replace laser thermistor.
	Damaged Harness or PCBA	See Inspect PCBAs and harnesses.
Drift Limit Exceeded Reading out of Limit	Failure of temperature control circuit.	See Check laser temperature control.

7.1.18. LCL CLB Dome Temp Processor

Symptom	Cause	Solution (Tasks)
Raw input voltage on analog channel is outside the A/D limits of 0 to 10 volts	Damaged Harness or PCBA	See Inspect PCBAs and harnesses.
	Thermistor broken	See Replace dome thermistor.
Drift Limit Exceeded Reading out of Limit	Inappropriate limit setting	See Section 4.9.1

7.1.19. LCL Coanda Pressure 1 (or 2) Processor

Symptom	Cause	Solution (Tasks)
Raw input voltage on analog channel is outside the A/D limits of 0 to 10 volts	Damaged Harness or PCBA	See Inspect PCBAs and harnesses
Drift Limit Exceeded Reading out of Limit	Pressure monitor tube disconnected from PCBA	See Inspect PCBAs and harnesses and Check air pressure and fittings

7.1.20. LCL Vacuum Pressure 1 (or 2) Processor

Symptom	Cause	Solution (Tasks)
Raw input voltage on analog channel is outside the A/D limits of 0 to 10 volts	Damaged Harness or PCBA	See Inspect PCBAs and harnesses
Drift Limit Exceeded Reading out of Limit	Vacuum monitor tube disconnected from PCBA	See Inspect PCBAs and harnesses and Check air pressure and fittings

7.1.21. PCB Temp Processor

Symptom	Cause	Solution (Tasks)
Raw input voltage on analog channel is outside the A/D limits of 0 to 10 volts	Damaged PCBA	See Replace the Interface PCBA.
Drift Limit Exceeded Reading out of Limit	Inappropriate limit setting	See Section 4.9.1

7.1.22. Laser Caliper Processor

Symptom	Cause	Solution (Tasks)
Bad Z input Bad LVDT input Bad STALsr input	As the possible reading for these sensors span the entire -10 V to+10 V range, it should not be possible to get this error unless there is a damaged EDAQ PCBA.	Replace the EDAQ
Bad CLBLsr input	This alarm should not be possible with the 4213-x2 hardware and software.	N/A

7.2. Non–alarm Based Troubleshooting

7.2.1. Functional Failure Troubleshooting

Symptom	Cause	Solution (Tasks)
Laser Caliper laser power indicator on but there is no emission from laser	Interlock PCBA not providing power to laser	See Diagnose interlock open circuit.
	Laser device failure	See Diagnose interlock open circuit.
Laser does not turn off when heads are split	Head split switch is short circuited	See Replace head split switch.
	Interface PCBA damaged or short circuited	See Replace the Interface PCBA.
Only 0 or +10 V signal from laser, laser emits red light	Laser device failure, obstruction	See Check laser .
	PCBA failure	See Replace the Interface PCBA.
Only 0 or +10 V signal from Z-sensor	Z-sensor cracked	See Confirm Z-sensor failure.
Sudden change in laser calibration slope (magnitude of change > 2 μm/μV or unexpected jump to +10 V during calibration	Dirt or obstruction in optical path	See Clean triangulation laser.
	Calibration range has been changed–adjust calibration limits	See Section 4.2.5
	Triangulation device failure (likely static or electrical short circuit)	See Check laser.
Calibration slope not smooth or discontinuous within the measurement range	Mechanical interference with dome perhaps caused by sheet guide	See Diagnose bad calibration.
	Loose or damaged parts such as the CLB module laser bracket	
Laser case temperature outside of range (36 ± 2) °C or Z-coil temperature out of range (42 ± 2) °C.	Thermistor broken or circuit failure	See Temperature-related Troubleshooting.
	PCBA power needs to be reset	
	Air flow may be too high or mill air too cold- reduce purge air flow	

Symptom	Cause	Solution (Tasks)
Z-sensor temperature spread > 0.2 °C	TEC cracked or corroded	See Replace the Z sensor TEC assembly.
	Thermal short circuit	Inspect hardware
	Electrical failure on PCBA	See Inspect PCBAs and harnesses.
Dome does not move when commanded	Stepper motor failure	See Diagnose dome movement problems.
	Drive electronics failure (or disconnected)	
Insert or retract indicators never on	Retract switch failure, or mechanical interference, or stepper motor failure.	See Diagnose dome movement problems then see Inspect PCBAs and harnesses.
	MSS Error	See Diagnose MSS alarms.
Pressure readings too low or do not change	Tube disconnected or blocked. Faulty regulator.	See Check air pressure and fittings.
Experion MX voltages and measurements do not change	Scanner down, EDAQ failure	See Diagnose MSS alarms.
	Interface PCBA failure	See Replace the Interface PCBA.
Vacuum drifting on trend plot	Vacuum hardware needs cleaning	See Check air pressure and fittings.
	Interface PCBA faulty	See Replace the Interface PCBA.
Staging error at the beginning of a calibration	Cannot reach position	See Diagnose dome movement problems.
Calibration stuck; will not finish	Cannot reach position–damaged LVDT	Change calibration limits, see Section 4.2.4.
		See Replace LVDT.

7.2.2. Performance Failure Troubleshooting

Symptom	Cause	Solution (Tasks)
Drift in caliper readings	Dirt on dome	See Clean exterior surfaces.
	Dirt on laser triangulation sensor optics	See Clean triangulation laser.
Profile error	Various causes	See Correct profile error.
Correlating with scanner X or Y	XY corrector was not made properly or there has been a mechanical alignment change. re-make X-Y corrector.	See Section 4.3.
XY Corrector seems unstable	X- or Y-sensor is unstable	Replace X or Y sensor (refer to your scanner manual)
Correlating with Z or LAS	Z- or laser displacement sensor calibration is not good or is unstable.	See Check calibration.
Errors correspond with maxima in head separation	Displacement sensor may be reading near the end of its range.	See Section 4.5
Air clamp does not hold sheet	Loss of air pressure	See Check air pressure and fittings

8. Storage, Transportation, End of Life

This chapter summarizes Honeywell policy with regards to the storage and disposal of components of the laser caliper measurement.

8.1. Storage and Transportation Environment

In order to maintain integrity of system components, storage and transportation of all equipment must be within the parameters shown in Table 8-1.

Table 8-1 Storage and Transportation Parameters

Duration of Storage	Acceptable Temperature Range	Acceptable Humidity Range
Short term (less than one week)	-20–45 °C (-4–113 °F)	20–90% non-condensing
Long term	-10–40 °C (14–104 °F)	20–90% non-condensing

8.2. 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 re-used, recycled, or disposed of in accordance with local environmental requirements or guidelines.

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

Guidelines for disposal of equipment by Honeywell or the customer for scanner-specific materials are:

- Remove all belts, wheels, and non-metallic parts (except plastic) from the scanner and dispose through the local refuse system.
- Recycle plastic parts.
- Wire and cabling should be removed and recycled (the copper may have value as scrap).
- Electrical and electronic components such as solder, circuit boards, batteries, and oil-filled capacitors, should be recycled or handled as special waste to prevent them from being put in a landfill, because there is potential for lead and other metals leaching into the ground and water.
- Metals should be recycled. They will, in many cases, have value as scrap, for example, beams, enclosures, mounting and retraction components, fasteners, and hardware.
- Except where identified in this chapter, the sensor does not contain hazardous or restricted materials.

9. Glossary

Actuator	Mechanical or electronic device that performs the control action in a control loop.
Back Side	See Drive Side.
Bin	The smallest measurement zone on the frame. Also called Bucket or Slice.
Cable End	Location of the electronics and/or the entry point for communications and power on the scanner.
CD Spread	Variation in the profile data equal to twice the standard deviation of the measured variable.
Coanda Effect	Tendency of air to flow along a curved surface. This is used to direct flow from inside the air clamp in a jet parallel to the surface of the sensor thereby creating a low pressure region which attracts the paper web.
Code	See Recipe.
Cross Direction (CD)	Used to refer to those properties of a process measurement or control device that are determined by its position along a line that runs across the paper machine. The cross direction is transverse to the machine direction that relates to a position along the length of the paper machine.
Data Storage and Retrieval (DSR)	A mechanism provided in real-time application environment (RAE) for storing recipe- or grade-dependent data, such as tuning, calibration, and setup values, and retrieving them when a recipe is loaded. The recipe- or grade-dependent data are saved to a database known as the Recipes database.
Digital Multimeter (DMM)	Electronic device used to measure electrical quantities such as voltage, current, and resistance and display the reading in a digital format.
Distant End	The end of the scanner opposite the cable end.
Drive Side (DS)	The side of the paper machine where the main motor drives are located. Cabling is routed from this end. Also called Back Side.
Experion MX	The name of Honeywell’s latest quality control system (QCS).
Ferrite	Ferrimagnetic materials used in high-frequency electro-magnetic circuits due to their high specific reluctances and small eddy currents. Ferrites are used in Honeywell contacting caliper sensors.
Front Side	See Tending Side.

Linear Variable Displacement Transducer (LVDT)	Used to provide an accurate displacement reference.
LUT	Device **L**ook**U**p **T**able.
Machine Direction (MD)	The direction in which paper travels down the paper machine.
Management Information System (MIS)	A system or subsystem that collects and manages information on the paper production.
Printed Circuit Board Assembly (PCBA)	Sensor electronic circuits and components assembled as multilayer electronic cards to which harnesses (cable assemblies) attach.
Quality Control System (QCS)	A computer system managing the quality of the paper produced.
R^2	R is known as *Pearson's R* and is a measure of the correlation between two variables. R^2 can have values between 0 and 1. 0 is uncorrelated, and 1 is perfectly correlated, for example, when one variable is plotted against the other, all the points line on a straight line.
Real-Time Application Environment (RAE)	The system software used by Experion MX QCS to manage data exchange between applications.
Real-Time Data Repository (RTDR)	The database managed by RAE to store system data and data for individual applications.
Recipe	A list of pulp chemicals, additives, and dyes blended together to make a particular grade of paper. Or, a table of database values used to make a grade of paper (see DSR).
Sensor Processor	A software program that takes one or many inputs from the MSS, converts those measurements to engineering units for measurement or measurement correction, performs automatic diagnostic tests, and reports on any alarm conditions. Also known as GSP.
Sensor Set	The term used in the sensor maintenance displays to describe a set of sensors working together on a scanner to perform one measurement.
Setpoint	Target value (desired value). Setpoints are defined process values that can be modified by entering new values through the monitor, loading grade data, and changing a supervisory target.
Smoothing Width	A value that determines the amount of averaging that will be applied to a measurement bin.
Standardize	An automatic periodic measurement of the primary and auxiliary sensors taken offsheet. The standardize measurements are used to adjust the primary sensor's readings to ensure accuracy.
Streak	A narrow cross-directional section of paper where a measured quality deviates significantly from the average of the entire width of the paper. Or, an area in an array of cross-directional measurements that deviates more than a certain amount from its surroundings. The amount of allowed deviation can be set up as an absolute number or as a percentage.
Target	A display area that is available for the user to make a selection or to enter data (RMPCT displays). Also refers to a numeric value that specifies a desired product quality. Also refers to an optical target used for laser calibration.

Tending Side (TS) The side of the paper machine where the operator has unobstructed access. Also called Front Side

Thermo-electric Cooler (TEC) Used in temperature control loops where both heating and cooling may be necessary. Also known as a *Peltier Cooler*. These devices cool on one side and heat on the other depending on the directional flow of electric current.

Trend Data displayed as a function of time.

A. Part Numbers

Appendix A provides a partial list of part numbers and descriptions for the laser caliper measurement system. A more complete listing is contained the assembly drawings shown in Appendix D.

Table A-1 Part Numbers

Part Number	Description
6510030134	Laser caliper sensor–comprehensive gauge test
6530200009	Thermal Joint Compound
6580500109	Sensor Interlock PCBA
6580801795	CLB harness (cable assembly)
6580801796	STA harness (cable assembly)
6581100066	white plastic calibration target (250 micron)
6581500030	EDAQ
6581500045	STA interface PCBA
6581500046	CLB interface PCBA
6581700326	Shim Guide, Static Module
6581800190	X- or Y-sensor
6581800226	Terminated Z-sensor assembly
6581800227	Laser Caliper STA Module Assembly
6581800228	Laser Caliper CLB Module Assembly
6581800240	LVDT assembly with LUT
6581800241	Stepper motor assembly
6581800245	Laser Assembly

B. FDA Laser Safety Submission

Appendix B provides laser safety documentation (as submitted to the USA FDA) explaining the classification of the scanner system as a Class-1 laser device.

Safety and Service Manual

Model 4213-02 & -52 Laser Caliper Sensor

TABLE OF CONTENTS

1. INTRODUCTION

The Honeywell laser caliper sensor contains a laser operating on the upper or lower side of a sheet product for the purpose of thickness measurement. The sensor is rated as a Class-I laser device in accordance with the Food and Drug Administration Regulations, Title 21 of the Code of Federal Regulations. This classification is valid for the device as long as it is used in accordance with these instructions. Included in these instructions are precautions to avoid possible exposure to laser and collateral radiation.

CAUTION: USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.

2. GENERAL DESCRIPTION OF THE LASER CALIPER PRODUCT

The sensor uses a self-contained laser displacement (triangulation) gauge, located either on the upper or lower side of a sheet product, to measure the location of the product's surface closest to the laser device. This information is combined with other measurements to provide a thickness reading for the product.

The semiconductor laser is contained inside a sealed, vendor-supplied laser gauge unit, which in turn is mounted inside a protective housing also mounted in an insulated scanning enclosure ("head") that provide rigid mounting, cooling and isolation from the environment (see fig. 1). The upper head (or lower head) of the scanner contains the laser triangulation device emitting at a wavelength of 670 nm at normal incidence to the paper surface through a small keyhole aperture. The surface of the upper head is 0.4 inch (10 mm) from the lower head. However, a 6 inch (150 mm) diameter dome rising from the side opposite the laser containing head and concentric with the laser beam reduces the head gap to 5 mm for about a 3 inch (75 mm) radius about the laser beam.

The laser employed has an output power that does not exceed 5 milliwatts at a wavelength of 670 nm. In normal operation, the device emits continuously (CW) at about 50% of the maximum power. The laser gauge unit contains the source and receiver optics and the electronics required to provide a displacement measurement. The source optics in the gauge unit provides a focused beam spot on the product sheet at the position that the sheet passes through the head gap. This laser spot is imaged onto a position sensitive detector inside the laser gauge unit, for which the measured position depends on the distance to the surface being measured.

Figure 1 provides a simple diagram of the laser light path

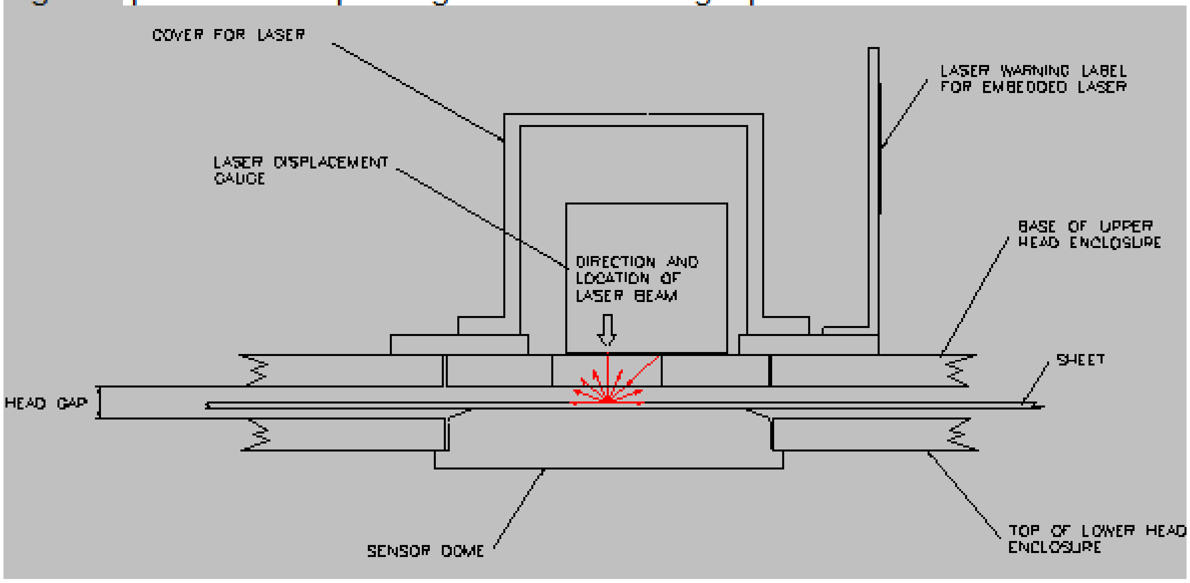


Figure 1: Schematic of laser beam path

Power to the laser can be interrupted manually by the end bell power switch, which powers down the entire scanner frame, or by the end bell key switch which extinguishes the laser alone. Power to the laser will be interrupted automatically by an interlock system if certain safety conditions are not met. If the heads are separated, or there is an attempt to remove the laser module inside the head, the interlock circuit will extinguish the laser.

3. SAFETY INFORMATION

A. Installed in the upper head of the scanner, the single-sided caliper sensor is rated as a Class-I device even though the embedded triangulation device is a Class IIIR (670 nm). If used in accordance with these instructions, access to visible laser radiation is not possible during operation or service. Safety interlock is provided to prevent accidental exposure to laser radiation when the scanning heads are separated, e.g., for sensor cleaning. Warning labels on the sensor give specific warnings and/or prohibitions related to sensor service procedures.

Caution
The laser displacement gauge is not designed for operation outside the scanner heads, and these instructions do not cover the hazards associated with such use. If it is ever required that the laser displacement sensor be removed from the head, the power to the laser must be turned off before head cover is removed.

B. The laser sensor includes the following safety features.

1. The vendor-supplied laser gauge is completely enclosed, ensuring that the only laser light emitted by the device comes from the source orifice, directed perpendicularly away from the laser containing head onto the sheet.

2. The head separation interlock turns off the laser power when the heads are separated. An electrical diagram of the interlock is shown in Figure 2 (see attachment 7.2.2 for a more complete description). The interlock system includes a magnetically-actuated switch that extinguishes the laser if the heads are split.

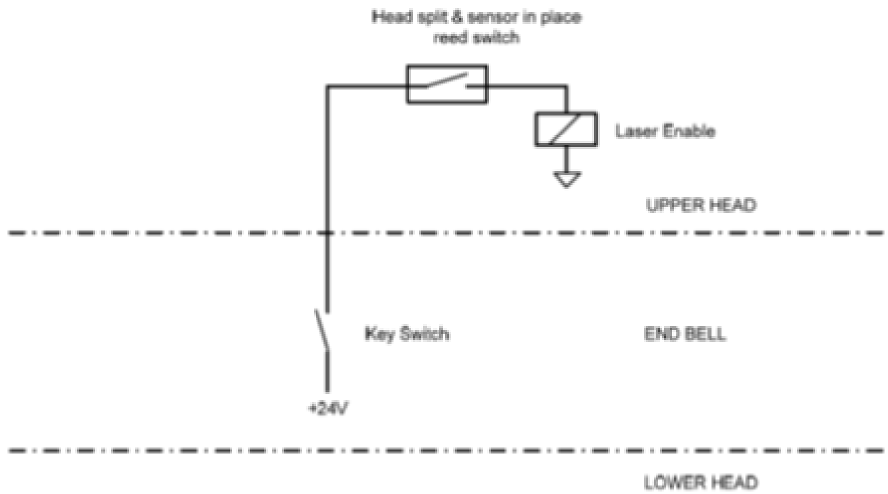


Figure 2: Interlock electrical schematic

Warning **Under no conditions is the interlock to be defeated.**

3. Certification and warning labels are located on and within the sensor head. These include a certification label on the outside of the head cover, plus a warning label on the enclosed laser displacement gauge indicating that it contains an embedded class IIIR device.

4. INSTRUCTIONS FOR SAFE SENSOR MAINTENANCE

The following rules must be strictly followed to ensure safe sensor operation and maintenance:

A. The laser should never be powered up unless the sensor module is mounted in the scanner upper head and the heads are aligned with one another.

B. Field repair work on the laser unit is not authorized. This may only be replaced as complete sealed unit.

C. Removal or replacement of the laser requires that power be turned off.

D. The head separation interlock must never be defeated.

5. INSTALLATION AND MAINTENANCE INSTRUCTIONS

A. Installation

1. Ensure 24V sensor power is off at the end bell.

2. Mount the laser sensor head module in the scanner head. Connect air supply, and water supply. Connect installation cables last. Verify connections. Verify overall head alignment with alignment pins.

3. Switch on the 24V sensor power at the end bell. Verify safety features:

   a. Disengage the clutch and displace one head from the other by about ¾ of an inch (19 mm). Verify the interlock extinguishes the laser. This can be confirmed by viewing the indicator LED on the PCB card. As the heads are separated the green indicator LED of the upper head PCB is expected to go off indicating the laser triangulation device have been disabled.
   b. When the heads are returned to their aligned position verify that the head indicator LED returns to the illuminated state.

4. Move heads to standardize position. Verify/adjust head alignment using alignment pins.

5. Align heads (see below).

B. Sensor Maintenance and Service

1. Sensor cleaning

   The sensor window may become affected by dust after a certain period of operation. It is then necessary to clean the sensor receiver window. The heads must be separated or the sensor module removed to perform this cleaning.

   Although the head interlock switch will automatically power the laser device off when the heads are separated, power shall also be switched off.

a. Follow procedures in Radiation Safety Manual, PN 6510020199 or current version, to ensure that basis weight and x-ray/ash gauge shutters are closed.

b. Turn off laser power using the key switch at the end bell.

c. Separate heads (provided this is authorized and licensed; if not the laser sensor module must be completely removed from the scanner).

d. Remove the dust cover. Thoroughly clean the flat laser protective window on the upper sensor module.

e. Return heads to aligned position.

f. Turn keys witch on.

g. Verify that laser warning labels on upper head covers are clean and clearly visible.

2. Sensor Troubleshooting

Suspected problems with sensor PCB (but not contained in the laser displacement unit itself) can be handled with no risk of radiation exposure since the PCB can be accessed and replaced without removing the sealed laser displacement device. The same is true of any components such as heaters or air or water plumbing. It is recommended, however, that power to the heads be switched off with the end bell key switch whenever work is being done inside the head.

Repairs or adjustments within the laser displacement device itself must not be made in the field. If the laser device fails, it must be replaced with a new sealed unit.

C. Laser Caliper PCBA Signal Descriptions

Appendix C provides PCBA signal and LED descriptions for laser caliper measurement.

The laser caliper signals can be monitored, and the outputs adjusted, from the **MSS Card IO Point Monitor** display as shown is Figure C-1.

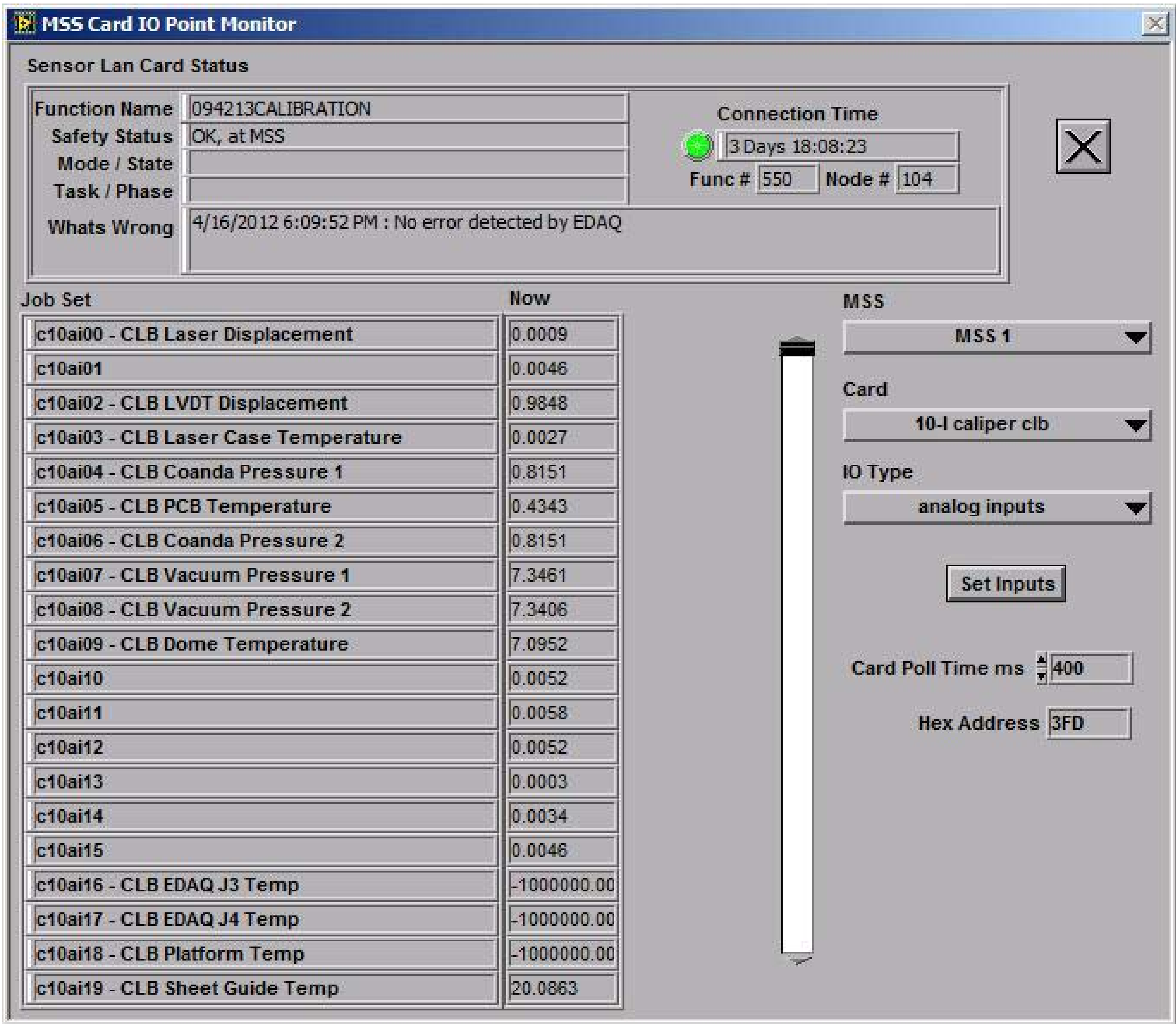


Figure C-1 MSS Card IO Point Monitor Display

The laser caliper signals can be monitored, and the outputs adjusted, from the **MSS Card IO Point Monitor** display.

A description of LCAL signals is provided in Table C-1.

Table C-1 LCAL Signals

Signal Name and Design Location	Comment
STA Analog Inputs	
STA Z Displacement (c0xai00)	Signal representing the displacement measured by the z-module's z-sensor. Signal maps a ± 2000 µm displacement range into approximately 0–10 V signal range. Signal reads more negative when its target (the stainless steel dome) moves closer to the z-module.
STA Z Coil Temperature (c0xai01)	Signal representing the temperature of the temperature controlled z-coil. The relationship to convert between signal, VZT, in volts, and temperature, T_{ZT}, in °C, is: $T_{ZT} = 3.1409\ V_{ZT}^2 – 35.954\ V_{ZT} + 95.033$.
STA Laser Displacement (c0xai02)	Signal representing the displacement measured by the z-sensor module optical displacement device. Signal maps a ± 2000 µm displacement range into 0–10 V signal range. Signal reads more negative when its target (flag or sheet of paper) moves closer to the STA module.
STA Laser Case Temperature (cxxai03)	Signal representing the temperature of the temperature controlled z-sensor module optical triangulation unit's invar heat sink. The relationship to convert between signal, VUH, in volts, and temperature, T_{UH}, in °C, is: $T_{UH} = 2.8348\ V_{UH}^2 – 47.611\ V_{UH} + 92.163$.
STA PCB Temperature (cxxai04)	Temperature in °C : $T = V \times 10$.
(cxxai05)	Z-coil temperature from control circuit. The relationship to convert between signal, V_{ZT}, in volts, and temperature, T_{ZT}, in °C, is: $T_{ZT} = 0.5424\ V_{ZT}^2 – 46.866\ V_{ZT} + 100.4$.
CLB Analog Inputs	
CLB Laser Displacement cxxai00	Not used
CLB LVDT Displacement (cxxai02)	Signal representing the displacement measured by the CLB module LVDT. Signal maps a ± 1700 µm displacement range into ± 10 V signal range. Signal will read more negative when its target (stainless steel dome) moves further into the gap.
CLB laser case temperature (cxxai03)	Not used
CLB Coanda pressure 1 (cxxai04)	Signal representing the pressure supplied to a Coanda. The Coanda must be identified using Figure D-10. The relationship to convert between signal, V, in volts and pressure, P, in psi, is: $P = 3.75 * (V-1)$
CLB PCB Temperature (cxxai05)	T(°C) = V * 50
CLB Coanda pressure 2 (cxxai06)	Signal representing the pressure supplied to a Coanda. The Coanda must be identified using Figure D-10. The relationship to convert between signal, V, in volts and pressure, P, in psi, is: $P = 3.75 * (V-1)$
CLB Vacuum Pressure 1 (cxxai07)	Signal representing the vacuum supplied to an air-clamp plenum. The plenum must be identified using Figure D-10. The relationship to convert between signal, V, in volts and Vacuum, in kPa, is: $Vac = -12.8 * V + 115$.
CLB Vacuum Pressure 2 (cxxai08)	Signal representing the vacuum supplied to an air-clamp plenum. The plenum must be identified using Figure D-10. The relationship to convert between signal, V, in volts and Vacuum, in kPa, is: $Vac = -12.8xV + 115$.

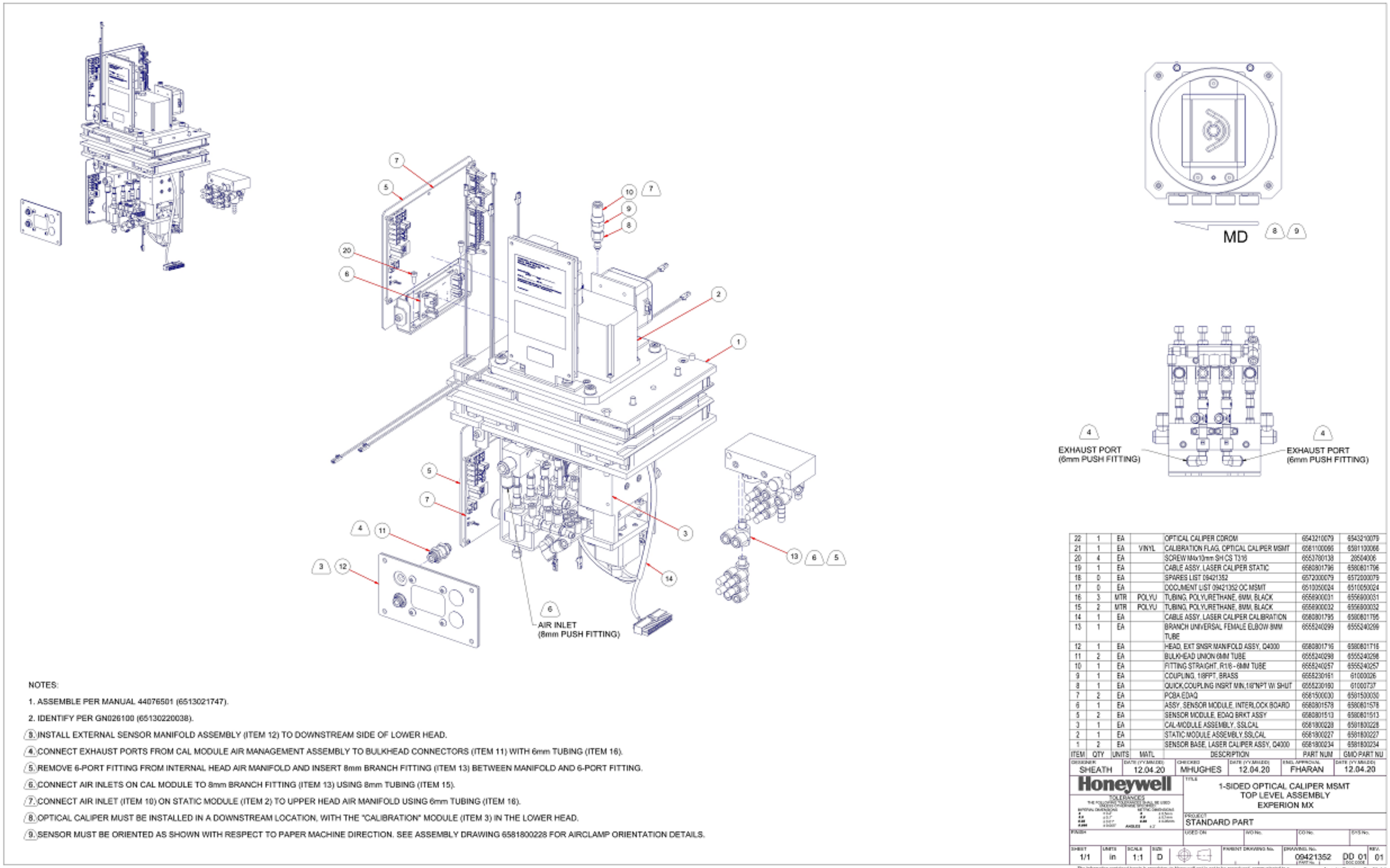
Signal Name and Design Location	Comment
CLB Dome Temp (cxxai09)	Temperature of thermistor embedded in dome (°C). $T = -25.78 \ln(V) + 70.839$.
CLB Analog Outputs	
CLB Stepper Mtr steps (cxxao00)	This field can be used to command stepper motor steps directly to the MSS. The CLB module target displacement is related to the number of steps by the following ratio: 0.656 steps per micron. An entry of zero steps must be entered between subsequent moves while using this display in order to reset the Stepper motor move finished flag.
STA Digital Inputs	
STA Laser Power (cxxdi00)	This digital input indicates the state of the z-sensor module laser interlock. This indicator is ON if the system interlock is satisfied. Note, that this does not mean that the laser is powered up as the interlock PCBA has to supply + 24 V independently.
STA Power Supplies OK (cxxdi01)	Indicates that the power supplies for the two temperature control circuits are functioning properly.
STA Watchdog OK (cxxdi04)	Interlock PCBA ok?
STA Module In Place (cxxdi05)	In-place switch closed (this should always be on as we don't currently use the in-place switch)
CLB Digital Inputs	
CLB laser power (cxxdi00)	This indicator is ON if the system interlock is satisfied.
CLB Stepper Mtr insert limit (cxxdi01)	This digital input indicates whether the CLB module's dome is at the extreme insertion limit of its travel (set by firmware).
CLB Stepper Mtr retract limit (cxxdi02)	This digital input indicates whether the CLB module's dome is at the extreme retracted limit of its travel. Also called the home position.
CLB Module In Place (cxxdi05)	Should always be on
Stepper motor move finished (cxxdi05)	This digital input indicates that the stepper motor has completed executing a requested move. If on, it must be reset before subsequent moves can be made (see entry for Stepper motor steps).
CLB Digital Outputs	
CLB Stepper Mtr direction (cxxdo00)	This digital input set to request motion direction of the CLB module's target (dome). The OFF status indicates the dome will move towards the full retract position, and an ON indication means the dome will travel into the gap towards its insert limit.
CLB Heater Power Disable (cxxdo02)	Do not use
CLB Sneeze (cxxdo03)	Not used
CLB Flag (cxxdo04)	Not used
CLB Stepper Mtr Step (cxxdo07)	Indicates steps sent to stepper motor

D. Assembly Drawings

Appendix D provides assembly drawings for the laser caliper measurement system.

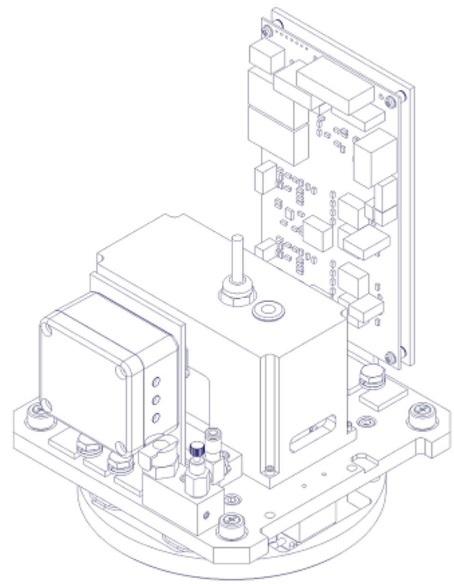
ATTENTION

Figures depicting product diagrams or schematics are included in this manual for illustration and explanation purposes only, and may not match the drawing that is currently available and/or shipped with your product.



ITEM	QTY	UNITS	MATL	DESCRIPTION	PART NUM	GMO PART NU
22	1	EA		OPTICAL CALIPER CDROM	6543210079	6543210079
21	1	EA	VINYL	CALIBRATION FLAG, OPTICAL CALIPER MSMT	6581100066	6581100066
20	4	EA		SCREW M4x10mm SH CS T316	6553780138	28504006
19	1	EA		CABLE ASSY, LASER CALIPER STATIC	6580801796	6580801796
18	0	EA		SPARES LIST 09421352	6572000079	6572000079
17	0	EA		DOCUMENT LIST 09421352 OC MSMT	6510050024	6510050024
16	3	MTR	POLYU	TUBING, POLYURETHANE, 6MM, BLACK	6556900031	6556900031
15	2	MTR	POLYU	TUBING, POLYURETHANE, 8MM, BLACK	6556900032	6556900032
14	1	EA		CABLE ASSY, LASER CALIPER CALIBRATION	6580801795	6580801795
13	1	EA		BRANCH UNIVERSAL FEMALE ELBOW 8MM TUBE	6555240299	6555240299
12	1	EA		HEAD, EXT SNSR MANIFOLD ASSY, Q4000	6580801716	6580801716
11	2	EA		BULKHEAD UNION 6MM TUBE	6555240298	6555240298
10	1	EA		FITTING STRAIGHT, R1/8 - 6MM TUBE	6555240257	6555240257
9	1	EA		COUPLING, 1/8FPT, BRASS	6555230161	61000026
8	1	EA		QUICK,COUPLING INSRT MIN,1/8"NPT W/ SHUT	6555230190	61000737
7	2	EA		PCBA EDAQ	6581500030	6581500030
6	1	EA		ASSY, SENSOR MODULE, INTERLOCK BOARD	6580801578	6580801578
5	2	EA		SENSOR MODULE, EDAQ BRKT ASSY	6580801513	6580801513
3	1	EA		CAL-MODULE ASSEMBLY, SSLCAL	6581800228	6581800228
2	1	EA		STATIC MODULE ASSEMBLY,SSLCAL	6581800227	6581800227
1	2	EA		SENSOR BASE, LASER CALIPER ASSY, Q4000	6581800234	6581800234

Figure D-1 Sensor Assembly Drawing



ITEM	QTY	UNITS	MATL	DESCRIPTION	PART NUM	GMO PART NU
55	1	EA		JUMPER SHUNT 2.54mm 2 POLE	6540690016	21000897
54	1	EA		ISOLATOR, Z ELECTRONICS, SSLCAL	6581700399	6581700399
53	2	EA	SS 304	SCREW 4-40X1.25" SH CS T304	6553060346	28104081
52	1	EA	VINYL	LABEL HONEYWELL ASSY NO. REV LEVEL	6551430064	00283201
51	1	EA		THERMISTER ASSY,30K,STATIC MOD,SSLCAL	6581800233	6581800233
50	0.3	MTR	POLYU	TUBING, POLYURETHANE, 4MM, BLACK, Q4000	6556900030	6556900030
49	0	EA		SEALANT RTV SILICONE 3145	6530230020	16000040
48	1	EA		TERMINATED Z-SENSOR ASSY, SSLCAL	6581800226	6581800226
47	0	EA		THERMAL JOINT COMPOUND	6530200009	16000049
46	1	EA		LABEL DANGER LASER RADIATION, SSLCAL	6551420211	6551420211
45	1	EA		LABEL LASER IDENTIFICATION, SSLCAL	6551410089	6551410089
44	2	EA		SCREW # 2-56 X .87 PANPHL SS	6553060406	28102017
43	1	EA	FBGLS	THERMAL INSULATION, STATIC MODULE	6581100065	6581100065
42	4	EA	DRON	SPACER Z-MODULE LCAL	6581700049	6581700049
41	1	EA		LASER ASSY, STATIC MODULE, SSLCAL	6581800245	6581800245
40	1	EA		BRACKET MNTG,STATIC MODULE,IF,SSLCA	6581600086	6581600086
39	1	EA	304SS	SCREW 8-32X3/4 SH CS T304	6553060140	28108009
38	4	EA	304SS	BOLT 1/4-20x1/2" HX T304	6553000019	28116014
37	4	EA	302SS	WASHER FLAT 1/4x.064" SS18-8	6553020095	28316007
36	4	EA	304SS	WASHER SPLT 1/4x.062" T304	6553020042	28316004
35	2	EA	NYLON	SCREW 8-32 X .37 SHCS NYLON 30% GLASS	6553060405	6553060405
34	4	EA		SCREW 4-40x.25 PH PAN SEM ZN	6553060250	28104077
33	1	EA		BASEPLATE,STATIC MODULE,SSLCAL	6581700328	6581700328
32	1	EA		THERMOELECTRIC COOLER ASSY,Z-COIL,SSLCAL	6581800243	6581800243
31	1	EA		PCBA SINGLE SIDED LASER CALIPER Z MODULE	6581500045	6581500045
30	1	EA		STANDOFF, REED SWITCH, STATIC MODULE	6581700329	6581700329
29	1	EA		PURGE BLOCK ASSY,STATIC MODULE,SSLCAL	6581800231	6581800231
28	1	EA		BRACKET,Z-SENSOR,ELECTRONICS,SSLCAL	6581600083	6581600083
27	1	EA		HEADSPLIT SWITCH, STATIC MODULE, SSLCAL	6581800244	6581800244
26	2	EA	304SS	SCREW 8-32x1/2 SH CS T304	6553060023	28108015
25	2	EA	304SS	WASHER SPLT 8x.040"T304	6553020055	28308002
24	3	EA	T304	SCREW 2-56x1/4 SH CS T304	6553060294	28102011
23	3	EA	18-8SS	SCREW 2-56X3/4" PH PAN SS18-8	6553060174	28102023
22	4	EA		SCREW 6-32x1.37 PAN PHL T304	6553060281	28106043
21	4	EA	316SS	WASHER SPLT 6x.031"T316	6553020054	28306001
20	1	EA		RING, COIL FORM, LASER CAL	6581700050	6581700050
19	4	EA	304SS	SCREW 10-32x.75 SH FLT T304	6553060161	28110034
18	4	EA	316SS	SCREW 10-32x1/2 SH CS T316	6553060105	28110006
17	4	EA	304SS	WASHER SPLT 10 x.047" T304	6553020044	28310004
16	4	EA		SCREW 4-40x0.5 SH CS T304	6553060283	28104018
15	1	EA		SCREW 4-40x3/16 SH BUT T304	6553780150	6553780150
14	1	EA		GROMMET,9/32"ID,5/8"OD,5/32 PNL	6553060057	6553060057
13	1	EA		DUST COVER,STATIC MODULE,SSLCAL	6581700318	6581700318
12	1	EA		KEYHOLE INSERT,STATIC MODULE,SSLCAL	6581700319	6581700319
11	1	EA		RETAINER CLIP,HEATSINK,SSLCAL	6581600084	6581600084
10	1	EA		COVER,LASER,STATIC MODULE,SSLCAL	6581700320	6581700320
9	1	EA		HEATSINK,LASER,STATIC MODULE,SSLCAL	6581700321	6581700321
8	1	EA		INSULATION,LASER,STATIC MODULE,SSLCAL	6581700322	6581700322
7	1	EA		FITTING STRAIGHT M5-4MM TUBE	6555240294	6555240294
6	2	EA		SCREW,8-32, 3/16"SHOULDER,1"LG,SS	6553060398	6553060398
5	1	EA		LASER MOUNTING PLATE,SSLCAL	6581700325	6581700325
4	1	EA		SPACER,COILFORM, SSLCAL	6581700327	6581700327
3	1	EA		THERMOELECTRIC COOLER ASSY,LASER,SSLCAL	6581800242	6581800242
2	4	EA		WASHER FLAT .377x.163x1/8T TEF	6553020124	28306013
1	1	EA		SHIM GUIDE,STATIC MODULE,SSLCAL	6581700326	6581700326

DESIGNER	DATE (YY.MM.DD)	CHECKED	DATE (YY.MM.DD)	ENG. APPROVAL	DATE (YY.MM.DD)
SHEATH	12.03.20	MHUGHES	12.03.20	FHARAN	12.03.20

Honeywell

TITLE: 1-SIDED OPTICAL CALIPER MSMT STATIC MODULE ASSEMBLY SINGLE SIDED LASER CALIPER

TOLERANCES

PROJECT: STANDARD PART

FINISH

USED ON	WO No.	CO No.	SYS No.
094213X2			

SHEET	UNITS	SCALE	SIZE	PARENT DRAWING No.	DRAWING No.	REV.
1/4	in	1:1	D		6581800227 DD 01	01

Inventor Drawing - See Model

NOTES:

1. ASSEMBLE PER MANUAL NO. 44076501 (6513021747).
2. IDENTIFY PER GN026100 (6513020038).
3. APPLY THERMAL COMPOUND (ITEM 47) TO BOTH SIDES OF TECS, AS WELL AS THEIR MATING SURFACES.
4. REMOVE LABELS FROM MOUNTING PLATE SIDE OF LASER AND CLEAN WITH ALCOHOL. LEAVE LABELS ON VISIBLE SIDE.
5. APPLY THERMAL COMPOUND (ITEM 47) TO MATING SIDE OF LASER (ITEM 41) AND LASER MOUNTING PLATE (ITEM 5).
6. APPLY THERMAL COMPOUND (ITEM 47) TO THE BOTTOM SURFACES OF ITEM 9.
7. ATTACH 4MM TUBING (ITEM 50) TO FITTING (ITEM 7) AND THREAD THROUGH COVERS TO PURGE BLOCK (ITEM 29) BEFORE SECURING THE COVERS TO THE BASEPLATE.
8. APPLY THERMAL COMPOUND TO THREADS OF THERMISTOR (ITEM 51).
9. ATTACH ITEMS 11 AND 15 AFTER SECURING ITEMS 9 AND 10 TO BASEPLATE (ITEM 33).
10. NOTE ORIENTATION OF TECS. SMALLER SIDE IN CONTACT WITH COILFORM (ITEM 48), LARGER SIDE IN CONTACT WITH BASEPLATE (ITEM 33).
11. RTV ITEM 43 TO ITEM 13 USING ITEM 49.
12. TO SIMPLIFY ALIGNMENT, ATTACH SPACERS (ITEMS 42) TO DUST COVER (ITEM 13) BEFORE SECURING THEM TO BASEPLATE (ITEM 33).

Figure D-2 Laser Caliper STA-module Assembly (1 of 4)

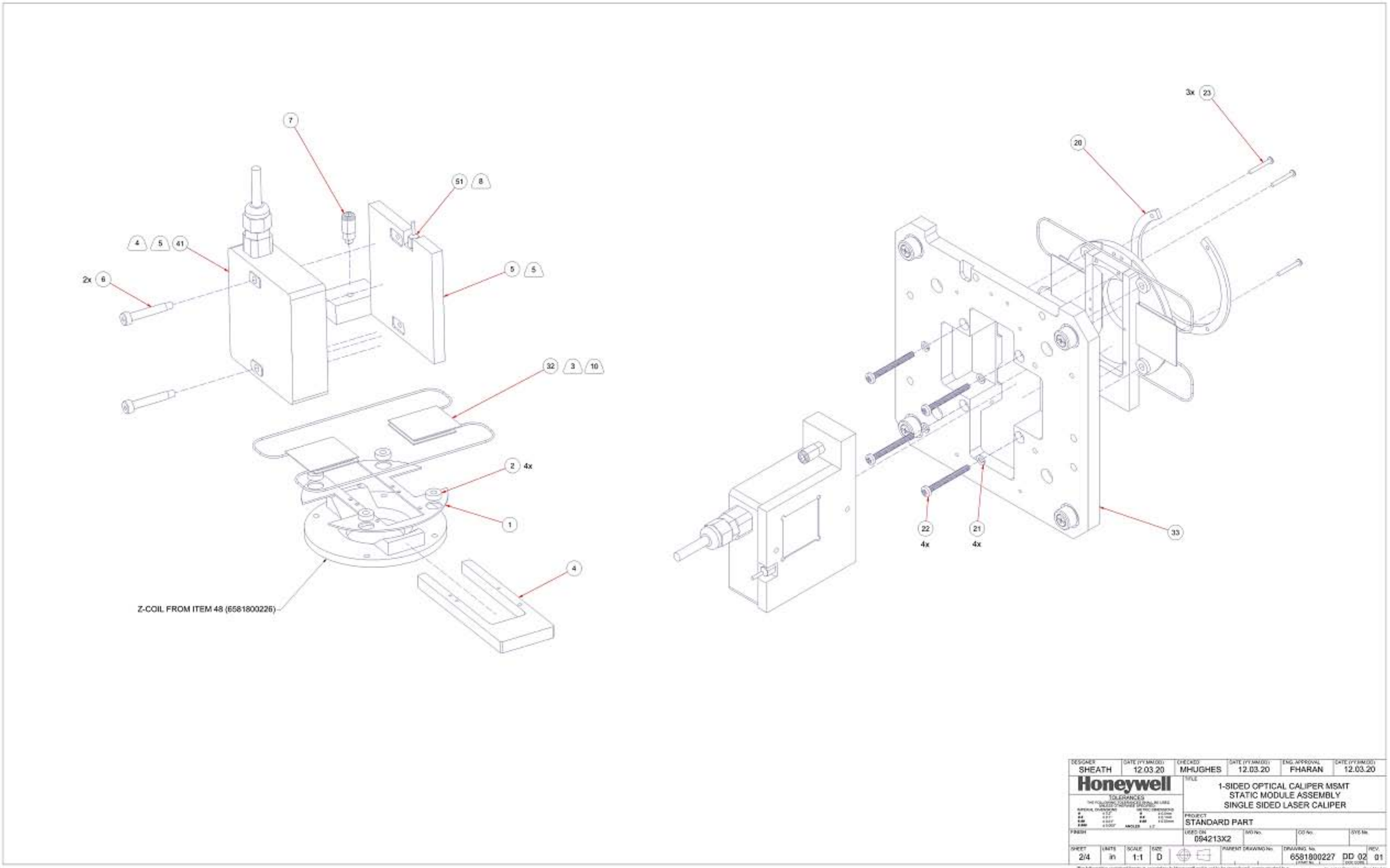


Figure D-3 Laser Caliper STA-module Assembly (2 of 4)

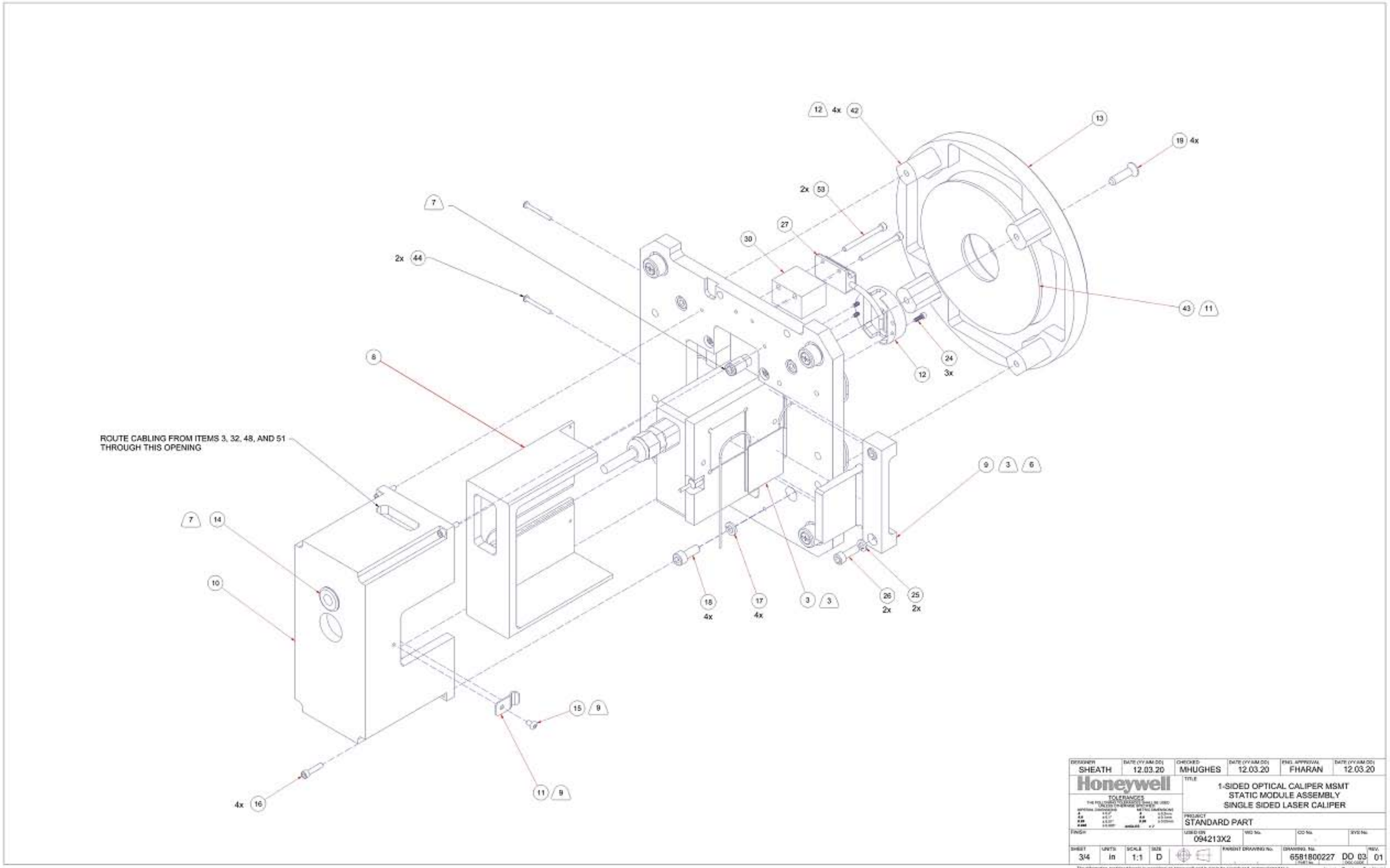


Figure D-4 Laser Caliper STA-module Assembly (3 of 4)

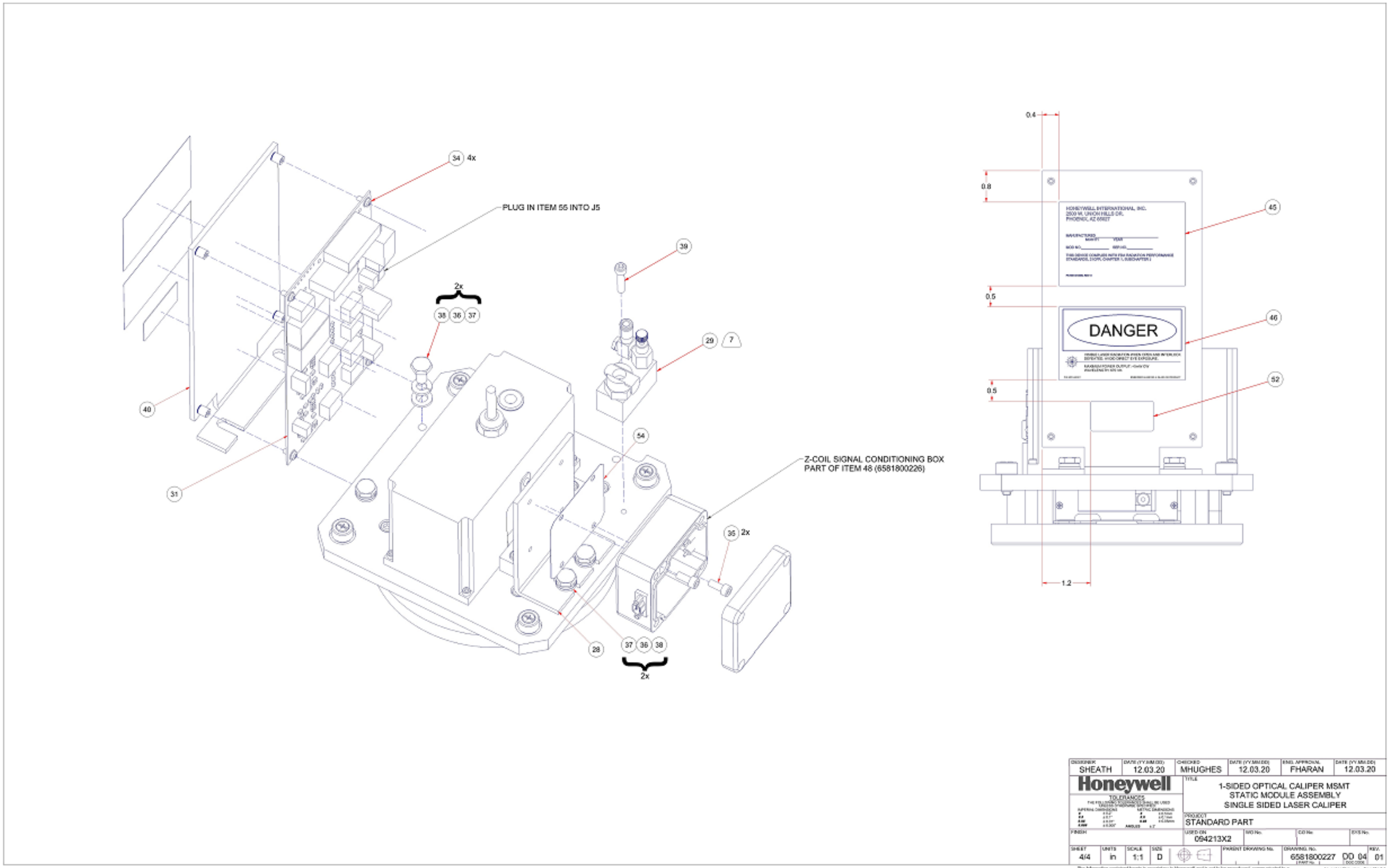
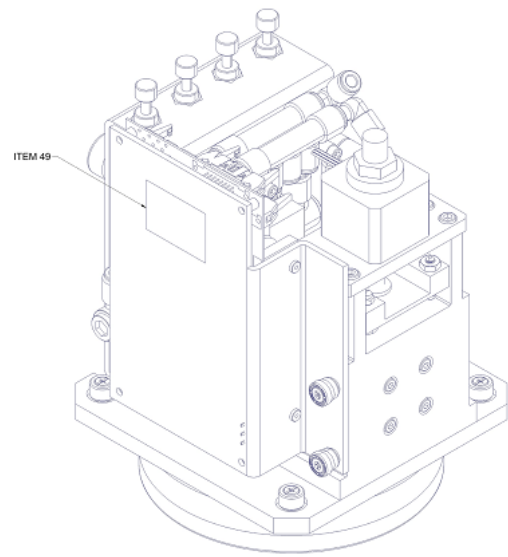


Figure D-5 Laser Caliper STA-module Assembly (4 of 4)



NOTES:

1. ASSEMBLE PER MANUAL NO. 44076501 (6513021747).
2. IDENTIFY PER GN026100 (6513020038).
3. USE 0.006" FEELER GAUGE TO ALIGN LINEAR STAGE (ITEM 2) TO BRACKET (ITEM 5). ENSURE EVERYTHING IS SQUARE.
4. FULLY INSERT LOCATING BUTTON. THESE WILL BE SET DURING SENSOR TESTING.
5. USE 0.016" FEELER GAUGE TO ALIGN CONNECTOR PLATE (ITEM 4) TO BRACKET (ITEM 5). ENSURE EVERYTHING IS SQUARE.
6. ATTACH STEPPER MOTOR ASSEMBLY (ITEM 23) TO STEPPER MOTOR BRACKET (ITEM 41) USUNG ITEMS 8 AND 28. THEN SLIP STEPPER MOTOR WASHER (ITEM 31) OVER STEPPER MOTOR SHAFT AND ATTACH TO CONNECTOR PLATE (ITEM 4) USING ITEMS 33 AND 32. DO NOT FULLY TIGHTEN NUT (ITEM 33). ONCE ITEMS 2 AND 41 HAVE BEEN SECURED TO SLIDE MOUNT (ITEM 1), TIGHTEN STEPPER MOTOR SHAFT NUT (ITEM 33).
7. DO NOT FULLY SECURE ITEM 3 USING ITEMS 16 UNTIL THE DOME BODY (ITEM 9) HAS BEEN MOUNTED TO ITEM 5 (AS SHOWN ON SHEET 3).
8. RTV MAGNET (ITEM 10) INTO DOME (ITEM 6) USING ITEM 44.
9. APPLY THERMAL COMPOUND (ITEM 45) TO THERMISTOR THREADS (ITEM 38) PRIOR TO ATTACHING TO DOME (ITEM 6).
10. ROUTE LEADS OF THERMISTOR (ITEM 38) THROUGH OPENING IN DOME BODY (ITEM 9) AND BASEPLATE (ITEM 37).
11. RTV O-RINGS (ITEM 11) INTO COUNTERBORES IN DOME BODY (ITEM 9) USING ITEM 44.
12. ORIENT AIRCLAMP (ITEM 7) ACCORDING TO SYSTEM DESCRIPTION, SEE SHEET 5.
13. APPLY THERMAL COMPOUND (ITEM 45) TO THE BACK SIDE OF IC'S FROM I/F BOARD (ITEM 42) THAT MATE WITH I/F BRACKET (ITEM 24).
14. POPULATE HOSES AS DESCRIBED ON SHEET 4 USING ITEMS 47 AND 46. ENSURE TUBING IS CUT IS CLEANLY AND SQUARELY.
15. LABEL ALL FOUR REGULATORS AS SHOWN ON SHEET 5.
16. ONCE ITEM 41 IS FASTENED TO ITEM 1, STRETCH SPRING AND ATTACH TO SPRING PINS ON ITEM 41 AND ITEM 4.
17. LABEL HOSES WITH CORRESPONDING PRESSURE SENSOR "Uxx" DESIGNATION. ON U4 AND U17 CONNECTORS USE A SMALL AMOUNT OF RTV OR 1/8" HEAT SHRINK ON SENSOR NIPPLE TO SECURE HOSE.
18. TO PREVENT DAMAGE TO LVDT, INSERT WITH ONLY A FEW THREADS OF ENGAGEMENT. LVDT WILL BE ADJUSTED DURING OVEN TEST.

ITEM	QTY	UNITS	MATL	DESCRIPTION	PART NUM	GMO PART NU
50	1	EA		JUMPER, BASE IN PLACE SWITCH, SSLCAL	6581600300	6581600300
49	1	EA	VINYL	LABEL HONEYWELL ASSY NO. REV LEVEL	6551430064	00283201
48	2	EA		PLUG, 6MM TUBE, BLUE	6555240249	6555240249
47	0.5	MTR	POLYU	TUBING, POLYURETHANE, 4MM, BLACK, Q4000	6556900030	6556900030
46	2	MTR	POLYU	TUBING, POLYURETHANE, 6MM, BLACK	6556900031	6556900031
45	0	EA		THERMAL JOINT COMPOUND	6530200009	16000049
44	0	EA		SEALANT RTV SILICONE 3145	6530230020	16000040
43	6	EA		SCREW 4-40x.25 PH PAN SEM ZN	6553080250	28104077
42	1	EA		PCBA - LASER CALIPER CAL MODULE	6581500046	6581500046
41	1	EA		BRACKET,STEPPER MOTOR,SSLCAL	6581700315	6581700315
40	1	EA		SCREW 10-32x1/4 SH SET T304	6553080239	28110070
39	3	EA	304SS	SCREW 10-32x.75 SH FLT T304	6553080161	28110034
38	1	EA		THERMISTER ASSY,30K,CAL MODULE,SSLCAL	6581600232	6581600232
37	1	EA		BASE PLATE,CAL-MODULE,SSLCAL	6581700309	6581700309
36	8	EA		AIRLINE CONNECTOR,M5 TO 6MM TUBE,SSLCAL	6581700316	6581700316
35	4	EA	304SS	SCREW 1/4-20 x5/8" SH CAP T304	6553080220	28116009
34	1	EA		SPRING, EXT. .026x.250x.700	6553400068	6553400068
33	1	EA	304SS	NUT 6-32 HEX 11/32 T304	6553010041	
32	5	EA	304SS	WASHER SPLT 6x.040"T304	6553020055	28306002
31	1	EA	BRS	WASHER, STEPPER MOTOR, LASER CAL	6581700081	6581700081
30	2	EA	304SS	NUT 10-32 HEX 3/8 T304	6553010026	28210005
29	2	EA		LOCATING BUTTON 10-32 X 1.0"	6581100013	25000731
28	4	EA		SCREW 4-40X3/8 SH CAP T304	6553080264	28104007
27	2	EA	304SS	BOLT 1/4-20x1/2" HX T304	6553000019	28116014
26	2	EA	302SS	WASHER FLAT 1/4x.064" SS18-8	6553020095	28316007
25	1	EA		AIR MANAGEMENT ASSEMBLY,SSLCAL	6581600229	6581600229
24	1	EA		MOUNTING BRKT,CAL-MOD. I/F BOARD,SSLCAL	6581600080	6581600080
23	1	EA		STEPPER MOTOR ASSY, SSLCAL	6581600241	6581600241
22	8	EA	304SS	SCREW 10-32x3/8 SH CS T304	6553080098	28110108
21	8	EA	304SS	WASHER SPLT 10 x.047" T304	6553020044	28310004
20	4	EA	304SS	SCREW 8-32x1/2 SH CS T304	6553080023	28108015
19	4	EA		SCREW M4x10mm SH CS T316	6553780138	28504006
18	4	EA	316SS	WASHER SPLT 4x0.9mm T316	6553720018	28704002
17	4	EA	316SS	SCREW M4x16mm SH CS T316	6553780051	28504009
16	8	EA		SCREW 4-40x1/4 SH CS T304	6553080275	28104013
15	10	EA		FITTING STRAIGHT M5-6MM TUBE	6555240285	6555240285
14	1	EA		LVDT ASSEMBLY, SSLCAL	6581600240	6581600240
13	6	EA	304SS	WASHER SPLT 1/4x.062" T304	6553020042	28316004
12	1	EA		GUIDE SHAFT,CAL-MODULE DOME,SSLCAL	6581700314	6581700314
11	10	EA	POLYU	O-RING #2-006 .114x.07" POLYUR	6553260073	25000374
10	1	EA		MAGNET SEMARIUM COBALT 1/2"OD X 1/4" THK	6581100004	25000563
9	1	EA		DOME BODY,CAL-MODULE,SSLCAL	6581700313	6581700313
8	12	EA	304SS	WASHER SPLT 4 x.031" T304	6553020049	28304001
7	1	EA		AIRCLAMP ASSEMBLY,DUAL COANDA W/ VACUUM	6581600230	6581600230
6	1	EA		DOME, CAL-MODULE,SSLCAL	6581700312	6581700312
5	1	EA		SLIDING STAGE BRACKET,SSLCAL	6581700311	6581700311
4	1	EA		CONNECTOR PLATE,SSLCAL	6581700310	6581700310
3	1	EA		BEARING, LINEAR, MISUMI LHCK6	6581100063	6581100063
2	1	EA		SLIDE TABLE SINGLE AXIS	6581100009	14000549
1	1	EA		SLIDE MOUNT, NARROW, LASER CAL	6581700138	6581700138

DESIGNER	DATE (YY.MM.DD)	CHECKED	DATE (YY.MM.DD)	ENG. APPROVAL	DATE (YY.MM.DD)
SHEATH	12.03.23	MHUGHES	12.03.23	FHARAN	12.03.23

Honeywell

TOLERANCES

TITLE: 1-SIDED OPTICAL CALIPER MSMT CAL-MODULE ASSEMBLY SINGLE SIDED LASER CALIPER

PROJECT: STANDARD PART

FINISH | USED ON | WO No. | CO No. | SYS No.

SHEET	UNITS	SCALE	SIZE	PARENT DRAWING No.	DRAWING. No.	REV.
1/5	in	1:1	D		6581800228 DD 01	01

Inventor Drawing - See Model

Figure D-6 Laser Caliper Sensor CAL-module Assembly (1 of 5)

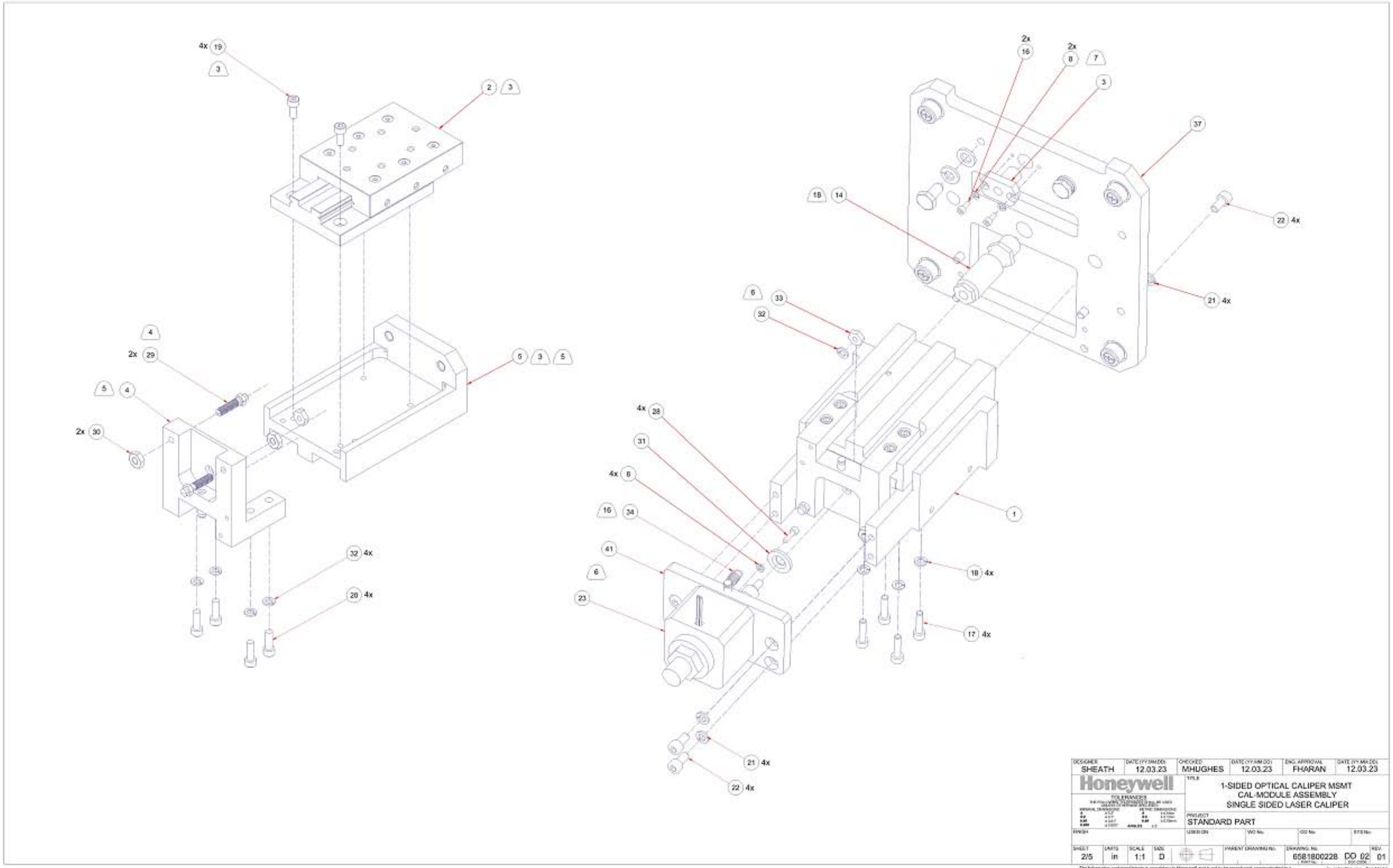


Figure D-7 Laser Caliper Sensor CAL-module Assembly (2 of 5)

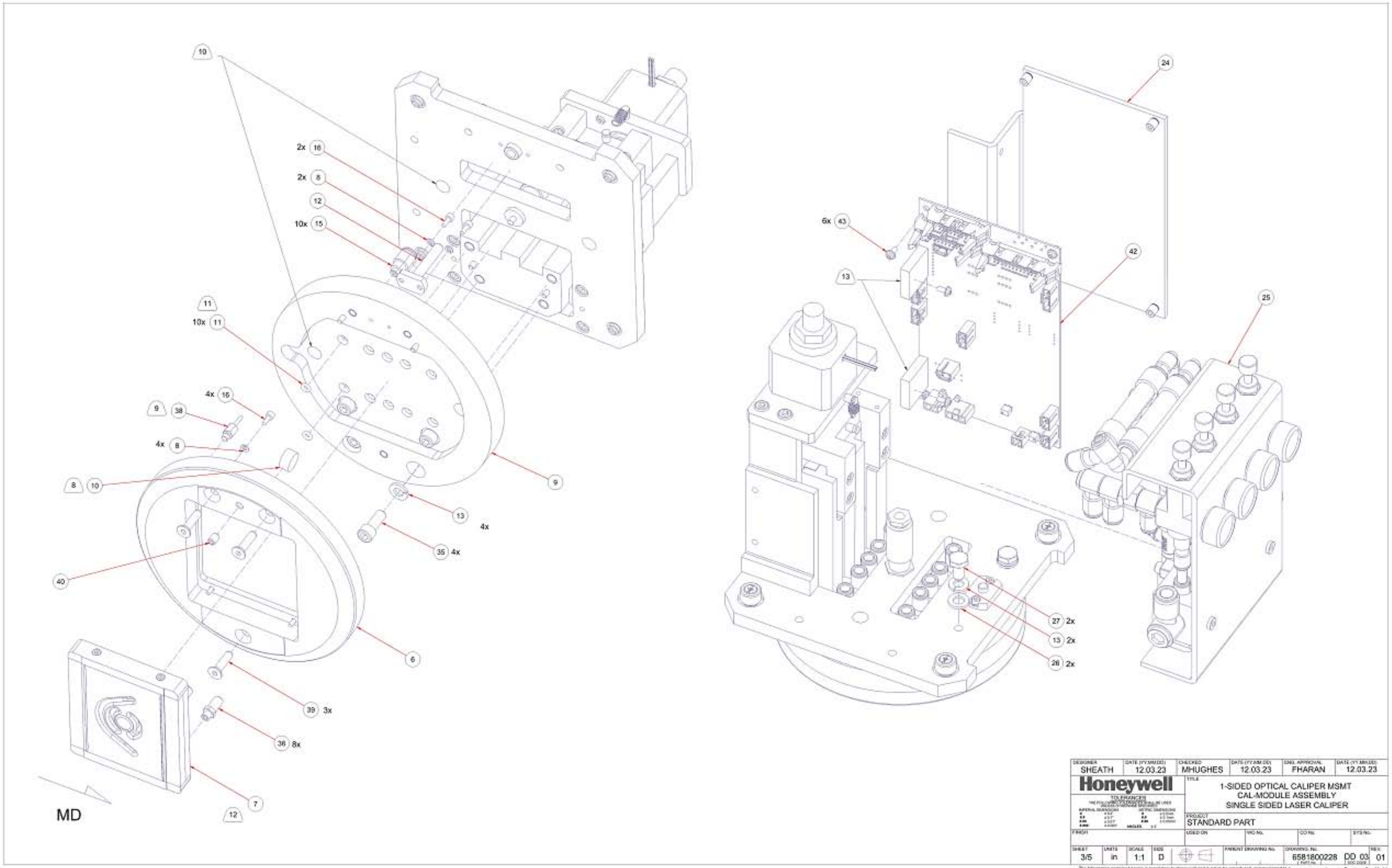


Figure D-8 Laser Caliper Sensor CAL-module Assembly (3 of 5)

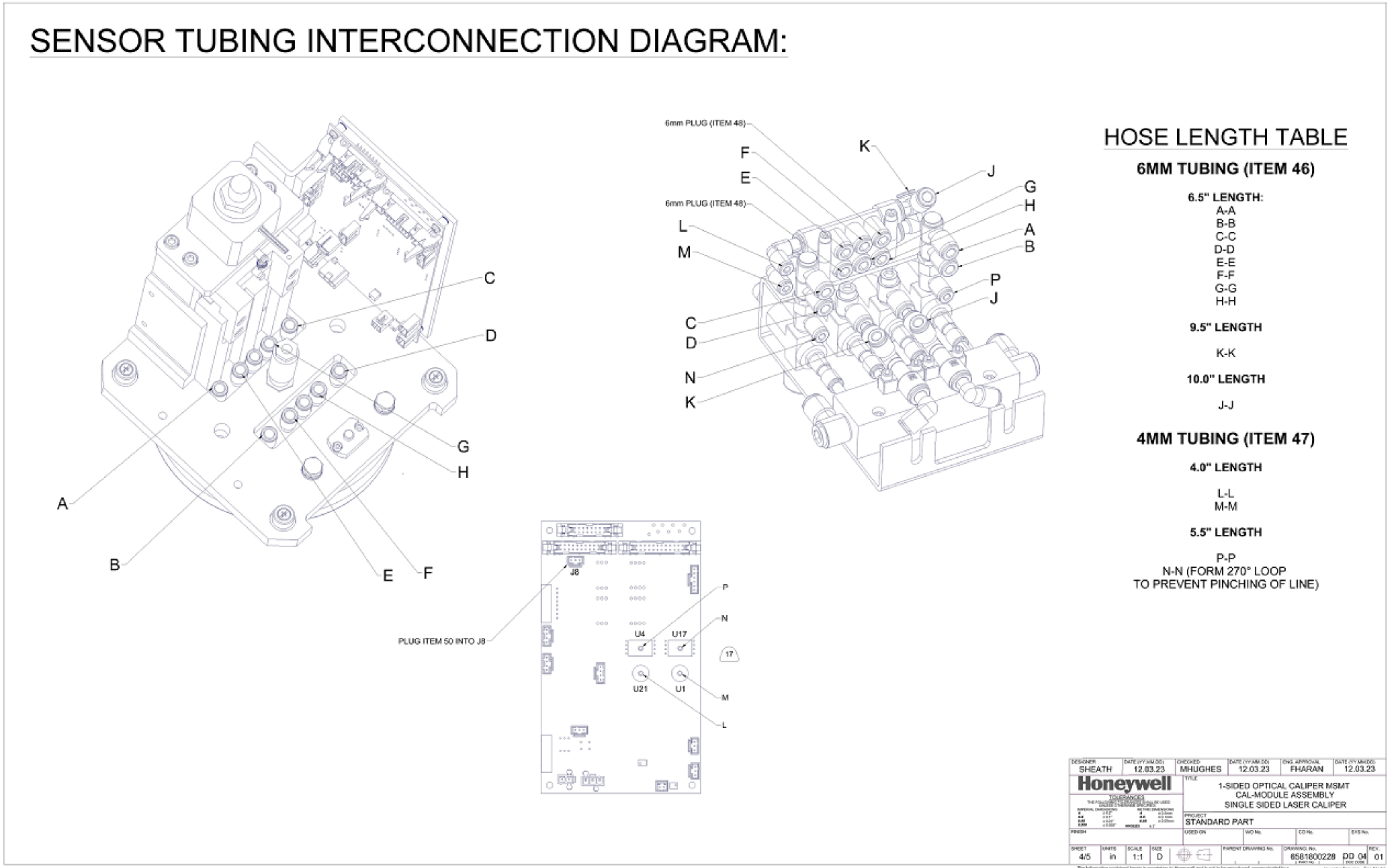


Figure D-9 Laser Caliper Sensor CAL-module Assembly (4 of 5)

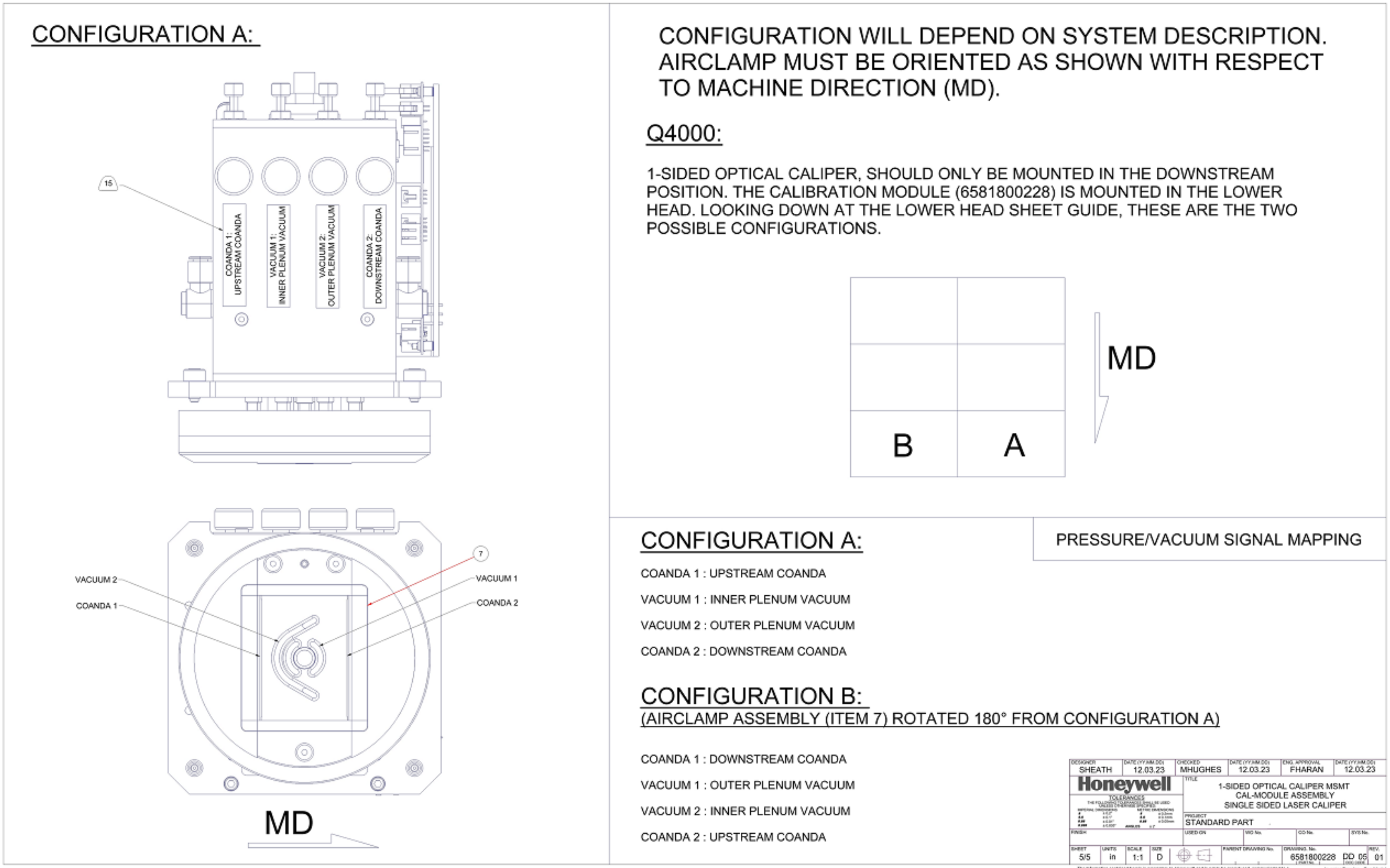
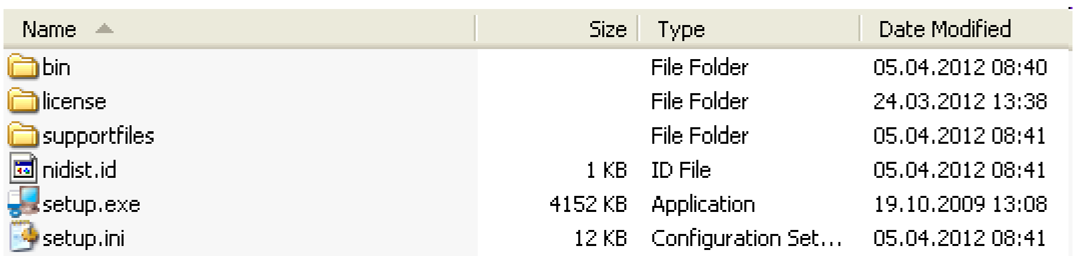


Figure D-10 Laser Caliper Sensor CAL-module Assembly (5 of 5)

E. Installation of CorrectorUtility

Appendix E provides installation instructions for the *CorrectorUility* program.

CorrectorUtility is distributed as an installation package, which is suitable for Pentium class PCs running Windows 2000 to Windows 7. It contains files such as those shown in Figure E-1 in the main directory of the distribution.



Name	Size	Type	Date Modified
bin		File Folder	05.04.2012 08:40
license		File Folder	24.03.2012 13:38
supportfiles		File Folder	05.04.2012 08:41
nidist.id	1 KB	ID File	05.04.2012 08:41
setup.exe	4152 KB	Application	19.10.2009 13:08
setup.ini	12 KB	Configuration Set...	05.04.2012 08:41

Figure E-1 Files in Distribution

1. The *setup.exe* file should be run from whichever media it is delivered on, for example, from the CD, or after unzipping a downloaded archive to a local drive. If any security warnings concerning running software of unknown provenance are shown, they should be overridden.

2. Some default installation directories will be proposed, such as shown in Figure E-2. It is recommended that the defaults be accepted, then the **Next** button can be clicked.

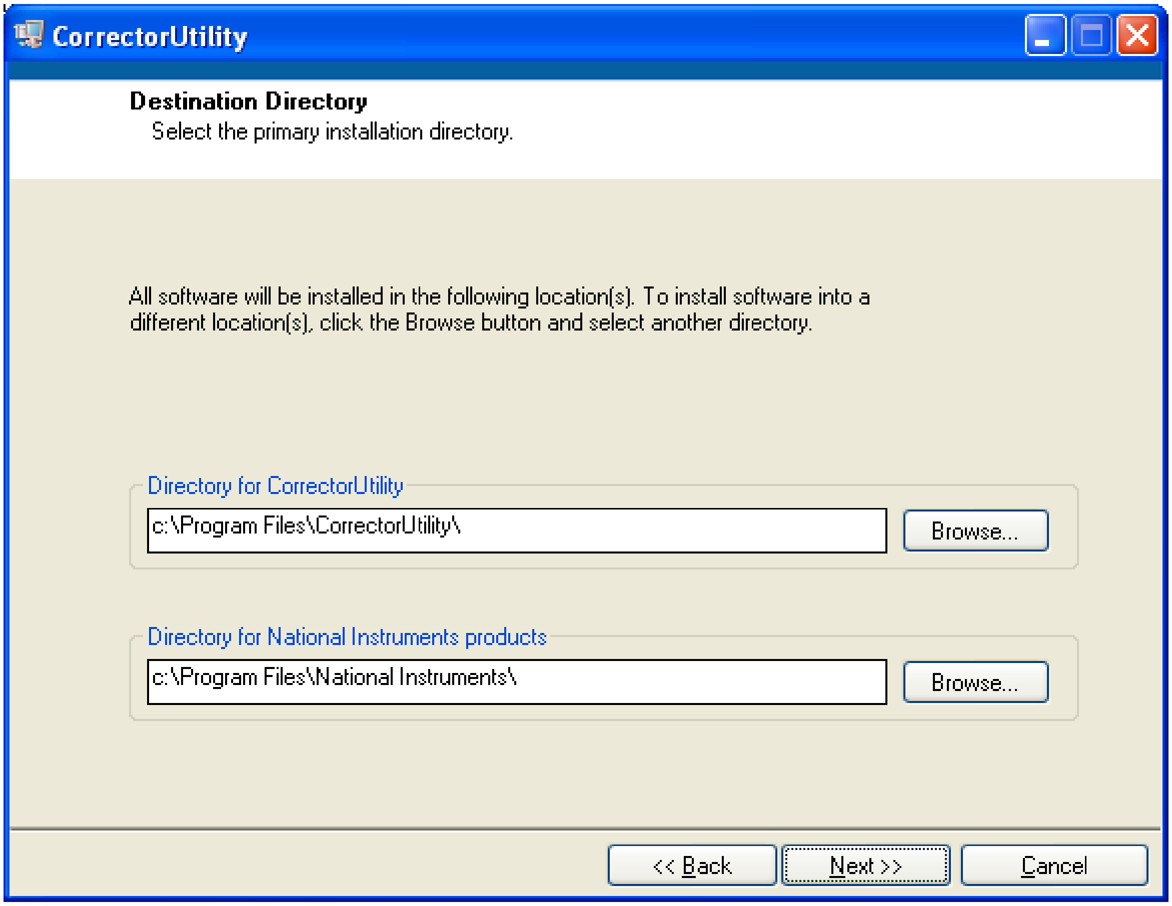


Figure E-2 Installation Directories

3. It is necessary to accept the license agreement from National Instruments. This license governs the Labview run-time incorporated in the utility.

4. A summary of the installation will appear, as shown in Figure E-3. Click **Next** to install the program.

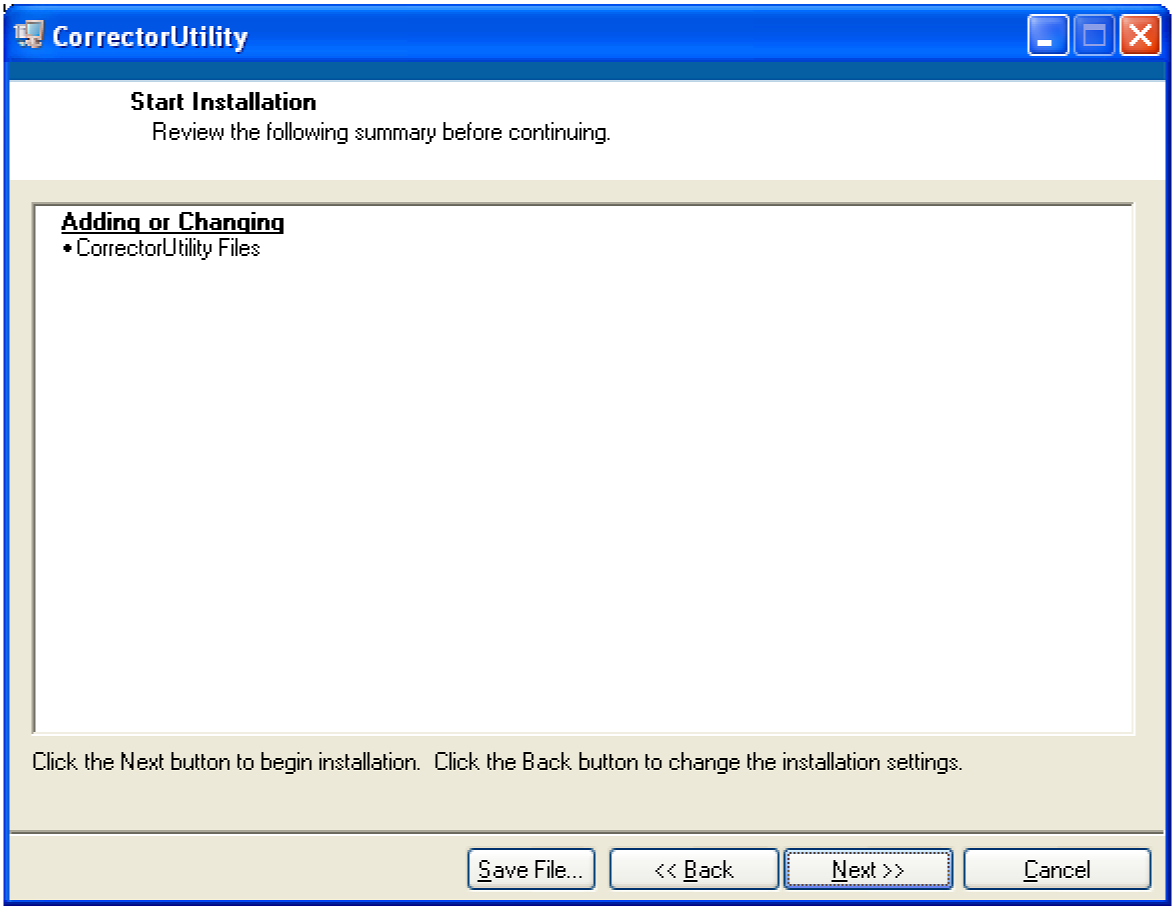


Figure E-3 Installation Summary

5. A progress screen will be shown during the installation; after installation is complete, an *Installation Complete* message appears.

6. A new program group **CorrectorUtility** should appear in the menu, containing a link to the *CorrectorUtility* program, as shown in Figure E-4.

Figure E-4 Program Menu