Honeywell Reflectance Infrared Spectrometer Sensor

User's Manual

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Reflectance Infrared Spectrometer Sensor User's Manual

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Introduction

The purpose of this manual is to provide an overview, and procedure to install, configure, and commission the 3-4810 Honeywell Reflectance Infrared Spectrometer (RIS) Sensor.

Audience

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

About this Manual

This manual contains 10 chapters, 1 appendix, and a glossary.

Chapter 1, System Overview, provides introduction to the measurement concept and overview of the sensor construction.

Chapter 2, Installation, provides steps for installing the RIS Sensor on a Honeywell scanner.

Chapter 3, Calibration, describes the calibration methods and procedures related to the RIS Sensor.

Chapter 4, RIS Optics, explains in detail the process for the optical construction of the sensor.

Chapter 5, RIS Electronics, introduces the electronics that are used to make the RIS Sensor and provides detailed overview of functional ideas and operations.

Chapter 6, Mechanics, Pneumatics and Cooling, describes the mechanical structure and the pneumatics of the RIS Sensor.

Chapter 7, Maintenance and Troubleshooting, describes procedure for cleaning, performing system checks and replacing parts within RIS Sensor.

Chapter 8, Transportation, Storage and End of Life, describes the standard procedure that needs to be followed during the storage, and disposal of certain sensor materials.

Chapter 9, Glossary contains definitions of terms.

Chapter 10, Appendix, describes the Default Values of Database Constants, provides all the software variables related to the RIS Sensor and their default value.

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 RIS (Reflectance Infrared Spectrometer) Sensor is intended for CWS (Continuous Web Solutions) on-line measurement applications. The sensor uses reflecting geometry for measuring the thickness of individual layer in multilayer plastic applications. The CWS applications include single and multiple coatings of extrusions on diffuse substrates such as paperboards, filled plastics, and matte finish metals.

The developed sensor is used for scanning cross-directional quality measurements on plastics, nonwovens, and coated products. The measurements include total thickness or area weight, and also the measurement of the individual layer compounds. The sensor uses a spectrometer to measure discrete wavelengths.

1.2. Overview of the RIS Sensor Head Construction

The RIS Sensor is constructed into a CWS sensor head box, which is otherwise known as a G-Head. The sensor works on the principle of single sided reflectance measurement. The sensor head contains IR source, receiver optics, and electronics for data acquisition, data processing, and control of the measurement routines. Figure 1-1 shows the general overview of the RIS Sensor build in the G-Head.

Figure 1-1 Overview of the RIS Sensor

When the G-Head cover is removed, the front view (Figure 1-2) shows the essential parts of the sensor such as: Control PCBA, Chopper location, IR source (incandescent halogen lamp) location, and one edge of Detector PCBA with its connector row.

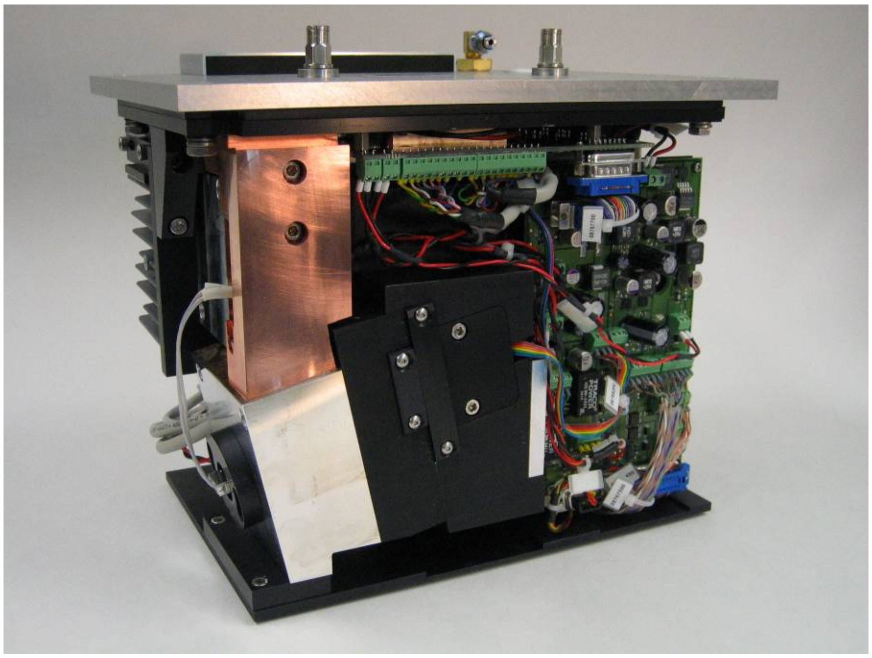


Figure 1-2 Front view of the sensor.

The sensor processor (cRIO) (Figure 1-3) is located at the back of the sensor head, and the pneumatic parts are located below the sensor processor. The movement of standard sample can be adjusted by the air valves. An adjustment to the air purge flow is also provided. You can also see the Standardization sample mechanics, the cylinder, and the magnet valve. The cabling between sensor processor and the different PCBAs is done by using the two cable pipelines routed through the mechanical structure of the sensor.

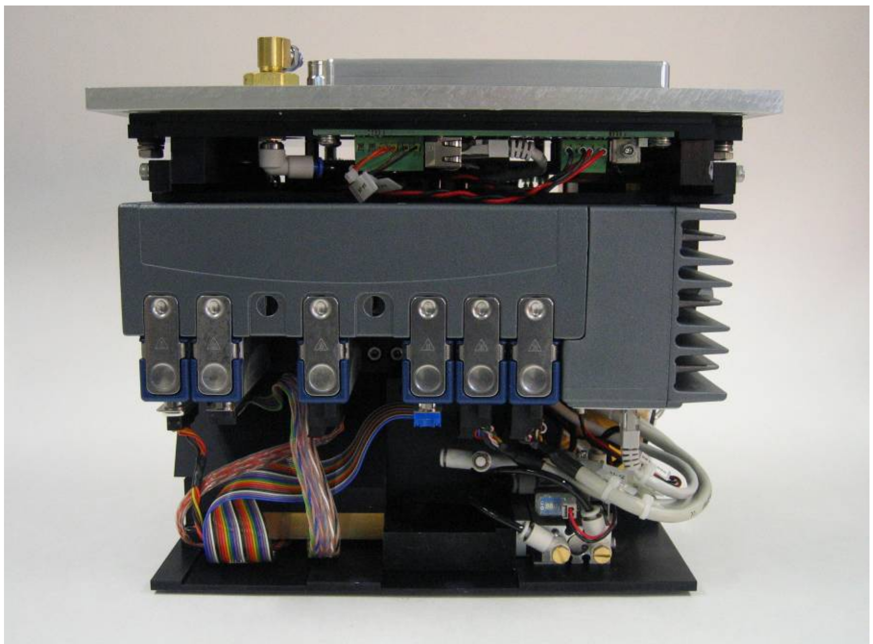


Figure 1-3 Back view of the sensor

From the top view (Figure 1-4) of the sensor you can locate sensor air inlet, water connections, and the electric connectors, which are normally covered by a lid during on-line operation.

Figure 1-4 Top view of the sensor

The bottom view (Figure 1-5) displays an opening for the optics through which the measurement is done. When the standardization sample is ON the opening is closed. When the standardization sample is OFF the source and receiver windows are exposed.

Figure 1-5 Bottom view of the sensor

1.3. Understanding Reflectance Infrared Spectrometer Measurement

RIS Sensor is a new infrared sensor, which is developed based on a specially designed detector–spectrograph module. The instrument measures 128 wavelength channels in a spectral range between 1.6 – 4.1 µm. The instrument is mainly designed for quantitative analysis of polymer coatings.

1.3.1. IR Source

The IR source is constructed using halogen lamp, condensing mirror, chopper wheel, reflector, and window. This design (Figure 1-6) uses large NA collector for the lamp, and a second mirror, which focus light behind the target plane. You can see the Window in the following figure.

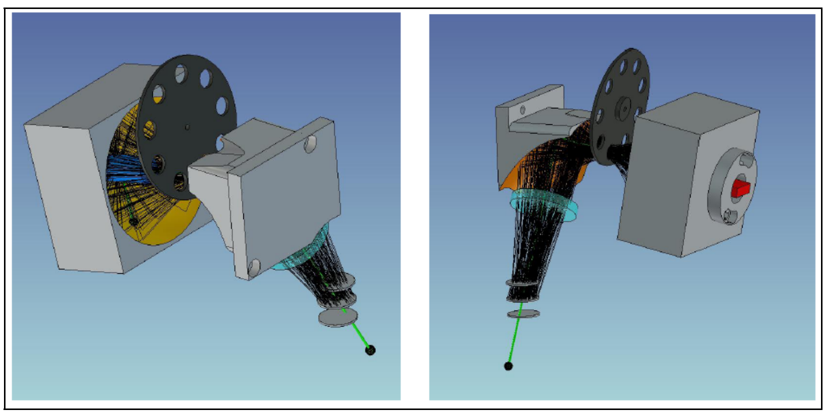


Figure 1-6 IR source design

1.3.2. Receiver Optics

The receiver optics is constructed using the following components: Window, condensing mirror, flat mirror, light mixing tube, second condensing mirror, second flat mirror, spectrograph, and detector.

Figure 1-7 is an illustration of IR light receiver optics within the instruments mechanical structure (rays shown in black). The first condensing mirror lies at the bottom, the second is on the right, and the detector is present at the top. The sample surface is illustrated as a sheet in the following instrument.

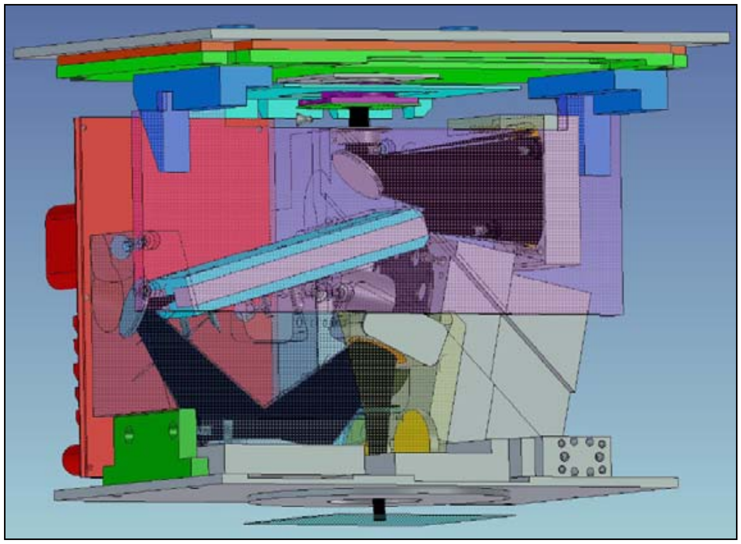


Figure 1-7 Illustration of IR light receiver optics

1.3.3. IR Detector

A 128 element array is used to detect the infrared light. The detector array is specially designed to match the demands of this sensor. The wavelength range of the detector is optimized for the RIS Sensor. The detector is thermoelectrically cooled.

1.3.4. Functional Structure of the RIS Sensor

The function structure of the RIS Sensor is illustrated in the Figure 1-8.

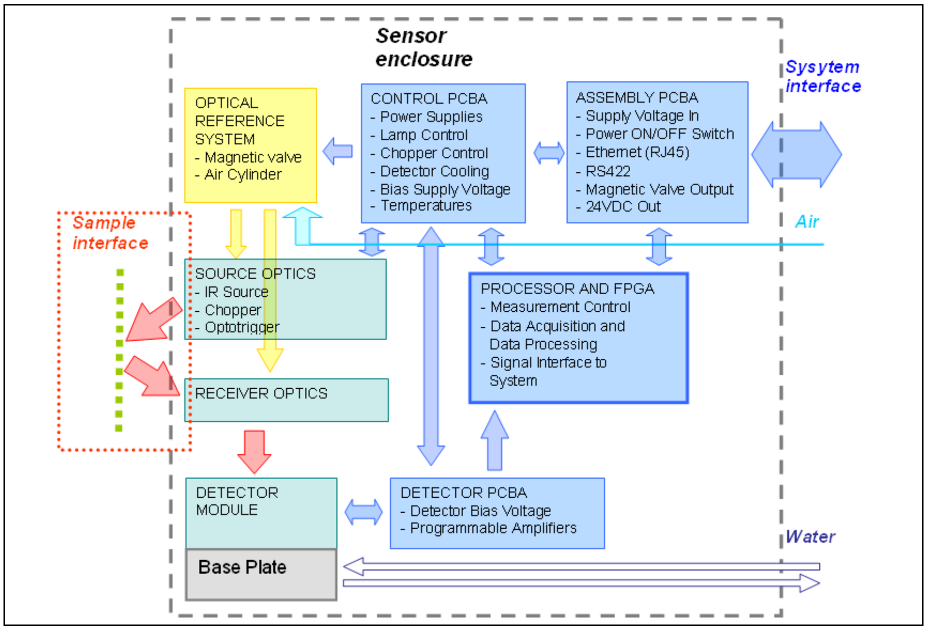


Figure 1-8 Functional schematics of RIS Sensor

1.3.5. Operational and Performance Specifications

Following are the brief list of the instrument characteristics:

- Spectral range: 1600 to 4100 nm (~6250, ~2440 cm-1).
- Spectral resolution: ~20 nm
- Spot size at the sample: ~ 4 x 12 mm
- Availability of sample spectrum and measurement frequency: every 10 milliseconds
- Measurement distance: 0 - 25 mm

2. Installation

This chapter describes the installation procedure for RIS Sensor. It describes the mechanical installation, and provides the details regarding communication. This chapter also provides the installation procedure to add the sensor to the existing scanner.

Following sections provide step-by-step instructions for installing the RIS Sensor. The steps mentioned in the chapter needs to be performed in the same order as listed (for first time installation).

The procedure also includes how to start/stop the MXProLine (RAE) -server. If there are any special instructions on the site on how to shutdown or re-start the servers or in which order those steps should be done, follow your local instructions. This situation is meant as an example. Follow the instructions, if there are data collector systems or links, which need special start/stop steps.

NOTE: Do not power on the sensors, scanners, or the MSS/PMP unless mentioned.

The sensor is provided with an ON/OFF switch. An additional software function is available to power ON/OFF sensor operation. To operate lamp, chopper, and thermoelectric cooler, you need the software function to be ON. When there is a request to power ON/OFF the sensor, it means that the sensor has to be powered ON/OFF using the sensor hardware switch. If there is a request to power ON/OFF Scanner and or MSS then use Main Circuit Breaker inside the MSS/PMP-box. When there is a request to power ON/OFF sensor lamp then use software function (There is a software button available in UI.)

CAUTION	When the sensor is operating, do not attach and leave the sample in the front of measuring head for long time, as the tungsten halogen lamp is very hot.

2.1. Hardware Requirements

Before installing the RIS Sensor, ensure that the system meets the following requirements:

1. MXProLine system with ProLine scanner (By default, your scanner contains the RIS Sensor installed to scanner. However, it is still recommended to check all connections in the installation location).

2. PCI-PCDAQ card (*P/N 05438200*) is installed in MSS Scanner (PMP Box)

OR

3. Scanner MSS has free PCI slot for PCI-PCDAQ. (Installation chapter also includes steps to perform the PCI-PCDAQ card installation and configuration.)

4. The default scanner installation version is 2080.

5. RAE 4 Update 8 and later, or RAE5 Update 1 and later

6. Water:

   - The minimum Coolant flow rate must be 1 litre/min

   - The Coolant temperature must be between +10 and +25 °C

7. Air:

   - Air Pressure must be between 100 - 300 kPa (1 – 3 bar) at sensor input

Consult Honeywell Engineering if these requirements are not met.

2.1.1. Materials Needed

The RIS Sensor is built in G-Head. For custom mounting options, contact Honeywell engineering.

The following sub-assemblies are included with the RIS Sensor:

- Sensor head (PN. 086730XX/ G-Head) with modified Assembly PCB (PN. 05444200) for Bulkhead.

NOTE: This sensor is a Single Side sensor.

- Users Manual
- Software ADD-ON packet (RIS add-on) for current RAE version.

The following subassemblies are not included with the RIS Sensor and must be ordered separately:

- PCI-PCDAQ card (P/N 05438200),
- Cabling from PCI-PCDAQ board to TS1 in PMP Box (P/N 6580800748 or similar),
- MXProLine Water Cooling Kit (P/N 09852700).

2.1.2. Tools

The following tools and materials are needed to complete the RIS Sensor installation:

- Wrench set – Imperial
- Ratchet socket set - Imperial
- Hex keys – Imperial
- Screwdriver set
- Exacto Knife

- Tie wraps – ¼”x6”long
- Anti-Seize compound
- Loctite – Thread locker

2.2. Hardware Installation

2.2.1. Mounting the Sensor Head

As a standard configuration RIS Sensor is assembled into G-Head box (Figure 2-1). The Mechanical head mounting to scanner is equivalent to the standard G-Head mounting.

NOTE:	This guide does not explain the procedures for adding the sensor to any older scanner model other than the model described in this manual. For any custom installation option, contact Honeywell engineering.

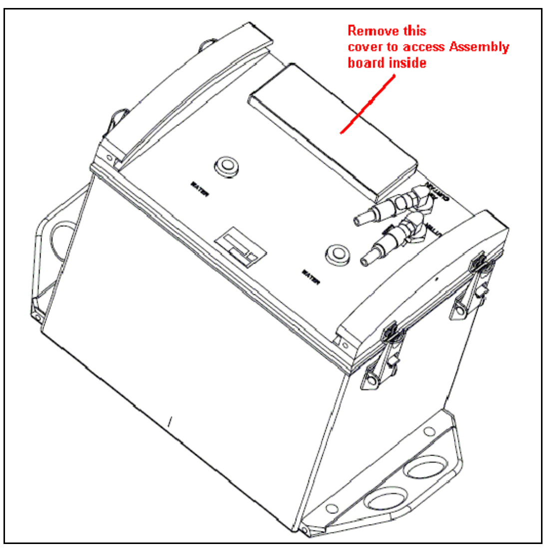


Figure 2-1 Example about G-Head

As a standard in any new orders, a site receives the scanner with a sensor head mounted. In this case only mounting check is needed.

To mount the sensor and to check the alignment, perform the following steps:

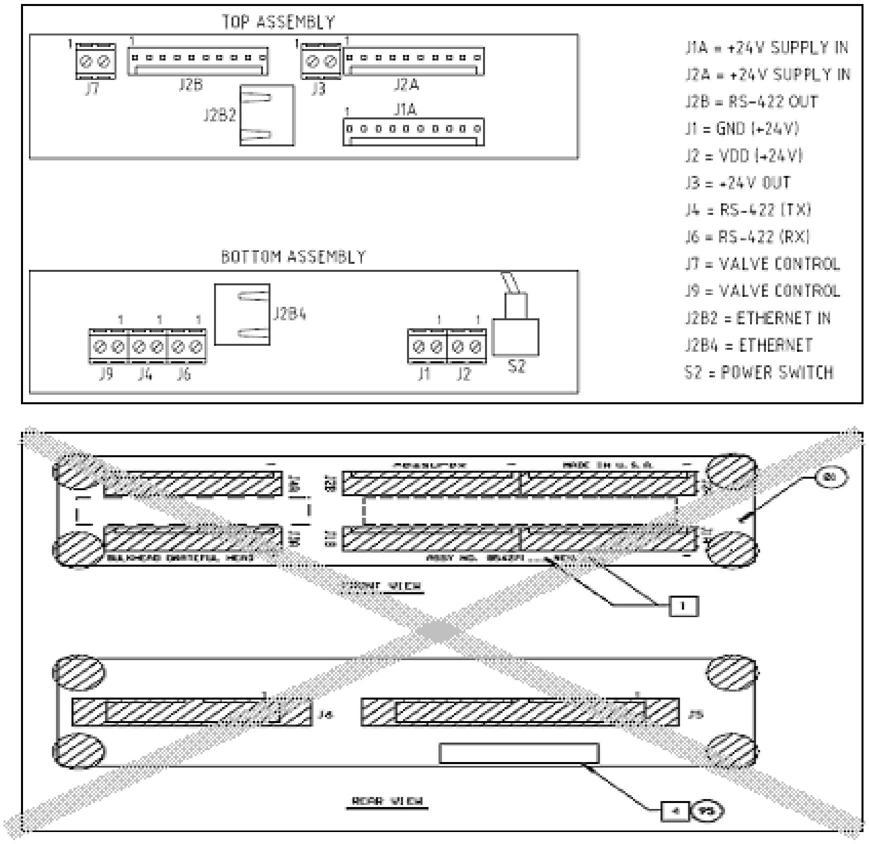
1. Before you begin, power off the scanner and the MSS/PMP.

2. Ensure that you have all the required mechanical parts.
3. Prepare the empty head carrier (or remove old head in case of custom installation)
4. Follow the instructions provided in the corresponding Scanner manual to mount the head to the scanner. (Model 2080-03 and 2080-13 scanners Manual PN. 46019100)
5. Follow the scanner manual instructions to adjust or correct the head alignment.

2.2.2. Connections

2.2.2.1. Connections to Head

Unlike earlier G-Heads with Assembly Board (PN. 05427100), the RIS Sensor uses its own dedicated RIS Assembly PCBA (PN. 05444200) for all electrical and communication connections (Figure 2-2).



FSIR Assembly PCBA P.N. 05444200 for FSIR Sensor

Assembly Board P.N. 05427100 to other sensors

Figure 2-2 Different Assembly boards

The RIS Assembly PCBA connectors at the bottom are used for cabling the sensor from actual sensor to Assembly board. This cabling is done by the manufacturer. During installation you need to concentrate only on the top connectors of Assembly PCBA carrying cabling from Assembly board to Scanner PowerTrack.

Table 2-1 Connectors from Scanner Endbell to RIS Assembly PCBA

Scanner Endbell Termination PCBA PN. 05425001			**Upper PowerTrack Endbell End Sensor Head End**						**RIS Assembly PCBA**		
Signal	Connector	Pin	Connector	Pin	Cable	Color	Connector	Pin	Connector	Pin	Signal
+24V	J1 U A	2	P1 U A	2	Cable 2	ORG	P1 A	3	J1A	3	VDD +24VDC
+24V	J1 U A	3	P1 U A	3	Cable 2	YEL	P1 A	4	J1A	4	VDD +24VDC
+24V RTN	J1 U A	4	P1 U A	4	Cable 2	GRN	P1 A	5	J1A	5	GND
+24V RTN	J1 U A	5	P1 U A	5	Cabl	BLU	P1 A	6	J1A	6	GND

Scanner Endbell Termination PCBA PN. 05425001			Upper PowerTrack Endbell End Sensor Head End						RIS Assembly PCBA		
					e 2						
+24V S	J1 U A	6	P1 U A	6	Cabl e 1	ORG	P2 A	3	J2A	3	VDD +24VDC
+24V S	J1 U A	7	P1 U A	7	Cabl e 1	YEL	P2 A	4	J2A	4	VDD +24VDC
+24V S RTN	J1 U A	8	P1 U A	8	Cabl e 1	GRN	P2 A	5	J2A	5	GND
+24V S RTN	J1 U A	9	P1 U A	9	Cabl e 1	BLU	P2 A	6	J2A	6	GND
(spare)	J3 U A	6	P3 U A	6	Cabl e 1	BRN	P2 B	1	J2B	1	TXD +
(flag 2)	J3 U B	2	P3 U B	2	Cabl e 1	ORG	P2 B	3	J2B	3	TXD -
(spare)	J3 U A	3	P3 U A	3	Cabl e 1	YEL	P2 B	4	J2B	4	RXD +
(spare)	J3 U A	2	P3 U A	2	Cabl e 1	GRN	P2 B	5	J2B	5	RXD -

Perform the following steps to connect cables to RIS Assembly PCBA:

1. Before you begin, power off the scanner and the MSS/PMP.

2. Remove the G-Head cover assembly and open the three screws that hold the shield cover of the access Assembly board.

3. Check and measure the PowerTrack wiring to confirm that it matches the sensor wiring.

4. Connect the PowerTrack connectors P1A, P2A and P2B. Due to the power requirement of the sensor, there is parallel power feeding for sensor (connectors P1A and P2A) coming from same power supply.

5. Do not connect cables to RIS Assembly PCBA connectors J3 or J2B2. These connectors are reserved for future use.

6. Do not connect output J7 unless required. This connector is reserved for special applications to control the cooling water circulation using the outer magnet valve. See RIS Electronics for more information.

7. Ensure that the Assembly board power switch is turned OFF. See Figure 2-3. Also, ensure that the green LED near the switch is not illuminated.

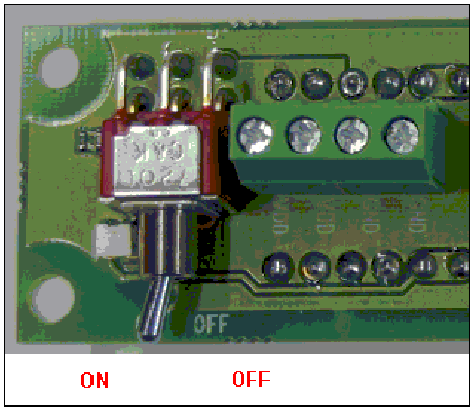


Figure 2-3 RIS Sensor power switch on Assembly board

8. Connect air from PowerTrack (¼"ID hose) to head air connection.

9. Connect water from PowerTrack to head water connections.

For more information on Connector details see *MXProLine Water Cooling Kit (P/N 09852700)*.

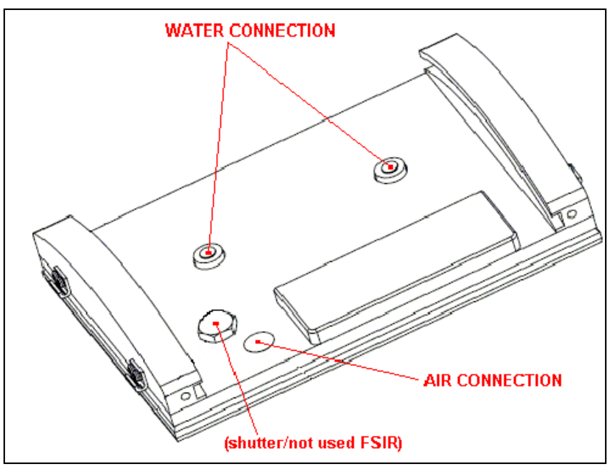


Figure 2-4 Example of G-Head plate

2.2.2.2. Connections in Scanner Endbell

It is important to check the wiring made for RIS Sensor at the Scanner Endbell. The RIS Sensor uses spare wires of PowerTrack for communication. The communication protocol is RS-422 and the pairs or wires must not be mixed. If a double head scanner is used, ensure that the signal cables are not mixed between two sensors, or signal cables and power cables are not mixed.

NOTE: Making notes and marking all wirings can help.

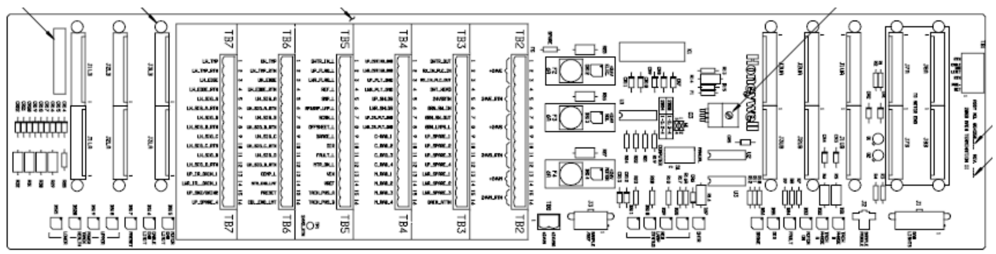


Figure 2-5 Example of endbell termination boards of one possible model of scanner

The default cabling for Upper Head installation from Sensor Head Assembly PCBA to endbell PowerTrack connectors is shown in Table 2-1.

Check wiring from system schematics. Perform the following steps to confirm cabling check and endbell cabling:

1. Before you begin, power off the scanner and the MSS/PMP.
2. Locate the communication wires from system drawings and measure the signal paths from Assembly PCBA to Endbell.
3. Locate power wiring and measure wiring paths from Assembly PCBA to Endbell.
4. Locate and check cabling between the Scanner and remote MSS/PMP box.
5. Measure the communication signal paths from Scanner Endbell to PMP-box terminal strip TS1.

2.2.2.3. Connections in MSS/PMP Box

The RIS Sensor communicates with the system using the PCI-PCDAQ board in MSS. Perform the following steps to confirm the cabling and PMP installation check.

1. Before you begin, power off the scanner and the MSS/PMP.

2. Check if the PCI-PCDAQ card (*P/N 05438200*) is installed in the MSS Scanner (Figure 2-6)

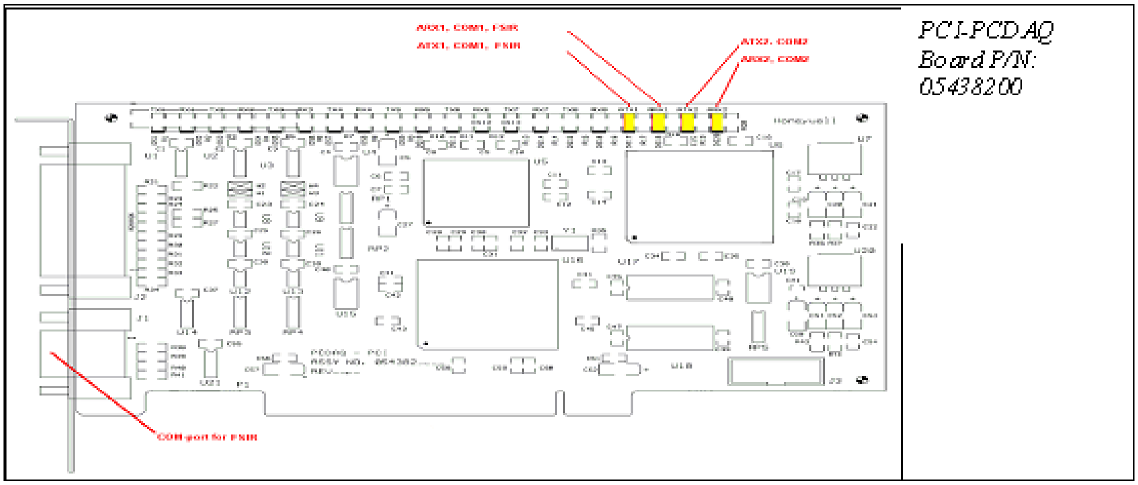


Figure 2-6 PCI-PCDAQ board layout with com-port and communication LED marked

3. From PCI-PCDAQ check if all jumpers are OUT (=OFF). You may need to remove board from MSS to see this.

4. Install PCI-PCDAQ to MSS.

Check or install cable from PCI-PCDAQ connector J1 to TS1 using cable *PN. 6580800748* or similar as in (Figure 2-7).

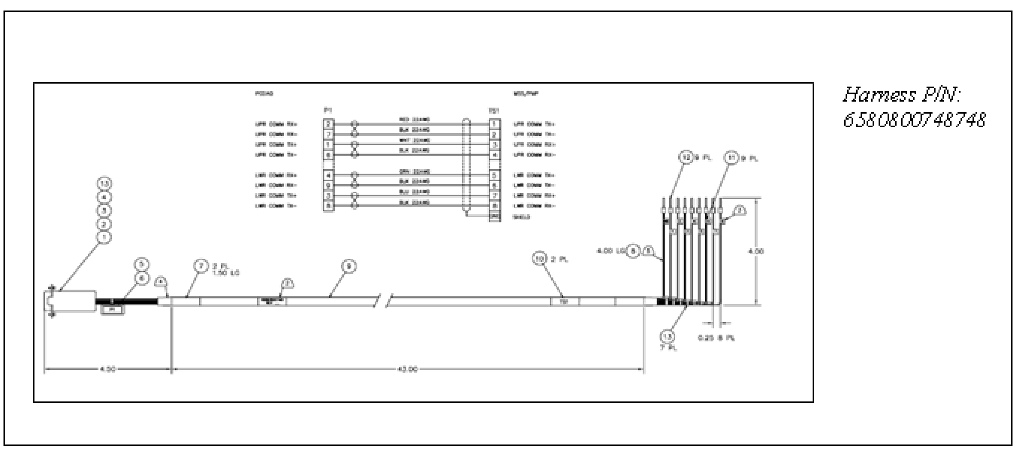


Figure 2-7 Harness cable from PCI-PCDAQ to TS1

5. Measure and compare your notes to system drawings and ensure that the communication lines (TX+, TX-, RX+, RX-) marking match each other. Default port for RIS Sensor in PCI-PCDAQ is Port number 1. (You may also need to use Port #2, for which you need to modify the wiring and do the necessary software changes).

Table 2-2 Communication lines of PMP

Communication line	PCI-PCDAQ J1	Cable PN. 6580800748		TS1 (PMP)
TX +	J1-1	P1-1	TS1-1	TS1-1
TX -	J1-6	P1-6	TS1-2	TS1-2
RX +	J1-2	P1-2	TS1-3	TS1-3
RX -	J1-7	P1-7	TS1-4	TS1-4

2.2.2.4. Service Connections Notes

WATER

The RIS Sensor requires the scanner water to flow through the head all time during operation. If the water does not flow, the sensor electronics may be damaged.

The coolant flow must be managed in such a way that the flow through the RIS Sensor head is not interrupted or controlled by flow through other sensors.

AIR

The RIS Sensor head requires compressed air to operate. Ensure that the air supply at the entrance of the sensor head is 100 - 300 kPa (1 – 3 bars). You can regulate the air supply if necessary.

2.2.3. Power up First Time

Perform the following steps to power up RIS Sensor for the first time.

1. Before you begin, power off the scanner and the MSS/PMP.
2. Ensure that the sensor hardware power switch is set to OFF.
3. Ensure that the air is not yet enabled for the sensor head.
4. Locate the sensor standardization sample, which also acts as a shutter for the optics (Figure 2-8).

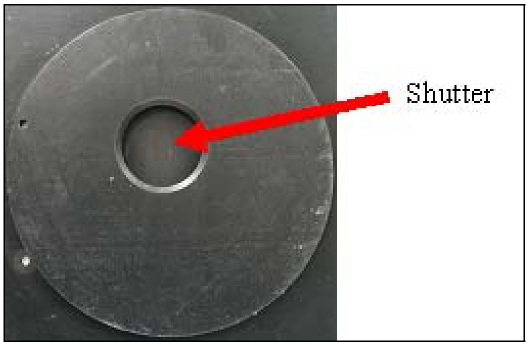


Figure 2-8 Outside bottom view of RIS Sensor when shutter is closed.

5. Move the shutter by hand to check if it moves freely from home position (full open) to standard position (full closed) and back. You can check this by removing the head cover.
6. Enable water flow to sensor head.

NOTE: It is mandatory to have a constant flow of cooling water all the time when sensor is powered on.

7. Enable air to sensor head.
8. Power up MSS/PMP
9. Measure from Endbell Termination board and from sensor end Assembly Board that there is +24V DC input according to the system drawings.
10. Power up RIS Sensor by using sensor hardware switch (Figure 2-3)

2.3. Software Installation

To enable RIS Sensor the first time, you need to install and configure several software before the sensor is online. Table 2-3 provides a checklist of the steps that you need to follow for the software installation.

Some actions like working with Configuration Browser may need Honeywell Software Engineer skills. As there is a high risk involved if there is an error during installation or configuration. It is recommended that only Honeywell trained engineers do it.

2.3.1. Installation of RIS Sensor Software Add-On

There are no detailed procedures provided for the installation as it is assumed that the installation is performed by a skilled person. The following table lists the order in which the software must be installed.

Table 2-3 Software installation steps

1	Check if the MXProLine system meets the RIS software requirements
2	Install RIS Add-On packet on the system server
3	Configure RIS Sensor to system
4	Configure and test PCI-PCDAQ Board
5	Configure MSS Job Set IO Parameters for RIS Sensor
6	Configure RIS Sensor and perform the operation check
7	Enter Configuration Parameters to RIS Sensor

When this User Manual was written (2009) the RAE-versions needed the RIS software Add-On packet. The current versions of RAE are RAE4 and RAE5. Every RAE Update level (RAE5 Update 1, RAE5 Update 2, and so on.) needs its dedicated Add-On packet depending on the RAE version and the Updated level. By default this software Add-On is installed during system build by the software engineer.

Follow the Add-On packet installation procedure to complete the installation.

2.4. Software Configuration

2.4.1. RIS Sensor to System

The RIS Sensor is configured in the system by using **Configuration Browser** tool.

1. Shutdown the Station on the Server.
2. Shutdown RAE by using RAE Control Panel.
3. Open the Configuration Browser tool.
4. Select **Build&Load Config Environment** (must be done after Software Add-on installation).
5. Right-click the sensor sets, select **Add Object**.
6. Select the correct sensor (RIS).
7. The new sensor must appear on the list.
8. Perform Re-Crunch of the system.
9. Launch RAE and check that RIS Sensor is in the Sensor Set on the *SCANNER SENSOR STATUS* page. At this point sensor can be disabled or enabled by default.
10. Go through the Sensor dedicated displays to check that the displays work without problems.
11. In the Windows File Explorer, check if there is a correct directory structure for RIS Sensor in *CS Data* directory.

2.4.2. Configuration and Test of PCI-PCDAQ Board

Section 2.2.2.3 explains the PCI PCDAQ board installation procedure and the necessary checks that need to be done for MSS. There are two steps involved with respect to the PCI-PCDAQ board settings. First, you must verify that MSS finds the board, and can use it. Second, you must verify that sensor communication works using the PCI-PCDAQ board. There are some software configuration steps that need to be performed before the system can power up.

At this point, the communication with the new sensor must be working fine. However, if the communication is still down, one of the reason for this can be incorrect settings. To correct this, you must start with basic troubleshooting, with respect to wiring, signal paths and possible hardware failure. It is also a good practice to a make note of settings or LEDs when communication is up, so that you can quickly isolate any communication problem that might arise in future.

The RIS Sensor communication link auto-establishes itself. In other words, when system is powered on and all devices start up, the RIS Sensor communication link comes up automatically. This can be checked from *SCANNER SENSOR STATUS* page, where the RIS Sensor status is displayed in green during the normal operation, when the installation is completed.

To configure and test the communication, perform the following steps:

1. Write down all configuration or parameters values before changing.
2. Power up PMP/MSS and Sensor.
3. Launch RAE and Station on Server, if they are not already running.
4. Check the condition of MSS from **MSS Monitor** > **MSS Setup Diagnostics** dialog box. The status must show Process DR Event marking normal running conditions.
5. Check if RIS Sensor is manually enabled in the *SCANNER SENSOR STATUS* page.

IF STATUS is UP (=ALL GREEN) then the sensor is communicating with system. Make a note of the parameter values.

IF STATUS is DOWN (=ALL RED) then some settings might be incorrect and correct settings must be enabled.

6. From the **MSSRemote Monitor** dialog box, go to **Pci Devices** display using **A** key, locate PCI-PCDAQ card line; for example in Figure 2-9 the card is shown in line 7.

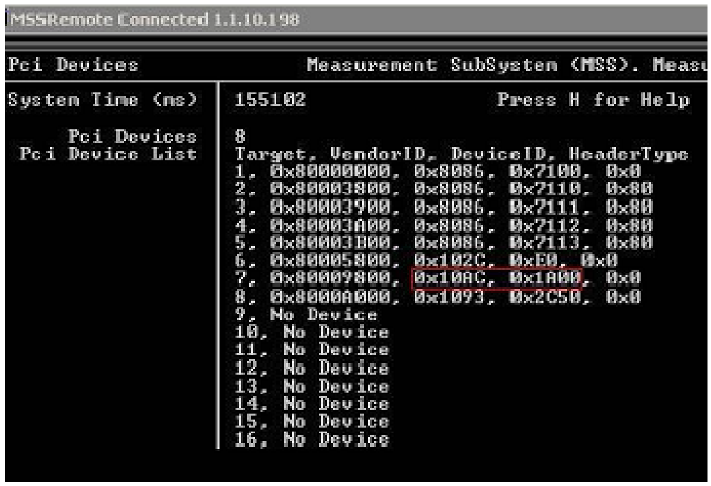


Figure 2-9 Pci Devices display

7. Make a note of its **Vendor ID** (10AC) and **Device ID** (1A00).

8. Add these IDs and write down the result ID.

For example: Device ID (1A00) + Vendor ID (10AC) =Result ID (1A0010AC)

9. Enter this result in PnP Vendor # column in **MSS PnP Setup** dialog box. (Figure 2-10)

NOTE:	When this manual was written, the default card naming generated by system software was not pointing to a direct relation with RIS Sensor. Hence, the person performing the installation must be fully aware of the MSS structure from the configuration point of view.

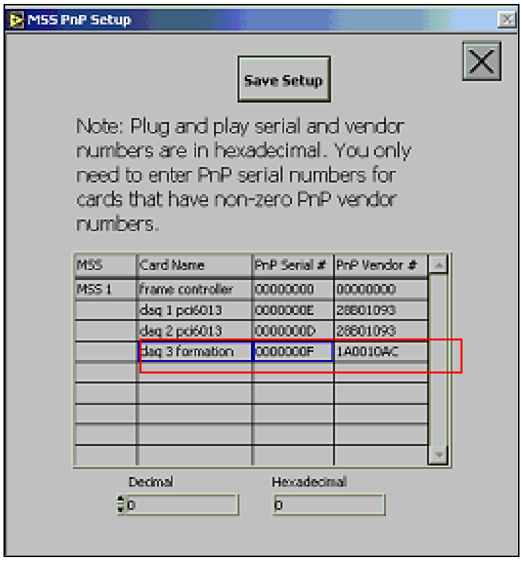


Figure 2-10 MSS PnP Setup popup window

10. In the **MSS Remote Connected** dialog box, use the 'UP (/DOWN)' arrow keys and move the selected card to top line, as displayed in Figure 2-11.

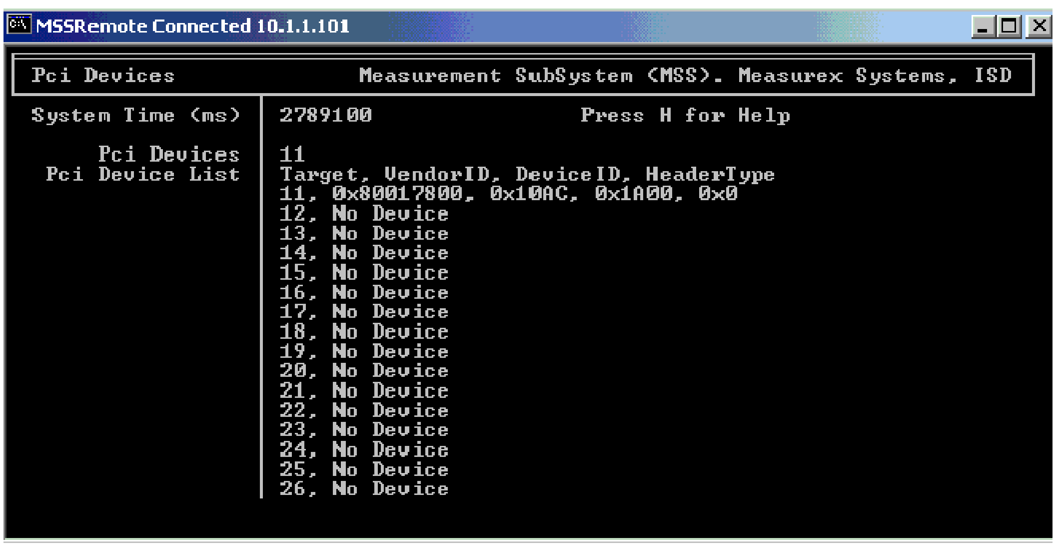


Figure 2-11 MSS Remote Monitor window displaying PCI Device list when PCDAQ card selected

11. Use the right (or left) arrow keys to select a display similar to as shown in example diagram, where you can see *DevNum(F)*, as shown in Figure 2-12.

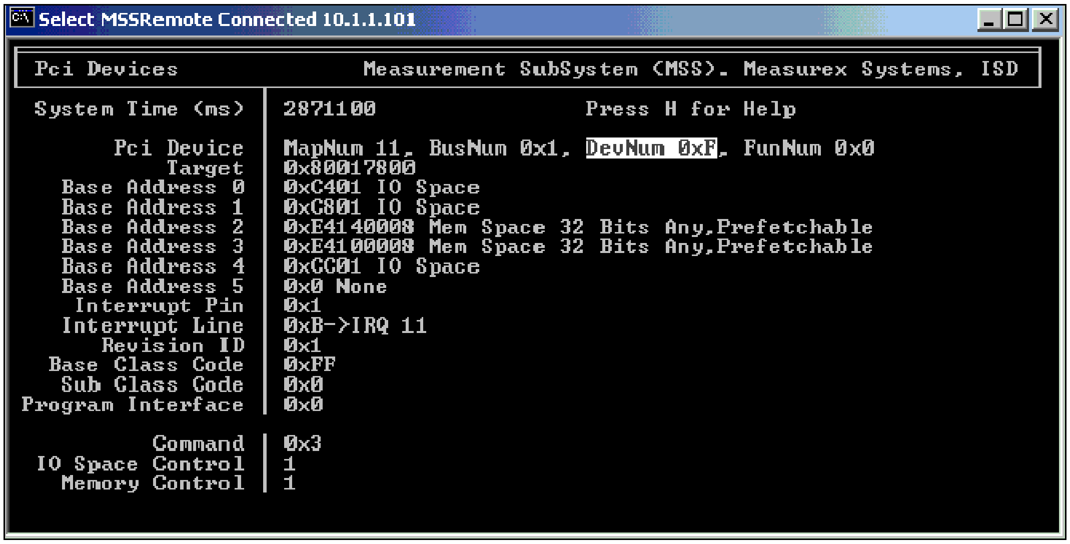


Figure 2-12 PCI Device list when PCDAQ card details selected

12. Enter this result in PnP Serial # column in **MSS PnP Setup** dialog box in the PCDAQ board used for RIS Sensor (Figure 2-10)

13. Power off and power on the MSS/PMP to reboot the sensor.

14. Wait for at least a minute to let the RIS Sensor and MSS to start up.

15. When MSS is online, check the PCI-PCDAQ board LEDs for RIS communication line. Also check if the sensor RIS Control PCBA board has two LEDs, TX/RX.

16. LEDs for TX and RX should flash simultaneously (When you visually inspect, you can see the communication going on but for human eye it looks like led's are flashing at the same time) as shown in Figure 2-13.

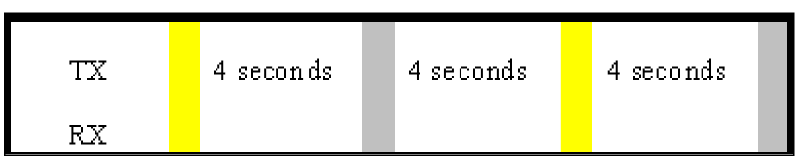


Figure 2-13 TX and RX LED

17. From the MSS **Remote Connected** dialog box, check if you can see **Foto Sensor via PCI-PCDAQ** card in the **Card Monitor**. See Figure 2-14. Note that default card naming can change after this manual revision.

18. From **MSS Job Set IO Point Monitor** dialog box, check if there is a similar *jobset* for RIS Sensor. The default name that comes from the system software at this time is *OptForm*, as mentioned in Figure 2-15.

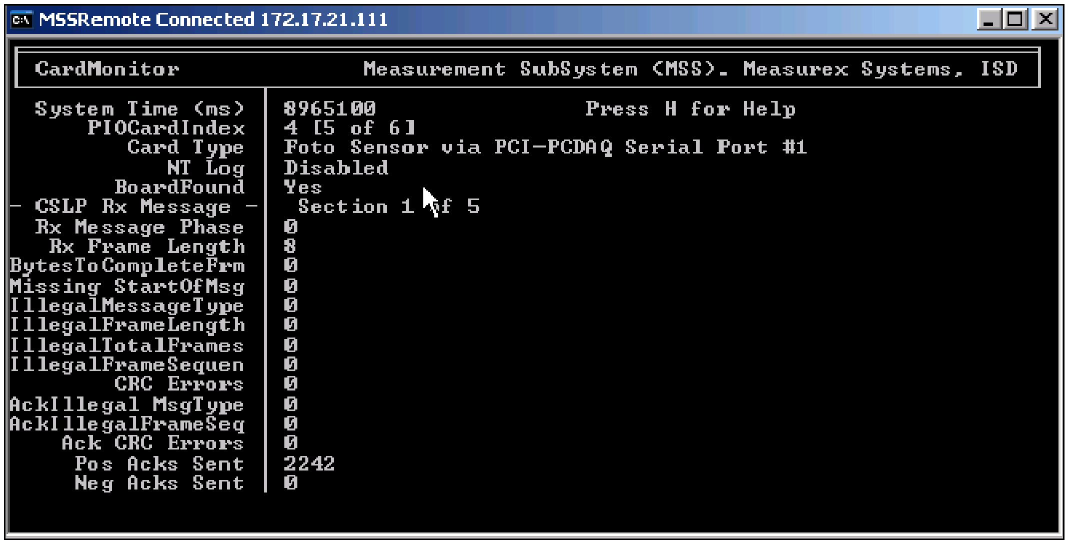


Figure 2-14 Card status for PCI-PCDAQ/RIS in MSS Monitor

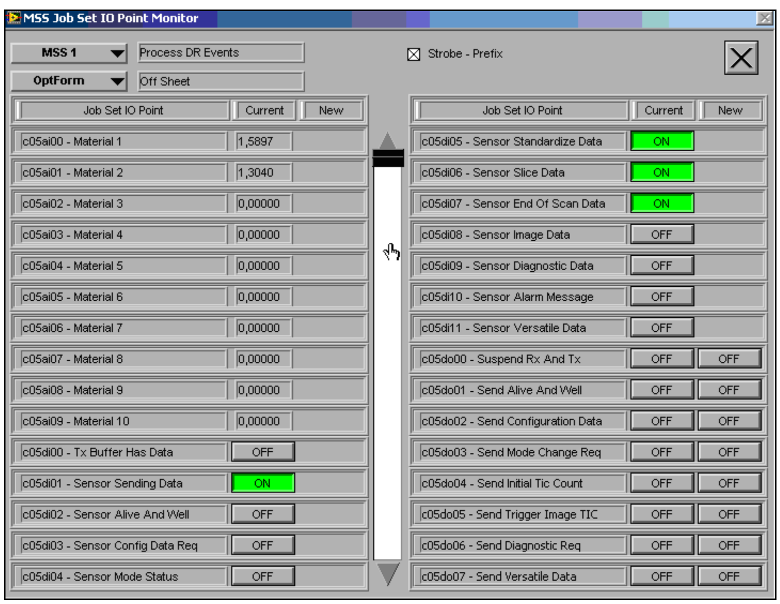


Figure 2-15 MSS Job Set IO Point Monitor for RIS Sensor

2.4.3.Configuration of MSS Job Set IO Parameters for RIS Sensor

Job set parameters are configured in the **MSS Setup Diagnostics** > **MSS Job Set IO Setup** dialog box (Figure 2-16). The default parameter values are provided in Table 2-4.

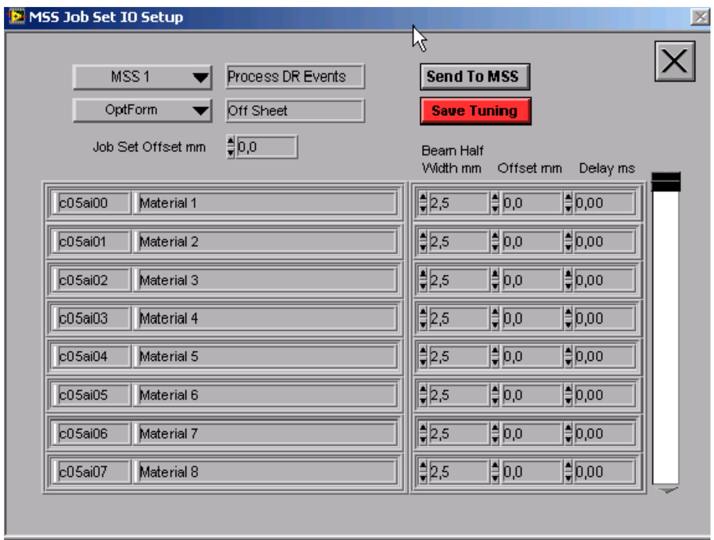


Figure 2-16 MSS Job Set IO Setup pop-up

Table 2-4 Job Set Parameters Default Values for RIS Sensor

Parameter	Value
Beam Half Width mm	2.50
Offset mm	Depends on installation position (default for MXProLine with only RIS Sensor is zero)
Delay ms	150

2.4.4.RIS Sensor Configuration and Operation Check

After the installation is complete, perform the following steps to check the RIS configuration and communication.

1. Make a note of all the configuration or parameters values before changing.
2. From **MXProLine Station** dialog box, load run grade.
3. Navigate through the **Recipe Maintenance** dialog box.
4. Click **Main Code** table to obtain RIS configuration table.
5. Ensure that the default value (8) saved for RIS Lamp Control Set Point parameter (Figure 2-17). This value will set the lamp intensity and if it is near zero, then light does not come from the lamp. Ensure you have a similar reasonable value for all the required grades. If you modify group, save the changes and load grade again.

Description	File Data	Current Data
1. RIS11P11 Signal Gain	1.	1.
2. RIS11P11 Integration Time [ms]	100.	100.
3. RIS11P11 Lamp Control Set Point(1..10)	8.	8.
4. RIS11P11 Model File Name	SE1pe.txt	CModel1.txt
5. RIS11P11 Hole averaging	False	False
6. RIS11P11 Hole 1 location [mm]	0	0
7. RIS11P11 Hole 2 location [mm]	0	0
8. RIS11P11 Hole 3 location [mm]	0	0
9. RIS11P11 Hole 4 location [mm]	0	0
10. RIS11P11 Hole 5 location [mm]	0	0
11. RIS11P11 Hole 6 location [mm]	0	0
12. RIS11P11 Material 1 Slope	1.	1.
13. RIS11P11 Material 1 Offset	0.	0.
14. RIS11P11 Material 2 Slope	1.	1.
15. RIS11P11 Material 2 Offset	0.	0.
16. RIS11P11 Material 3 Slope	1.	1.
17. RIS11P11 Material 3 Offset	0.	0.
18. RIS11P11 Material 4 Slope	1.	1.
19. RIS11P11 Material 4 Offset	0.	0.
20. RIS11P11 Material 5 Slope	1.	1.
21. RIS11P11 Material 5 Offset	0.	0.
22. RIS11P11 Material 6 Slope	1.	1.
23. RIS11P11 Material 6 Offset	0.	0.
24. RIS11P11 Material 7 Slope	1.	1.
25. RIS11P11 Material 7 Offset	0.	0.

Figure 2-17 Grade Configuration Table in system Recipe Maintenance display

6. Navigate to **RIS Engineering** dialog box. Select **Miscellaneous> Setups** (Figure 2-18).

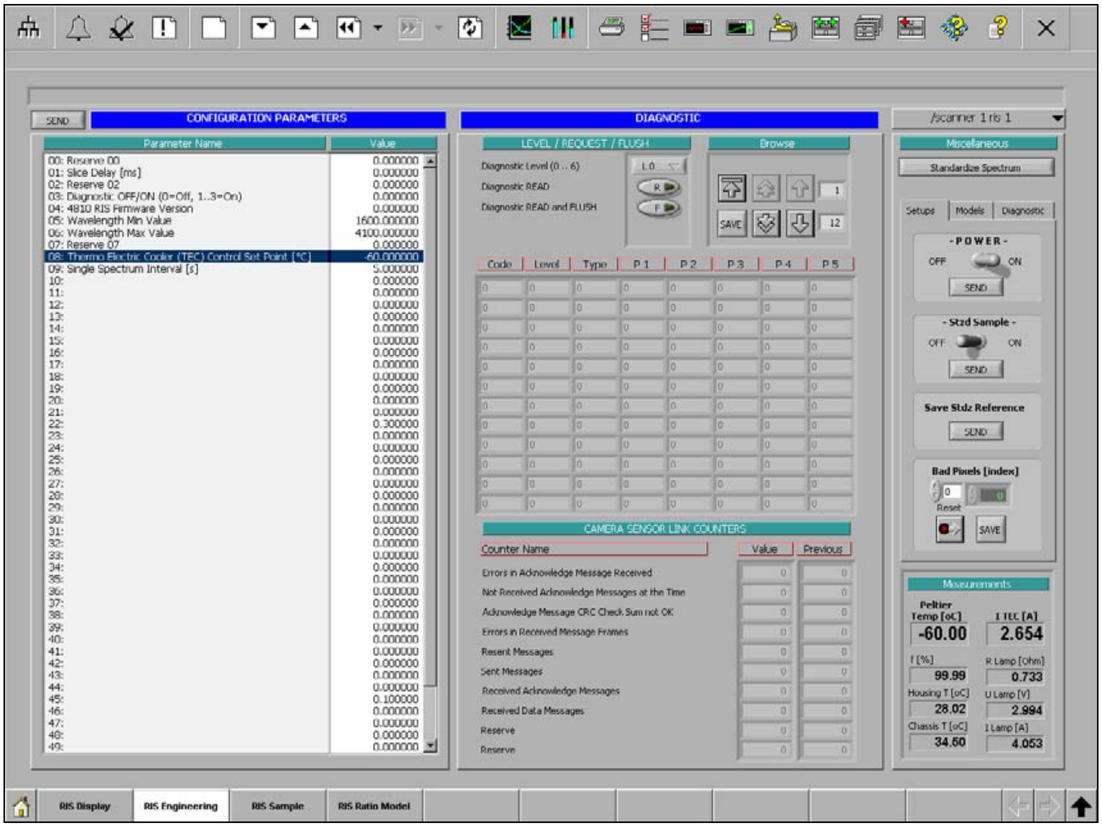


Figure 2-18 Overview of RIS Engineering page

7. Turn the **POWER –switch ON** and press **SEND** –button (Figure 2-19).

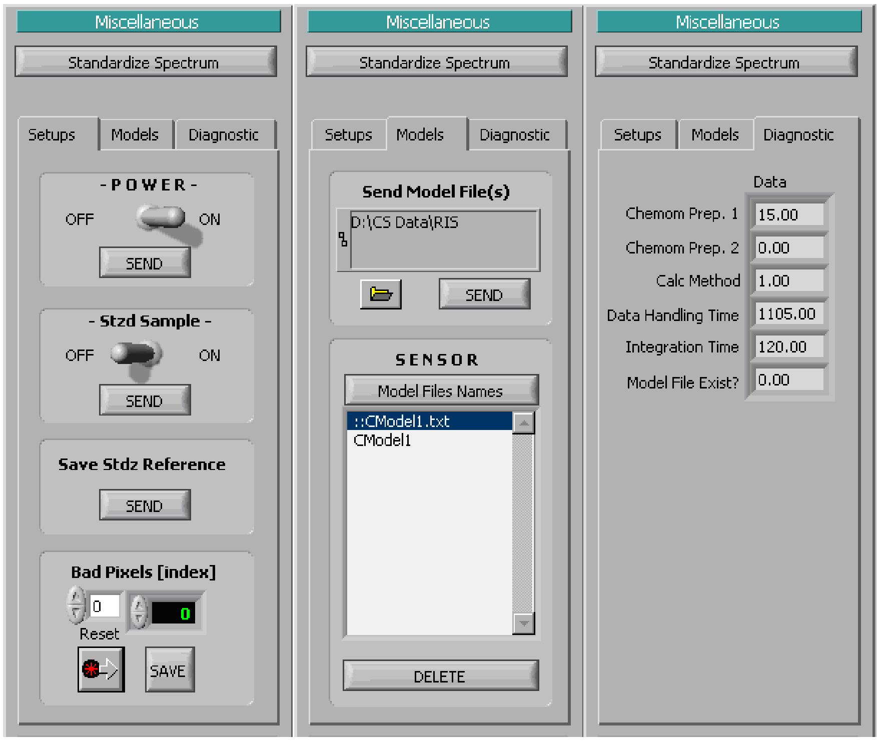


Figure 2-19 Contents of Miscellaneous section in RIS Engineering page

8. Navigate to **Measurements** –section and ensure (Figure 2-20) that chopper rotation value (%) is stable The limits can range between the following decimal values (100.00 ± 0.02 %).

9. You can hear the Chopper rotating when you stand closer to the sensor. As it is not practical to remove the sensor casing every time for measuring the lamps voltage, the rotating sound indicates that the power is ON and most likely the power is also available for the lamp.

10. Ensure that **I TEC [A]** is not above 4 A. If the value is higher than 4A (safe limit) then sensor is automatically powered down.

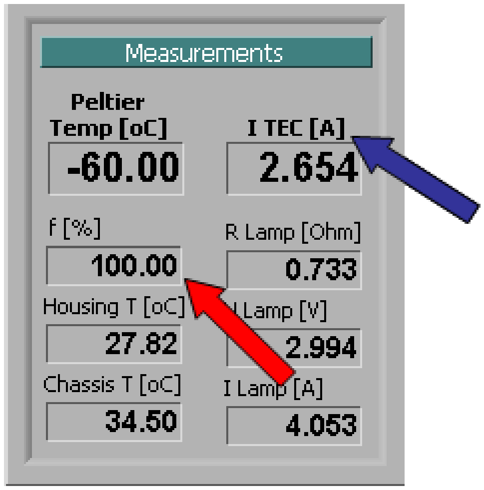
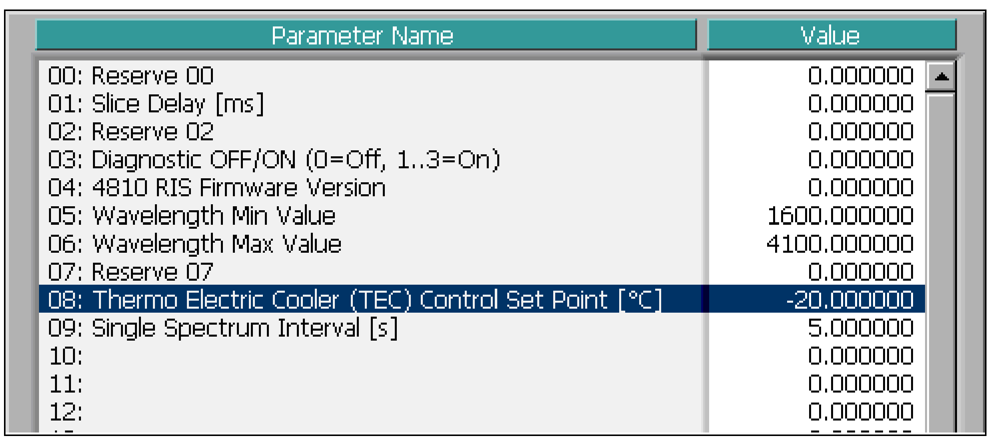


Figure 2-20 Measurements-section from RIS Engineering page

11. In the **RIS Engineering** dialog box, select **CONFIGURATION PARAMETERS** (note that these parameters are different than the recipe based parameters). Ensure that all parameters have default values as listed in this manual in Figure 2-21.

12. After checking or entering new values press **SEND** to send values to sensor.



Parameter Name	Value
00: Reserve 00	0.000000
01: Slice Delay [ms]	0.000000
02: Reserve 02	0.000000
03: Diagnostic OFF/ON (0=Off, 1..3=On)	0.000000
04: 4810 RIS Firmware Version	0.000000
05: Wavelength Min Value	1600.000000
06: Wavelength Max Value	4100.000000
07: Reserve 07	0.000000
08: Thermo Electric Cooler (TEC) Control Set Point [°C]	-20.000000
09: Single Spectrum Interval [s]	5.000000
10:	0.000000
11:	0.000000
12:	0.000000

Figure 2-21 Parameters-section from RIS Engineering page

If all the information provided are correct, then enable the sensor from **SENSOR STATUS**.

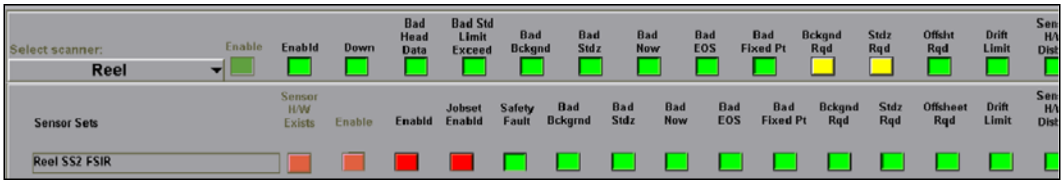


Figure 2-22 Sensor Status display

13. Perform manual standardize.

14. From **RIS Engineering** dialog box select **Standardize Spectrum** (Figure 2-23). Here you can see both **Previous** standardization spectrum and **Current** standardization spectrum. Ensure that standardize spectrums show direct lines.

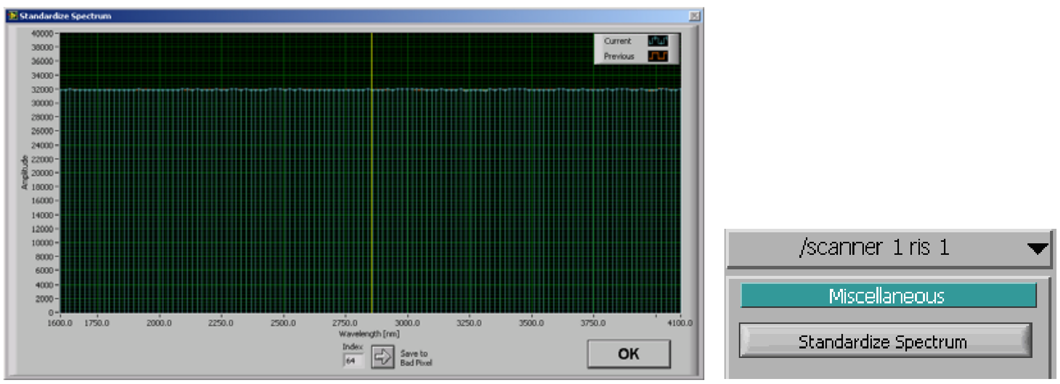


Figure 2-23 Standardize Spectrum pop-up from RIS Engineering page

15. Power down MSS/PMP. Leave RIS Sensor power ON.

16. Before proceeding to do the calibration procedure. From the RIS Display set Spectrum Positions, enable scanner to SCAN mode and ensure that there is some spectra update to display along with some measurement values.

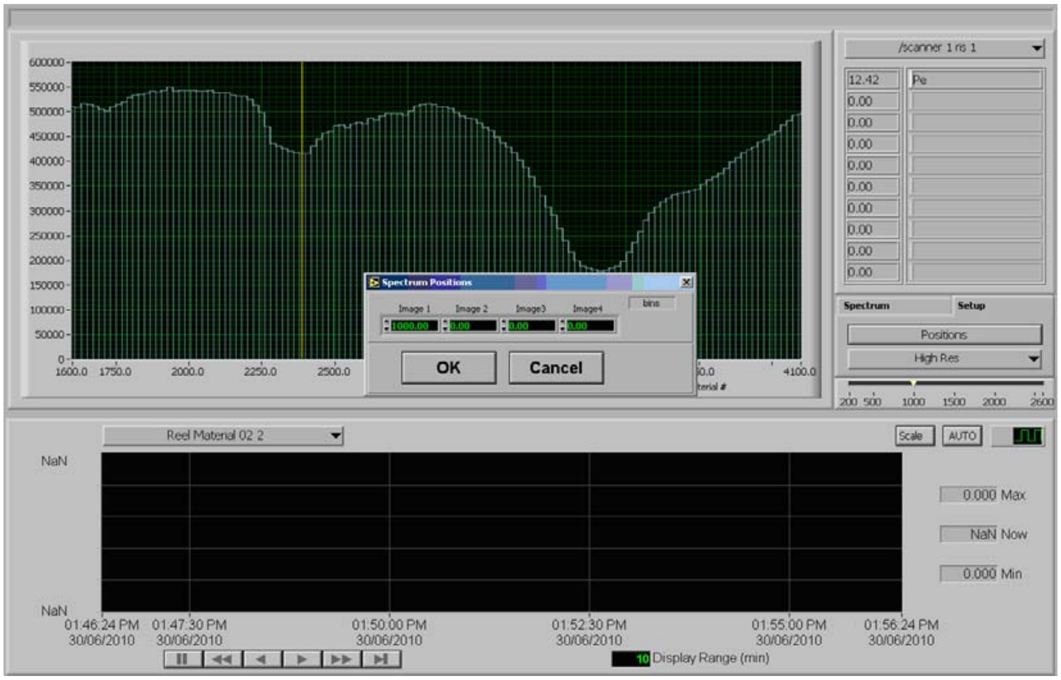


Figure 2-24 Spectrum Positions pop-up window

2.5. Final Checks after Installation

After the installation and configuration is complete, perform the following steps to ensure the completeness of the installation:

1. Shutdown MSS/PMP (power OFF)
2. Shutdown MXProLine Server (power OFF)
3. Start MXProLine Server as in normal startup procedure.
4. Power on MSS/PMP.
5. Wait until RIS Sensor communication link is up.
6. Do manual standardization.
7. Cover the RIS Sensor head with the sheet.
8. Check and follow measurements for over 10 minutes.
9. Take the sensor off sheet. System is now ready.

3. Calibration

3.1. Calibration Methods

The optional calibration methods for RIS Sensor are illustrated in Figure 3-1. The calibration starts with sample tests, which means collecting sample spectra from the required material. The spectra can be collected either from on-line moving web measurements or from off-line samples. After this, the calibration can be done either in the traditional way or by using chemometrics. Both methods require the laboratory values of the samples.

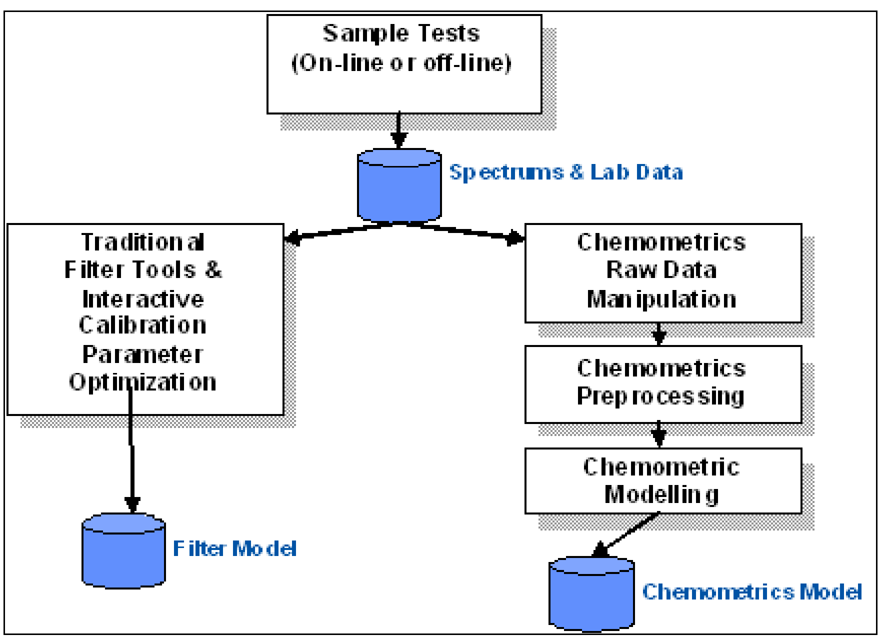


Figure 3-1 Calibration options of RIS Sensor

3.1.1. Sample Test Tool

The Sample Test Tool is a program designed for collecting the spectra of a sample set (Figure 3-2). The sampling can be done either online (Scanning Sample) or offline (Manual Sample). In the following figure you can see the sample spectrum of each collected sample.

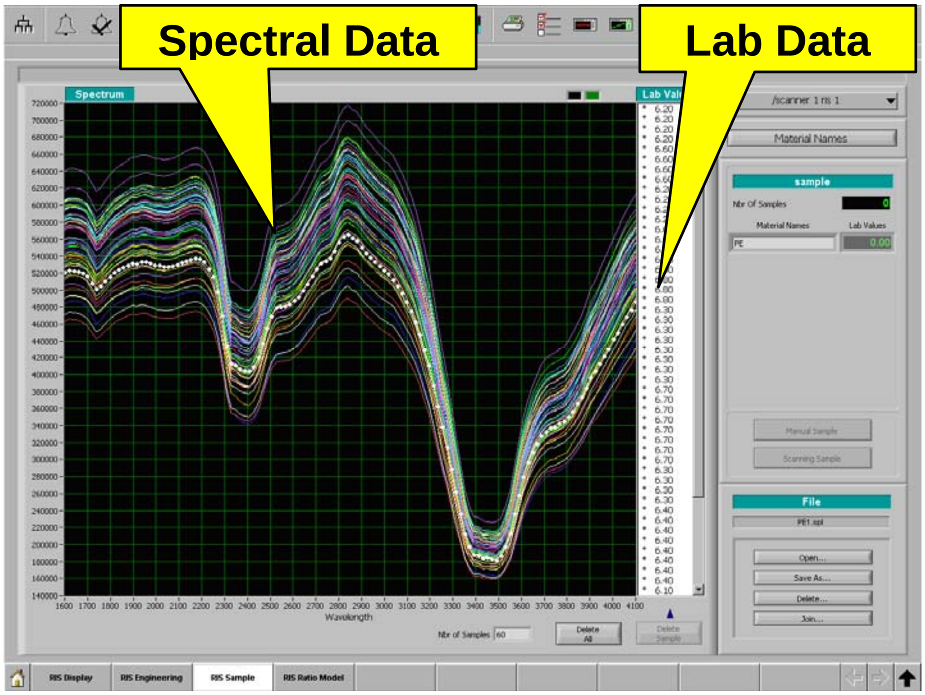


Figure 3-2 Example display of the Sample Test Tool

3.1.1.1. Material Names

Before the sample spectra are collected by the Sample Test Tool the materials must be named:

1. Click **Material Names**.
2. The **Material Names** dialog box appears. In this dialog box, you can type the names of materials (you can enter until 10 names) (Figure 3-3).
3. To delete a material, click the green LED on the right side of the name and click **Delete**.
4. To insert a material, click the green LED on the right side of the name and click **Insert**. A new row appears above the existing row.

5. Enter the details of the required material and click **OK**.

6. The material name appears on the right column of the Sample Test Tool.

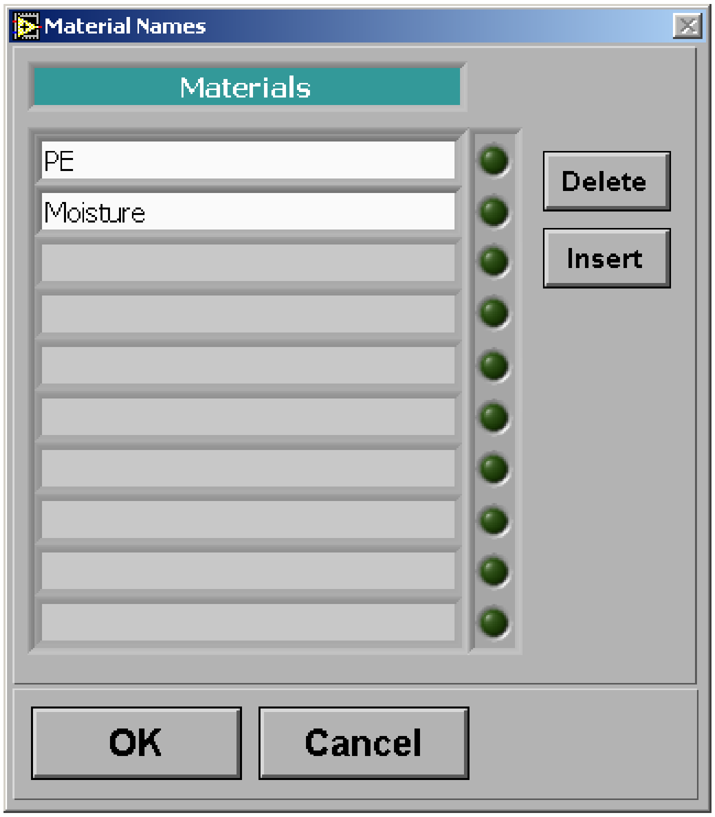


Figure 3-3 Materials pop-up window

3.1.1.2. Entering Lab Values and Collecting Spectra

The Lab Data values are required for every material that needs calibration. The Sample Test Tool accepts 1 – 10 materials simultaneously. With this tool it is possible to give the corresponding lab values of the material (grammage e.g. [g/m^2] or thickness e.g. [μm]) to each spectrum. When this is done a file containing the spectra and a file containing the corresponding Lab Data values of the material are saved. The Lab Data values must be entered separately for each material and saved. The number of Lab Data files must be equal to the number of the materials that are required to be calibrated.

1. Set the system to **Maintenance Mode** from the Maintenance display.

2. The **Manual Sample** button becomes active.

3. Enter lab values for the materials and set the sample to the measurement position of the RIS Sensor.

4. Click the **Manual Sample** Button.

5. The Sensor takes the sample and sends the spectrum to the server.

6. The spectrum and lab values are seen on the **Sample Test Tool** dialog box.

7. Perform steps 1-6 for all other samples.

3.1.1.3. Editing the Spectral Data

Editing data values is possible with the Sample Test Tool. To delete unwanted data values and spectrum:

1. Click the data value and the numbers that are highlighted.

2. Click the **Delete** button to delete the data value spectrum

3. If you want the lab values to be changed, it can be done by over writing the new value on the Lab Values box.

3.1.1.4. Saving the Spectral Data

Perform the following to save the Spectral Data:

1. Click the **Save as** button located on the right corner of the Sample Test Tool dialog box (Figure 3-4).

2. A pop-up window appears,

3. Write the file name in the pop up window.

4. Using the Sample Test Tool, you can also open (**Open**) the saved files.

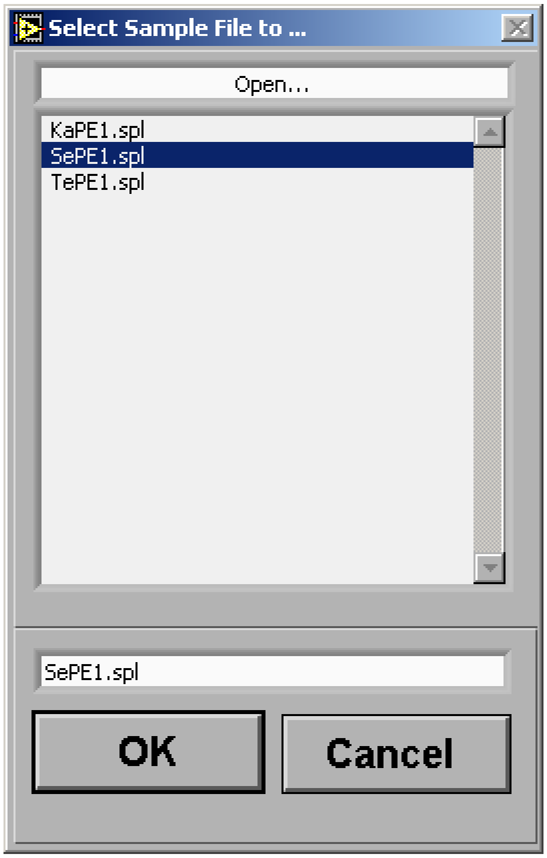


Figure 3-4 Pop-up window for naming the data files

3.1.2. Traditional Calibration Method

3.1.2.1. Three Wavelength Band Calibration

When using traditional filter type to determine the measurement and reference wavelengths, three wavelength band calibration is the default method. In this method the sensor is calibrated by using three wavelength bands (one measurement channel and two reference channels). The location of the measurement channel is normally chosen based on the known spectral information of the measured material. Typically, the measurement wavelength band is placed on the absorption peak of the measured materials spectra. The reference channels are typically chosen to locate nearest measurement band but, outside the absorption wavelengths.

To avoid interference of other materials on the measured results, it is also important to place the measurement and reference wavelengths outside the other absorption bands of the interfering materials.

In the calibration tool the measurement and reference channels can be placed by adjusting the lower and the upper limits of the band. This can be done on by dragging the lower and upper limit lines to the desired position or, by numerically writing the lower and upper limit values of the wavelengths.

This program calculates the average value of the pixels between the limits. These averaged pixel values are used for the calculation of the results. The program also calculates the center wavelengths (CWL) of the bands. If reference channels are chosen to be on both sides of measurement channel, a reference value is interpolated from the reference channels on the measurement CWL. The reference channels can also be on one side of the measurement channel, and thus the reference value is extrapolated from the reference channels on the measurement channel CWL.

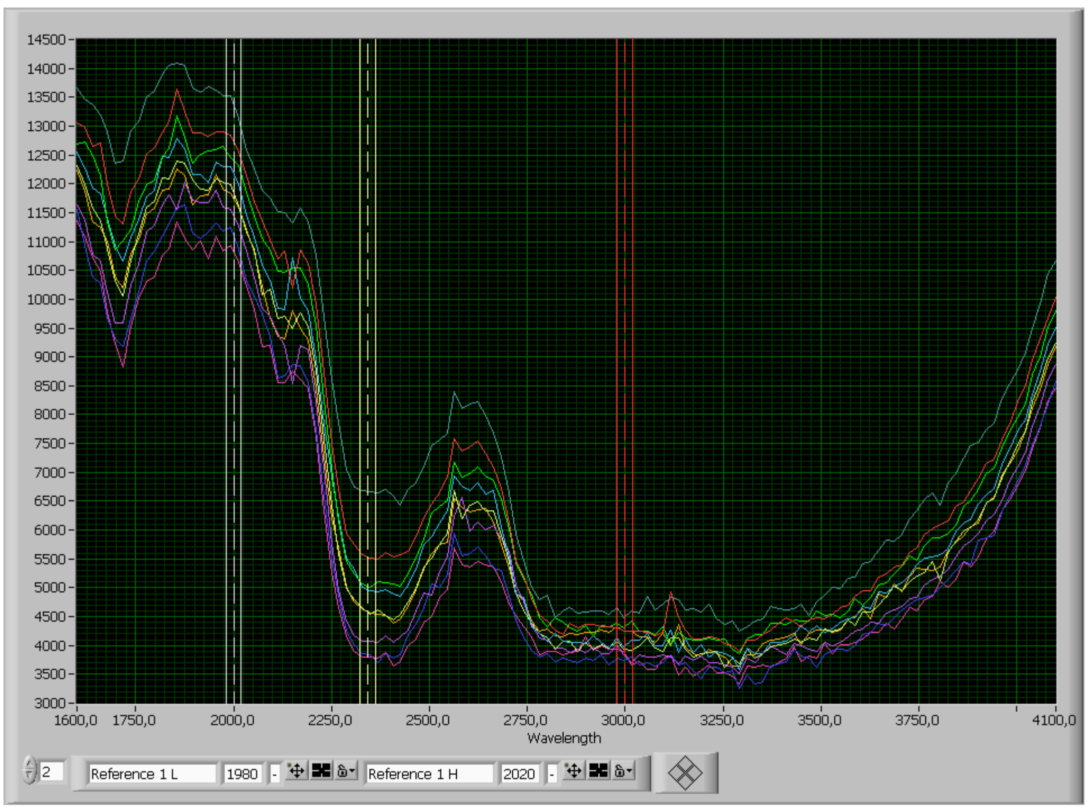


Figure 3-5 Example of three wavelength calibration

The RIS Sensor can also be calibrated by using two wavelength bands (one measurement and one reference band). The measurement program has two reference channels or bands by default. Both these bands must be adjusted on the same wavelength band, after which the program automatically handles the result as one reference band. The wavelength bands are created by defining the lower and the upper limits of the band.

There are two methods to do this adjustment. The simpler way is by dragging the lower and upper limit lines to the desired positions on screen. If a more accurate definition is needed, it can be done by entering the wavelengths of lower and upper limits values.

Measurement program calculates the limits and the average value of pixels for both the channels. These average pixel values are used for calculating the results.

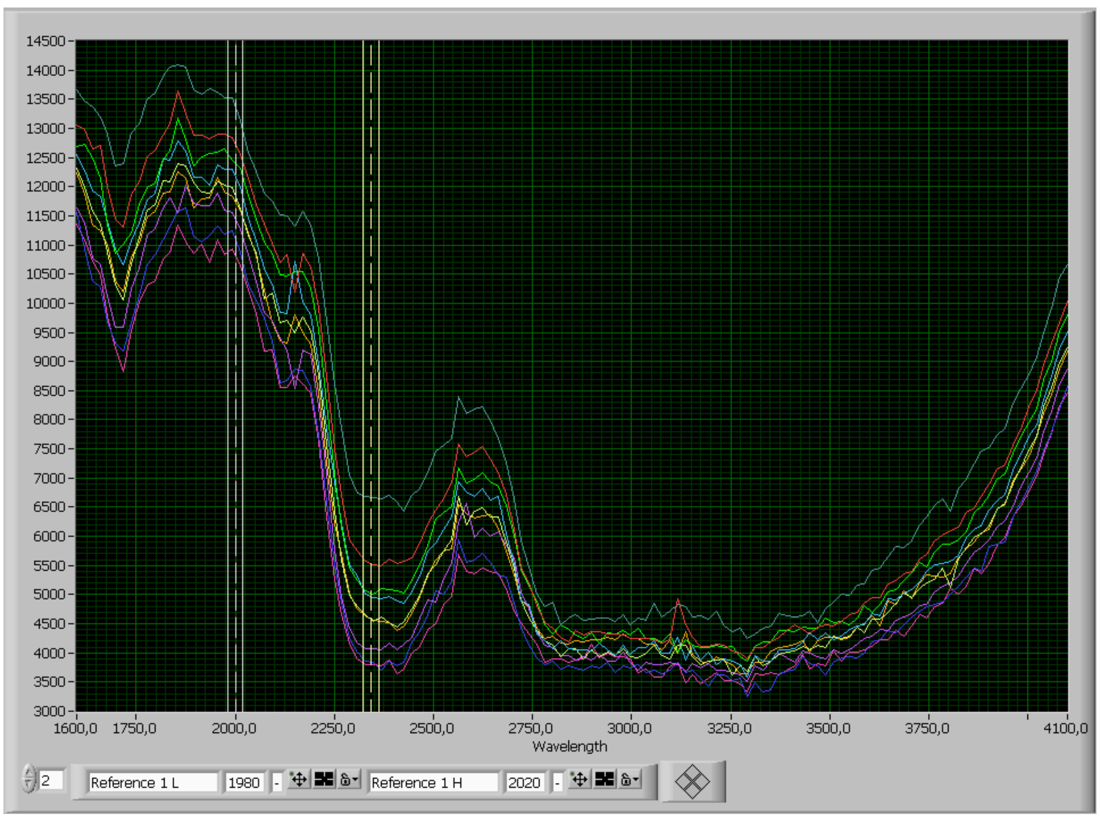


Figure 3-6 Example of two wavelength calibration

3.1.2.2. Interactive Tool for Calculating Calibration Parameters

By using the interactive calibration tool you can determine the calibration parameters (**SLOPE** and **INTERCEPT**) from a set of sample spectra and its corresponding laboratory values. The interactive measurement tool calculates least square fit to the data points and gives the SLOPE and the INTERCEPT equation. Also **R^2** and **RMSE** (Root Mean Squared Error) values are calculated for the validation of linear correlation and accuracy of the fit.

The interactive calibration tool provides real time calibration parameters for the selected wavelength configuration. During the movement of reference or measurement wavelength bands, the tool calculates these values automatically for each position. The idea is that the optimal configuration of reference and measurement wavelength bands can easily be sought using this interactive parameter calculation mode. By moving the wavelength bands it is possible to ensure accuracy in the group of the sample spectra.

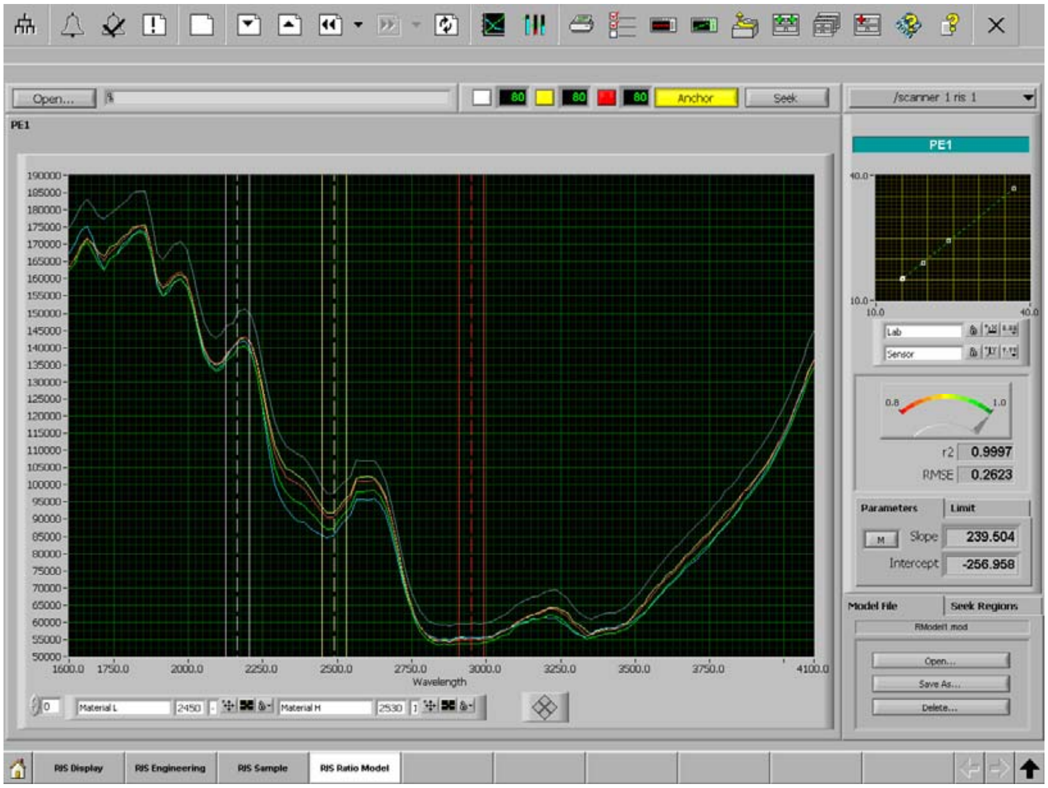


Figure 3-7 Example display of the Interactive Calibration Tool

The interactive calibration tool shows one measurement band and two reference bands on top of the sample spectra. The program integrates the spectrum points inside the band, and calculates the average points to represent the band in question.

The program calculates the ratio of the measurement and the reference values (R/M) and determines the fit with Lab values. Based on the fit, the tool plots the results with the corresponding lab values. The xy-plot visualizes in real time the quality of the fit for the chosen wavelength bands. The tool also calculates Coefficient of Determination (R^2) -value and Root Mean Squared Error (RMSE) of the fit.

The R^2-value illustrates the correlation between the data points. The R^2 is unit less value from 0 to 1. For ideal case $R^2 = 1$, which means perfect correlation between measurements and lab values. If $R^2 = 0$ there is no correlation. The aim is to get R^2 value as close as possible to 1.

For monitoring of the R^2-value there are numeric indicator and graphic meter indicator showing the values 0.8 – 1.0. The meter indicator is useful for quick monitoring of the most responsive areas of spectrum.

The RMSE value indicates the accuracy of the calibration. The unit of RMSE is the same as the unit of the given laboratory values. During calibration procedure the aim is to minimize the RMSE value to get the best accuracy for the measurement.

The calibration parameters **SLOPE** and **INTERCEPT** values can be given manually as well. Perform the following to enter the Slope and Intercept values.

1. Click t **M** –switch (M = manual, Figure 3-10)
2. Type the values in the **SLOPE** and **INTERCEPT** boxes.
3. The xy-plot shows the results of calibration versus Lab values. Also the program calculates the R^2 –value and RMSE value for the manual calibration.
4. The center line (center wavelength, CW) of the reference or measurement bands (dotted line) can be moved when the ANCHOR switch is OFF (yellow light is not on). The CW line can be moved in three different ways.
    - The easiest way is just to move the CW line with mouse (left button) and drag it to the desired position. As the CW moves the LOW and HIGH limits of the band automatically follows the CW

line. This method is very illustrative and provides an quick idea on the areas of spectra, where the best response of measurement can be expected. By scanning rapidly over the entire wavelength region with the measurement band and by monitoring the quality of the fit, it is easy to locate the regions of spectrum, which are sensitive to material in question.

- Another method to change the position of wavelength band is to write the new wavelength values to the LOW and HIGH limits of the band to the wavelength controls at left corner of the tool.
- Third method is to click the CW line. You can move the CW line to required position by left clicking on the mouse and use the navigation button located to the right of the wavelength controls. It is recommended to use the navigation button for accurate adjustment of the CW line.

When the ANCHOR switch is ON (the yellow light is on) the center wavelengths (CW) can not be moved. However, the LOW and the HIGH limits of the band can be changed in a similar way as described to alter the CW line.

1. The easiest way is to click and drag to the desired position.
2. Second method is to change the position of wavelength band is to write the new wavelength values in the LOW and HIGH limits fields of the wavelength controls at left corner of the tool.
3. Third method is to click on the CW line with the left button of mouse and use the navigation button at the right of the wavelength controls. The navigation button is recommended to be used for accurate adjustment of the limits.
4. The bandwidth can be changed by writing it directly to desired control box (the colors of the numbers are chosen to match corresponding wavelength band in question). These are located on the top of the spectrum display.

Another method to do the calibration is to use automated search of the wavelength band locations.

1. The **SLOPE** and the **INTERCEPT** values can be determined automatically by using the **Seek** operation.

2. Click the **Seek –** button the calibration tool . When you click the Seek button, it scans the wavelength bands over the spectrum seeking locations for measurement and reference wavelength bands, which gives the optimal correlation between calculated results and Lab values.

3. It is not necessary to use the whole spectrum range for the seeking operation. It is useful to restrict this optimization to defined wavelength regions. These regions can be set from the **Seek Regions** page (Figure 3-8) by giving lower (L) and higher (H) wavelength limits.

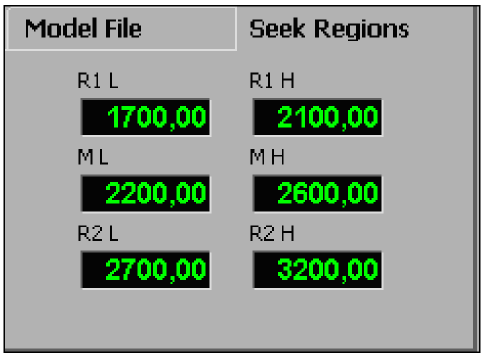


Figure 3-8 Seek Regions page

4. If the absorption peak wavelength of the measured material is roughly known, it is useful to define the region limits for measurement band around the absorption peak and the Seek operation is done inside these limits.

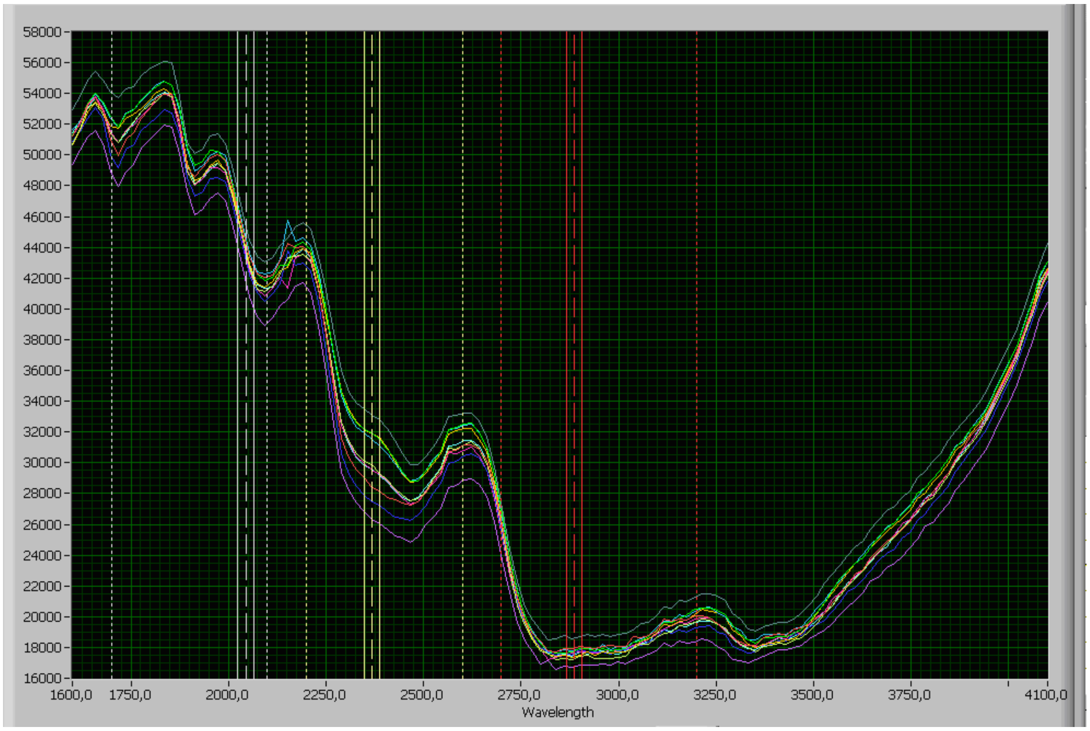


Figure 3-9 The Seek Region limits shown around the wavelength bands

5. You can also determine the optimal locations of reference bands can be found in similar way. After the first seek round these results are used as the starting point for the second optimization round. After several optimization rounds the results do not usually improve any more and this is the best setup for the wavelength bands (=”filters”) within the given limits.

6. There is also an option to restrict the automated Seek operation only to one or two of the wavelength bands. Click the colored square (corresponding color in the band limits), which is near the box that indicates the bandwidth. You can turn on the wavelength band inactive during the Seek operation. When turned inactive the colored square turns to smaller white square.

7. The limit value (Figure 3-10) is used to determine the maximum absolute value of the slope. It is useful to remember that with small slope values the measurement stability is better than with high slope values. By using automated search with low limit value the software finds more stable regions of spectrum for the calibration.

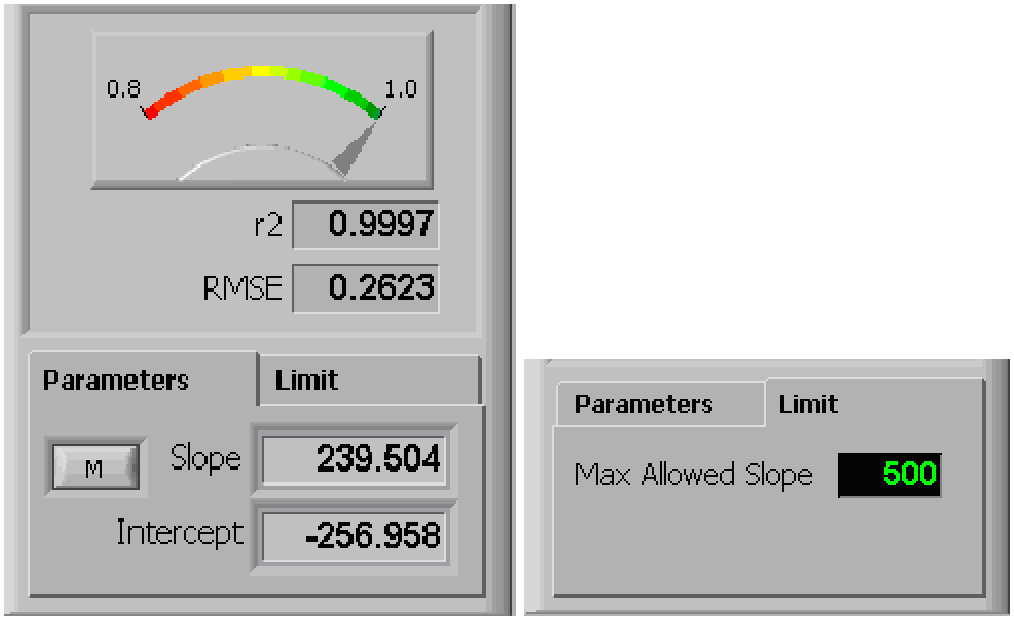


Figure 3-10 Slope and Intercept values and adjustable Limit value

8. When the calibration is ready click **Save As** button.

9. A **Select Sample File to…**window appears.

10. Enter the name of calibration file to save.

11. Clicking **OK** .

12. The calibration model file is now ready to be sent to the sensor.

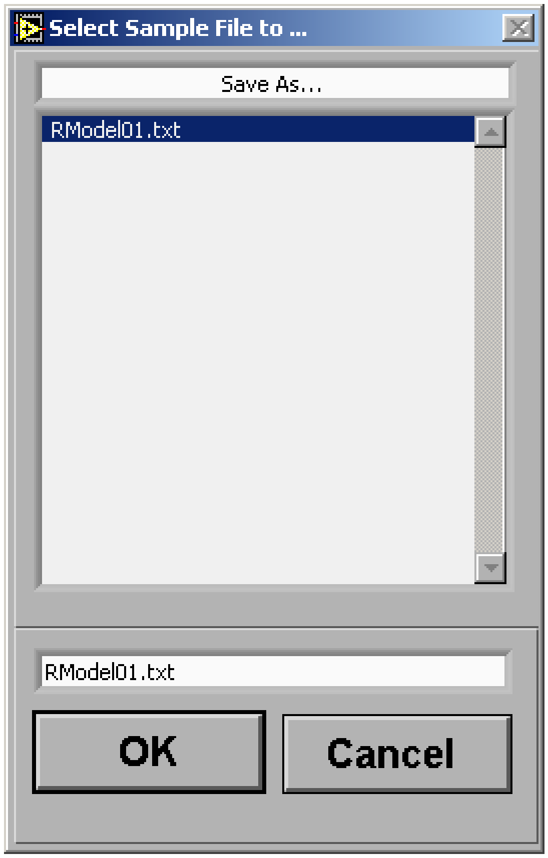


Figure 3-11 Saving of the sample file

3.1.3. Chemometric Calibration Tool

The chemometric calibration tool (RIS Chemom model) is found in bottom row of DaVinci RIS display. Sample Test Tool is used to collect the sample spectra and lab values for chemometric calibration (Figure 3-2).

3.1.3.1. Raw Data Display

In the first page of **Chemometric Calibration Tool** you see **Raw Data Display**. Using this display the sample spectrum files and the corresponding Lab Values files of the material are linked together for the chemometric processing. Also, with this display it is possible to link these files to a file containing spectral weighting data for chemometric processing.

The following figure displays the raw data spectra. The sample Lab Data values of each of the chosen material number (Lab Value) is shown. Also you can see the weighting values (optional) for each channel.

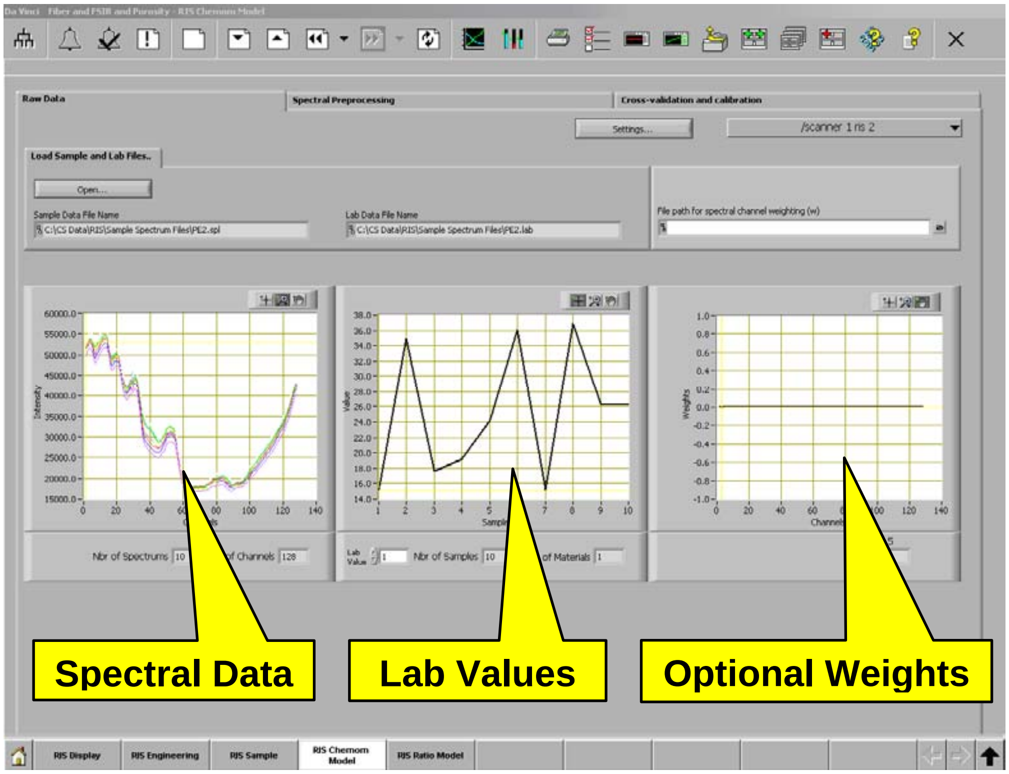


Figure 3-12 Example of the Chemometric Raw Data display

3.1.3.2. Chemometric Preprocessing Display

The chemometric preprocessing display is used in processing the data to the chemometric model. The display contains the following:

- Visualization
- Preprocessing
- Principal Components Display
- Active Spectrum Display

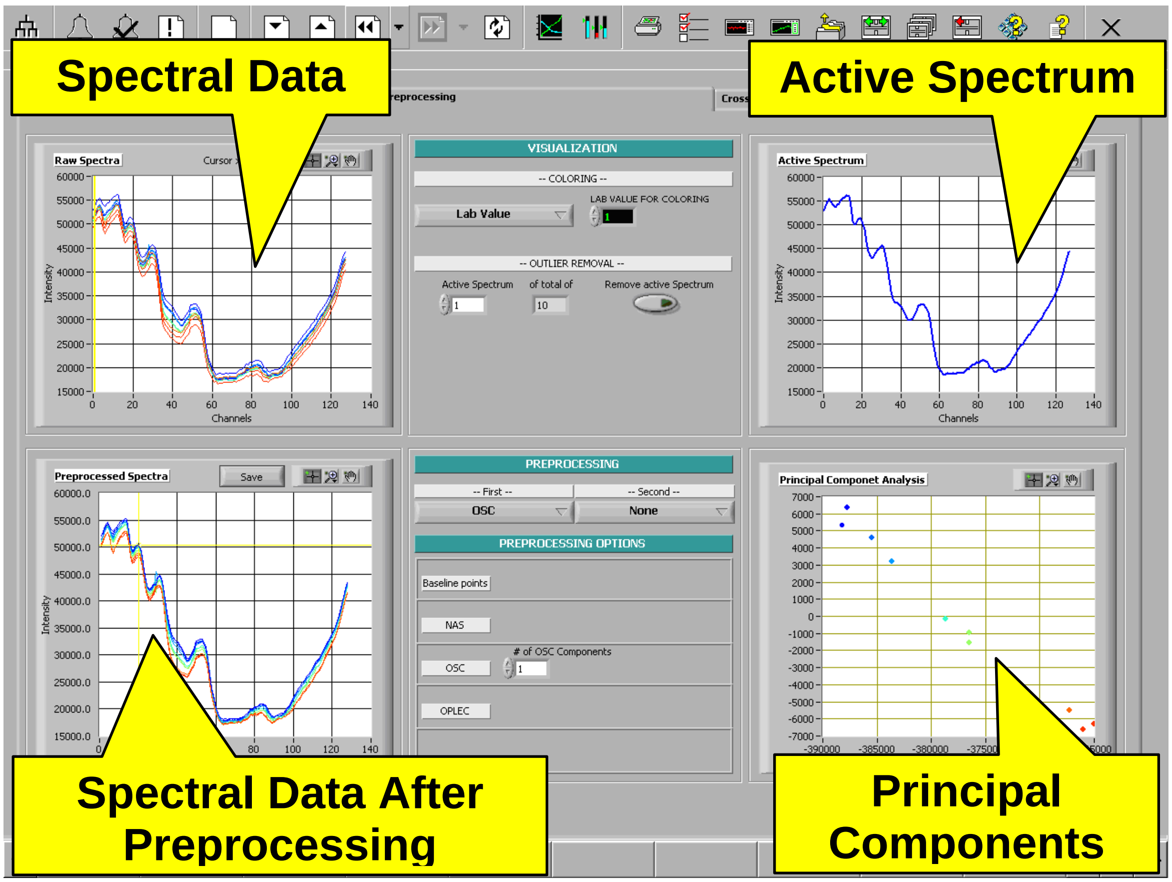


Figure 3-13 Example of the Chemometric Preprocessing display

Visualization

The intention of visualization is to show the sample spectra in a logical way, so that it is easy to see the effects of the preprocessing methods on the spectra. The coloring is important when using the Principal Components Analysis display. You can initiate or start coloring by clicking the **Lab Value** button. The coloring strategy of the spectra can be chosen from the following five options.

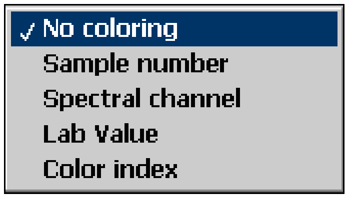


Figure 3-14 The coloring options window

The coloring is based on the logic that the spectra corresponding to the lowest material values are in **RED** and the spectra corresponding the highest material values are in **BLUE** and those values that are in between are colored according to the colors of rainbow.

Table 3-1 The coloring options

Option	Description
No coloring	Spectra has the same color (black)
Sample number	Coloring by sample number
Spectral channel	Coloring by spectral channel
Lab value	Coloring by lab value
Color index	Coloring by index

By selecting the **Lab Value for Coloring** –the lab values of available materials can be chosen for the coloring.

Preprocessing

The preprocessing of spectra can be done in two phases:

First: Many a times one preprocessing (First phase) fetches good results. The preprocessing method can be chosen from the options shown in the Figure 3-15. and second phase is optional.

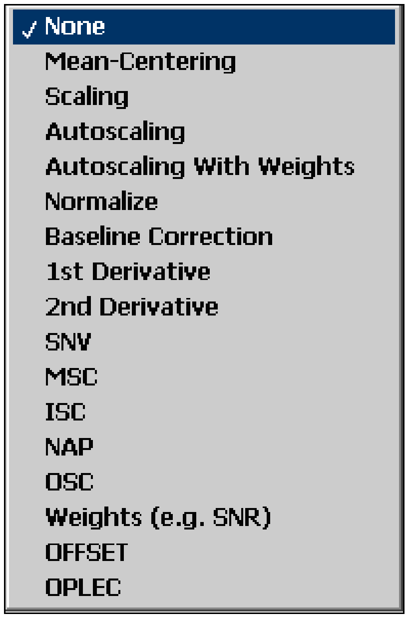


Figure 3-15 The optional preprocessing methods of Calibration Tool

Table 3-2 Preprocessing methods.

Method	Description
Mean-Centering	Mean-Centering is achieved by subtracting each element in a variable vector by the mean of that variable. Accounts for an intercept in a calibration model. Usually, the first component in multivariate models is the best multivariate approximation of mean spectra over calibration data set. Mean centering usually removes this offset component. As a preprocessing technique does not usually tackle any spectral interference.
Scaling	Variance scaling is achieved by dividing each element in a variable vector by the standard deviation of that variable. The primary reason for variance scaling is to remove weighting that is artificially imposed by the scale of the variables. Variance scaling is normally used when variables are from different scales and different units. Normally not often used in spectral data preprocessing.
Autoscaling	Autoscaling includes both mean-centering and variance scaling. As a preprocessing technique, autoscaling does not usually tackle any spectral interferences. Normally it is not used in spectral data preprocessing.
Autoscaling With Weights	Autoscaling followed by the weighting of spectral channels. Weights can be based on theory, prior experience, or experimentation. E.g. measured signal-to-noise data can be used to downweight spectral regions with relatively poor signal-to-noise ratio.
Normalize	Normalizing each spectrum with a given norm, e.g. with a Euclidean norm each spectrum is normalized to unit length. Two different norms are available for normalization that is Manhattan and Euclidean norms. Used for correcting additive physical interferences.
Baseline Correction	The Baseline Correction is often used to correct additive physical interferences. Baseline correction can be used when background spectral regions and baseline points can be identified. This algorithm uses Whittaker Perfect Smoother for smoothing the baseline.
1st Derivative	1st Derivative using Whittaker Perfect Smoother. The 1st derivate usually removes a constant offset term (level) over entire spectral region. Smoothing is used prior to derivative because derivation in general amplifies the noise in data.
2nd Derivative	2nd Derivative using Whittaker Perfect Smoother. This method is used like the 1st derivative but it removes both constant and slope baseline features over entire spectral region.
SNV	Standard Normal Variate (SNV) consists of row-wise mean-centering and unit variance scaling of each single spectrum. As a preprocessing technique, it resolves baseline offsets and simple multiplicative interferences.
MSC	Multiplicative Signal Correction (MSC) is a tool developed to correct for the significant light-scattering problems in reflectance spectroscopy. It is well known that particle size distribution affects measured spectra often in such away that all intensities increase as the particle sizes increase. Corrects for additive and multiplicative physical interferences.
ISC	Inverted Signal Correction (ISC) is a variation of MSC. It is used similarly. The technical difference is small and it is in that the spectral correction is done in forward
NAS	Net Analyte Signal (NAS) vector is the part of the gross signal which is orthogonal to the pure component spectra of the interferents.
OSC	Orthogonal Signal Correction (OSC) is used to remove spectral variation that does not correlate linearly with the response data.
Weights (e.g. SNR)	Weighting of spectral channels. Weights can be based on theory, prior experience, or experimentation. E.g. measured signal-to-noise data can be used to downweight spectral regions with relatively poor signal-to-noise ratio.
Offset Correction	Offset Correction consists of row-wise mean-centering. This is a simplified operation from SNV.
OPLEC	Optical Path Length Estimation and Correction (OPLEC) is a novel preprocessing method that is used to extract chemical information from the absorption spectra of turbid media and to eliminate the effects of varying optical path-length, which are due to the physical variations between samples.

The **Preprocessing options** (Second phase) are limited by the chosen (First phase) preprocessing method. The options are different according to the preprocessing method. The Calibration Tool shows the chosen preprocessing method and the options.

Table 3-3 The preprocessing methods with options

Method	Option	Description
Baseline correction	Baseline points: 1,128	Defines the baseline points to be used for the baseline correction. The spectra are processed to "go" via these points.
NAS	# of NAS Components	The number of Net Analyte Signal (NAS) components to be used. Each NAS component represents a vector that corresponds to the portion of signal of the analyte of interest that is independent of the signal attributable to interfering components.
OSC	# of OSC Components	The number of Orthogonal Signal Correction (OSC) components to be used. Each OSC component is orthogonal to responses (Y) and describes the largest variation in spectral data (X) that is to be removed by OSC correction.
OPLEC	• # of Analytes • # of LVs • 0:PINV • 1:PLS1	The assumed number of different chemical constituents in the system. The number of latent variables used in the computation of the OPLEC future correction vector. Additional parameter (0/1) used to define whether OPLEC uses pseudoinverse or PLS algorithm for the determination of the OPLEC future correction vector.

The preprocessed spectra are displayed on the left corner of the display. After good preprocessing method the spectra often seem to get more arranged according to the colors.

Principal Components Display

The principal components display shows the success of preprocessing and the linearization of data. This information is emphasized by the coloring of the sample spectra. After a successful preprocessing the different materials form logical rows or groups, having different colors. If the preprocessing method does not succeed the data points of different colors are spread diffusely and the spread does not seem to have logical patterns.

Active Spectrum Display

This display is available to support the work with raw data spectra. With this display it is possible to use the option **OUTLIER REMOVAL** to remove the spectrum(s), which is not needed to be processed. This can be done by writing the number of outlier spectrum in the **Active spectrum** box and by acknowledging the removal by clicking the **Remove active spectrum** button.

3.1.4. Chemometric Modeling Tool

The Chemometric Modeling Tool is used to choose the chemometric regression method for making the chemometric model. This tool also summarizes the results of the modeling. With this tool, you can view the modeling results and their success can be verified by cross validation.

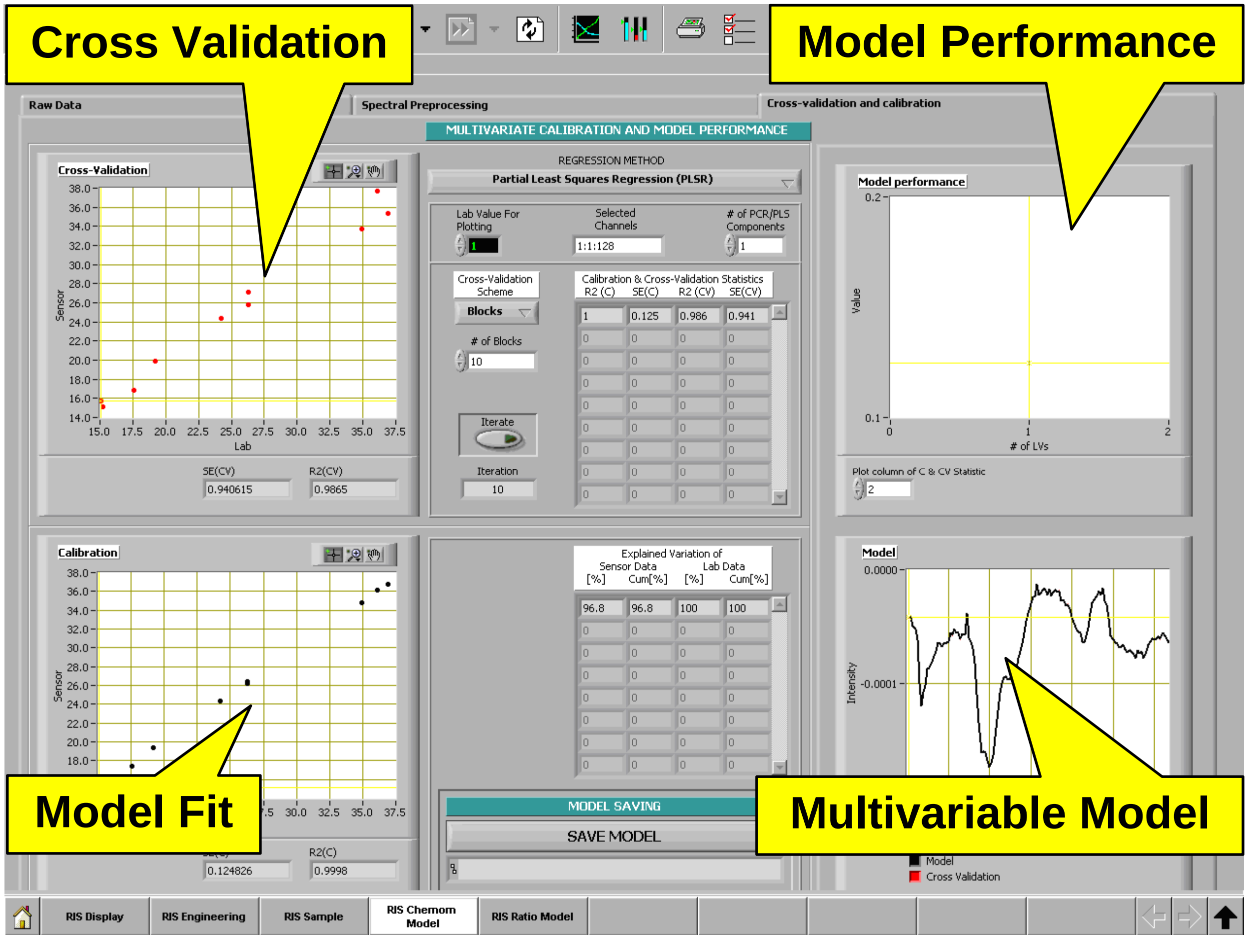


Figure 3-16 Example display of the Chemometric Modeling tool

The **Multiple Regression Method** is an optional chemometric methods available for the modeling (Table 3-4).

Figure 3-17 The regression methods window

Table 3-4 The regression method

Method	Description	Reference Reading
MLR	Multiple Linear Regression	Martnes, H , Naes T Multivariate Calibration, Wiley NewYork, 1991
PCR	Principal Component Regression	
PLSR	Partial Least Square Regression	

The **Lab value for plotting** field is used for selecting the Lab Value set (material) number.

The **Selected Values** field is used to select the pixels of spectrum used for the modeling. The format is **start:stop:end**. So 1:1:128 means that all pixels starting from first until 128th pixel are used.

If **MLR** or **PCR** is chosen for the regression model **Used variance in X (PCR)** will be enabled. This table indicates the variance of the principal components.

For **PCR** and **PLSR** models a table **Calibration & Cross-Validation Statistics is enabled** to indicate the quality of the fit. In this table the number of **PCR/PLS components** can be chosen for the construction of the model. Based on the components number the model highlights same amount of rows of the table **Calibration & Cross-Validation Statistics**.

3.1.4.1. Cross-Validation

Cross-Validation Scheme button has two methods (Figure 3-18) through which the quality of the model can be validated. They are:

1. Blocks
2. Random

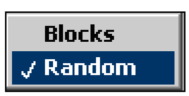


Figure 3-18 Cross-Validation Scheme button

Table 3-5 Cross-Validation Scheme options

Options	Description
Blocks	Data values ared divided to a given number(#) of Blocks. One Block at a time is left out from the model construction during Cross-Validation.
Random	Data values are divided to a given number (#) of Blocks, which are selected randomly from the data values. One Block at a time is left out from the model construction during Cross-Validation.

With the **number of Blocks** box it is possible to define the number of groups to which the sample data is divided for the cross validation process. During cross-validation one of these groups is left out of the model construction.

Then this model is used for the calculation of cross-validation fit. By clicking the **Re-Iterate** button the iteration can be done again for a new group of data. The Iteration box shows the number of sample data groups to which the data is divided for the cross validation.

Calibration & Cross-Validation Statistics table shows the statistical indicators (columns) versus number of latent variable **#LV** (rows).

Table 3-6 Indicators of Calibration & Cross-Validation Statistics

Indicator	Description
R2(c)	Coefficient of determination in calibration
SE(c)	Standard error of calibration
R2(cv)	Coefficient of determination in cross-validation
SE(cv)	Standard error of cross-validation

Cross Validation graph shows the Sensor values versus the Lab data by using a model, which is constructed using the data that contain only s partially measured data. When constructing the model, part of the measured data is consciously left out of the process. The part, which is left out of the model, can be chosen either randomly or by using certain blocks. The intention of this method is to indicate the stability of the model. By changing the data groups, which are left out of the model and constructing the corresponding models of the rest, it is possible to compare these models to the model containing all the data.

The boxes **SE(cv)** and **R2(cv)** below the graph shows standard error value and coefficient of determination of the fit.

Calibration

The **Calibration** graph shows the **Sensor** values versus **Lab** data of the data groups, which was used for making of the model. The boxes **SE(c)** and **R2(c)** below the graph shows the standard error value and coefficient of determination of the fit for the number of used principal components.

A table is created for the **PLSR** model, which shows, how well the principal components is used for the model (Table 3-7).

Table 3-7 Explained Variation of Sensor Data / Lab Data

Indicator	Description
Sensor Data [%]	Percentage of explained variation of spectrum values by the principal component
Sensor Data Cum[%]	Cumulated percentage of explained variation of spectrum values by the principal components
Lab Data [%]	Percentage of explained variation of lab values by the principal component
Lab Data Cum[%]	Cumulated percentage of explained variation of lab values by the principal components

Model

The Model graph shows the model regression coefficients versus pixel number for the model (black) and for the cross-validation (red).

Model Performance

The **Model Performance** plot visualizes the results of **Calibration & Cross-Validation Statistics** table versus the number of latent variable (**#LV**). The columns of the table can be chosen by selecting the **Plot of column** check box.

With this plot it is easier to see the relative effect of number of used latent variables on the quality of the model. Normally couple of first latent variables are sufficient to make **SE(c)** close to zero. By adding the latent variables (**LV**) it may decrease the **standard error of calibration** value, but there is a danger that it starts modeling the noise attached to the measured data.

Saving the Model

When the model is ready, you can save the model by providing a name for the model with a file extension as **.txt** . Click **Save Model** to save the model.

Sending the Calibration Model Files to Sensor

Before the sensor is ready to measure it must have a calibration model. You can send the saved calibration model file to the sensor through the **Engineering display** (Figure 3-19). Only one file can be sent at a time.

1. Open the folder below Send Model File(s).

2. Select the file.

3. Accept the file by clicking OK.

4. Send the file to sensor by clicking the SEND button.

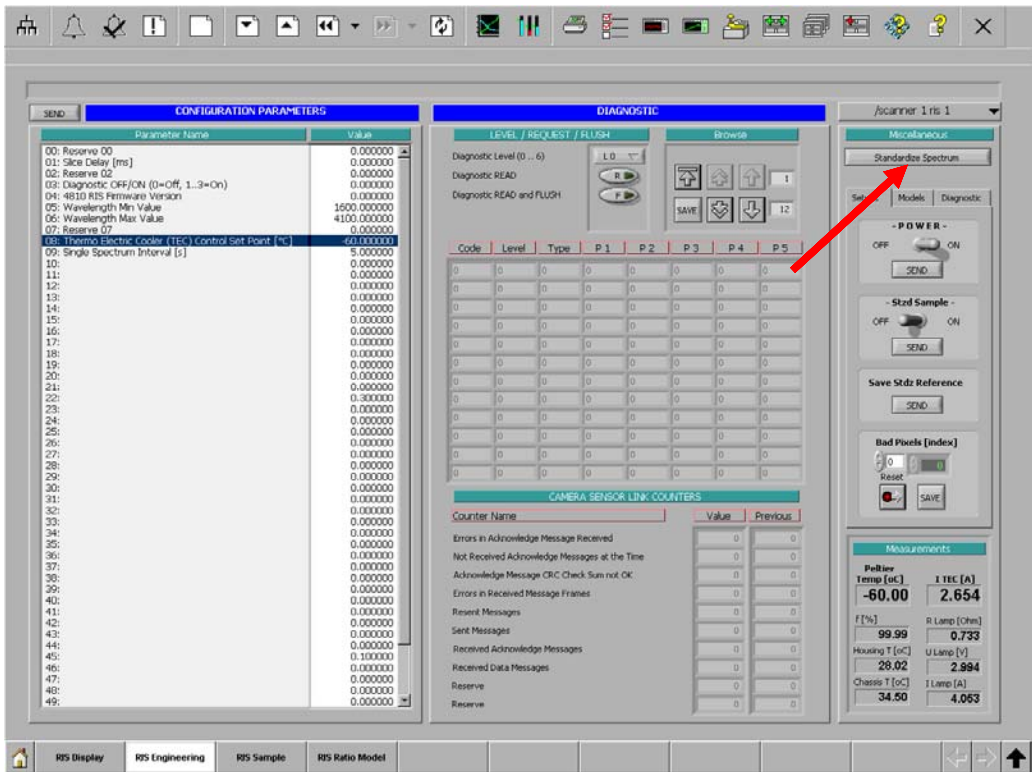


Figure 3-19 Models display of RIS Engineering page

Models Display

The **Models** display in the **RIS Engineering** page is built for the verification and handling of calibration models stored in the memory of RIS Sensor (Figure 3-20).

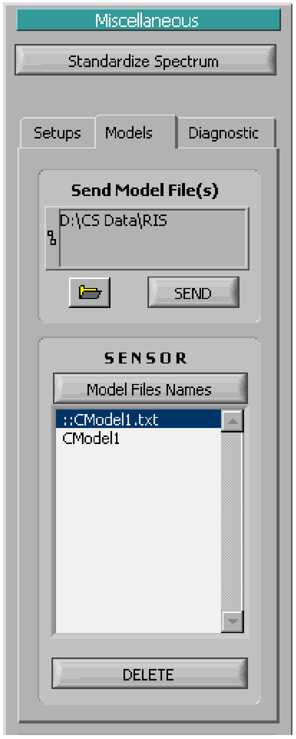


Figure 3-20 Models Display showing calibration models loaded in the RIS Sensor

Diagnostic Display

While the sensor is operating the Calculation Method (Ratio = 0, Chemometrics = 1) and the preprocessing methods that are used for the chemometric model can be checked from the diagnostic display.

The **Data Handling Time** indicates the time needed by the program to calculate the results. The Data Handling Time is important with chemometrics, because different chemometric models are used different times for the calculation of results. The **Integration Time** is the time used by sensor for collection of spectral data.

If the Data Handling Time is greater than the Integration Time the measurement program automatically increases the integration time to the next greater value than the Data Handling Time.

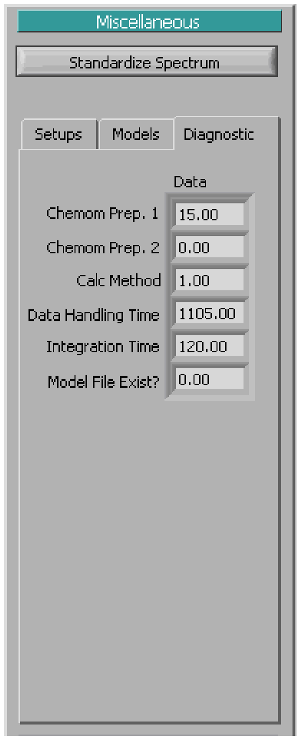


Figure 3-21 Display for diagnostics of chemometric measurement

Grade Definition

During grade definition, the file name of the calculated model (Ratio/Chemometric) must be given for each grade.

To operate with grades, perform the following.

1. Open **Recipe Maintenance** display
2. Click **Main Code Table**.
3. From the **Select Value For Data Groups** dialog box, select the **RIS11P1x configuration table**, which contains the configuration parameters of the grade in question.

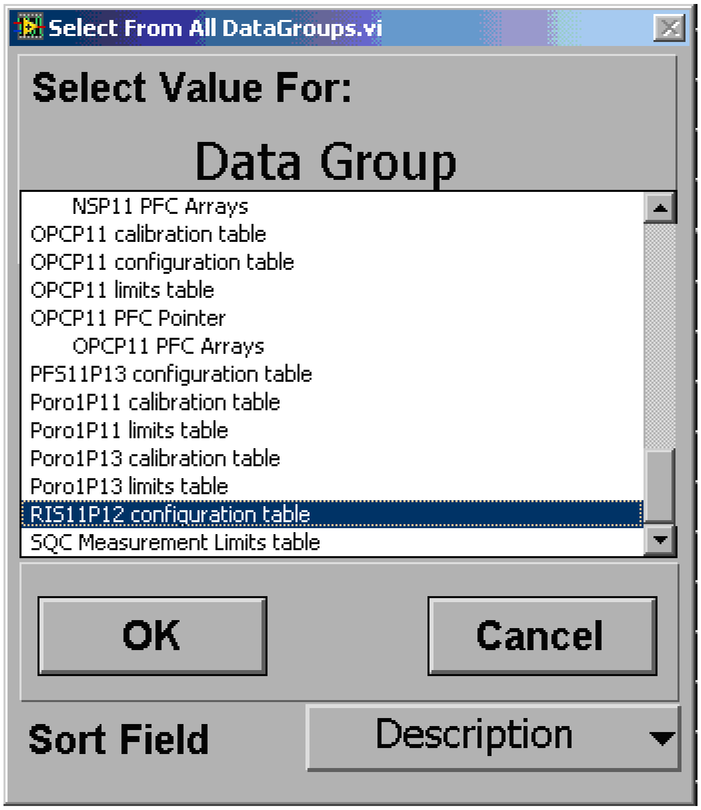


Figure 3-22 Select Value For pop-up window

4. This opens the configuration table, which contains the file name(s) of calculation method(s). The defined grade must contain file name, which contains the model.

Description	File Data	Current Data
1. RIS11P11 Signal Gain	1.	1.
2. RIS11P11 Integration Time [ms]	100.	100.
3. RIS11P11 Lamp Control Set Point(1..10)	8.	8.
4. RIS11P11 Model File Name	SE1pe.txt	CModel1.txt
5. RIS11P11 Hole averaging	False	False
6. RIS11P11 Hole 1 location [mm]	0	0
7. RIS11P11 Hole 2 location [mm]	0	0
8. RIS11P11 Hole 3 location [mm]	0	0
9. RIS11P11 Hole 4 location [mm]	0	0
10. RIS11P11 Hole 5 location [mm]	0	0
11. RIS11P11 Hole 6 location [mm]	0	0
12. RIS11P11 Material 1 Slope	1.	1.
13. RIS11P11 Material 1 Offset	0.	0.
14. RIS11P11 Material 2 Slope	1.	1.
15. RIS11P11 Material 2 Offset	0.	0.
16. RIS11P11 Material 3 Slope	1.	1.
17. RIS11P11 Material 3 Offset	0.	0.
18. RIS11P11 Material 4 Slope	1.	1.
19. RIS11P11 Material 4 Offset	0.	0.
20. RIS11P11 Material 5 Slope	1.	1.
21. RIS11P11 Material 5 Offset	0.	0.
22. RIS11P11 Material 6 Slope	1.	1.
23. RIS11P11 Material 6 Offset	0.	0.
24. RIS11P11 Material 7 Slope	1.	1.
25. RIS11P11 Material 7 Offset	0.	0.

Figure 3-23 Example of a Grade Configuration table

The given model can be used for measurement after grade change.

.

4. RIS Optics

4.1. Infrared Source

The infrared source of the RIS Sensor is a 45 W halogen lamp. The lamp is used below the nominal voltage.

4.2. Chopper

The chopper is constructed of eight holes chopper wheel containing brushless ball bearing loaded to the DC motor. The chopper wheel is installed directly to the axis of the motor and is tightened with hex screw. To control the chopper rotation speed, the chopping frequency of the wheel is read through the wheel holes with transmissive optoschmitt sensor. Pulse train is fed to the processor for digital closed loop control.

4.3. Reflectors and Mirrors

The IR light of the lamp is focused to the aperture of chopper wheel by using custom made condensing reflector. A gold plated surface is used as a reflecting surface.

After chopper the pulsed IR light is focused through a window on the sample by using custom made condensing reflector.

The IR light, which is collected from the sample through the receiver window, is first folded by a flat mirror, which directs the rays on a condensing reflector. This reflector efficiently focuses the IR rays to the input aperture of light mixing tube. Between the condensing reflector and the light mixing tube there is a flat mirror used for redirecting the rays to the input aperture of light mixing tube.

The IR ray, which comes from the output of the light mixing tube, are collected by custom designed gold plated reflector, which makes the picture of the output aperture of light mixing tube on the surface of detector array. There is one folding flat mirror between the reflector and the detector.

4.4. Windows

Two windows are used in the construction of the RIS Sensor. These windows prevent dirt from entering into the sensor optics. The chopped light is directed on the sample surface through the first window at light source side. The second window at the receiver optics separates the optics from outer environment of sensor head.

Figure 4-1 Source and receiver windows of RIS Sensor

4.5. Light Mixing Tube

The light mixing tube is designed to minimize the pass line effect on the sensor response. While passing through the light mixing tube the measured IR light experiences multiple reflections. The purpose of these reflections is to mix all the rays that are coming from the sample. This ensures that the light coming from every single point of the sample surface is spread as evenly as possible on the whole detector array surface.

4.6. Spectrograph

The spectrograph is specially designed for the RIS Sensor, and is located inside the detector module.

4.7. IR Detector Array

RIS Sensor uses 128 element IR detector array. The detector module is custom made for Honeywell. The wavelength range of the detector material is specially optimized for the RIS Sensor. The detector temperature is measured and the cooling is done with closed loop digital controller.

5. RIS Electronics

5.1. Detector Electronics of RIS Sensor

The detector electronics are located inside the detector module. The main function of the electronics is to carry the circuitry for processing the signals of each element of the 128 element detector array. In addition the detector electronics function is also to support the basic operations of the detector array (bias voltage, detector array cooling and array temperature measurement).

5.1.1. Detector Bias Voltage

Bias voltage is needed for the normal operation of the IR detector. The raw unfiltered (40 VDC) bias voltage is originally made at the Control PCBA. This voltage is fed to the Detector PCBA, which filters and stabilizes the voltage to 32 VDC. This stabilized bias voltage is sent to the Detector module, which spreads the voltage to each element of the IR detector array.

5.1.2. Preamplifiers

On the detector electronics there is a preamplifier with fixed gain for each element of the 128 element IR detector array. The amplified signals of each element are also separately filtered before sending the signals to analog multiplexers.

5.1.3. Multiplexers

The detector electronics inside the detector module contains eight analog multiplexers. The 128 amplified and filtered signals of the IR detector array is fed to these multiplexers, so that each multiplexer has input for 16 signals. The eight output lines of the multiplexers are sent out of the detector module to the Detector PCBA.

5.1.3.1. Multiplexer Control

The multiplexers are controlled by using five digital lines. Three lines (A0-A2) of these are used for the addresses , one line (EN1) gives the clock pulse and other is used for (EN2) data enable.

5.1.4. Detector Temperature Control

The IR detector array is thermoelectrically cooled by using Peltier cooler. For the control of the cooling the temperature of the chip is measured by using a thermistor, which is on the IR detector array chip. The detector electronics is used to connect these signals between Detector PCBA and IR detector array.

5.2. RIS Detector PCBA

Detector PCBA supports the operation of IR detector module and the operations and communication between Control PCBA and processor unit.

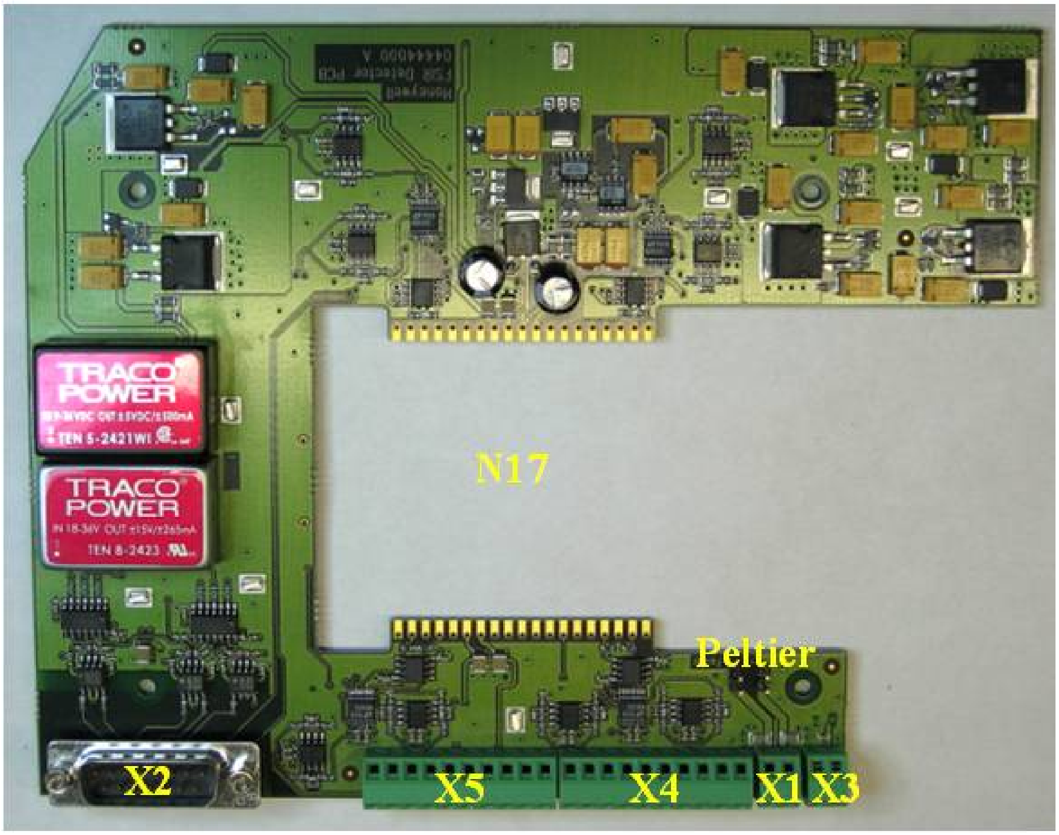


Figure 5-1 RIS Detector PCB

5.2.1. Bias Voltage

Elements of IR detector array use bias voltage. The +32 VDC bias voltage is filtered and regulated from the raw voltage (+40 VDC), which is generated at the Control PCB. The measured voltage must be 32 ± 1V. To ensure that the bias regulator is operating check the LED V3.

Table 5-1 The input and output pins of Bias Voltage

Signal	Input pin	Detector Connection
BIAS 40VDC (pos)	X3.1	-
BIAS 40VDC (neg)	X3.2	-
BIAS 32VDC (pos)	-	N17.32
BIAS 32VDC (neg)	-	N17.33

5.2.2. Thermoelectric Cooler and Temperature Measurement

The Detector uses thermoelectric cooler (TEC). The electric current for the cooling comes from the Control PCBA. The Detector PCBA is used only to make the connections between the Control PCBA and the Detector.

Table 5-2 The input and output pins of TEC

Signal	Input pin	Detector connector
PELTIER +	X1.2	N17.22, N17.23
PELTIER -	X1.1	N17.20, N17.21

The temperature of detector elements is measured by using thermistor. The measured thermistor value (resistance) is sent to the Control PCBA for the interpretation of temperature.

Table 5-3 The input and output pins of thermistor

Signal	Detector connector	Output D15-M
THERM1	N17.30	X2.7
THERM2	N17.31	X2.8

5.2.3. Programmable Gain Amplifiers and Differential Output Amplifiers

The eight signals gets multiplexed and these spectrum signals from detector are sent to the Detector PCB first (connector N17). These signals are first sent to eight input buffer amplifiers after which the signals are sent to eight programmable amplifiers.

All the programmable amplifiers are controlled by the same digital lines EN1 (CS/LD), EN2 and A0. The gains of the amplifiers are _, 1, 2, 5, 10, 20, 50, 100 and 200. You can program these eight amplifiers to have the same gain value.

After the programmable amplifiers the eight signals are sent to output buffer amplifiers, which make the output signals differential (positive/negative output).

Table 5-4 The input and output pins of multiplexed spectrum signals

Signal	Input pin	Positive output pin	Negative output pin
OUT1_16	N17.39	X4.2	X4.1
OUT17_32	N17.27	X4.4	X4.3
OUT33_48	N17.41	X4.6	X4.5
OUT49_64	N17.25	X4.8	X4.9
OUT65_80	N17.2	X5.2	X5.1
OUT81_96	N17.18	X5.4	X5.3
OUT97_112	N17.4	X5.6	X5.5
OUT113_128	N17.16	X5.8	X5.7

5.2.4. Isolation of Control Inputs

Detector PCB uses five optoisolators in digital lines coming from Control PCB. The isolated lines are PGA_CS/LD, PGA_DIN, A1, A2 and EN1.

Table 5-5 The input and output pins of Detector control signals

Signal	Input pin D15-M	Detector connector
PAG_CS/LD	X2.1	-
PGA_DIN	X2.2	N17.13
A1	X2.3	N17.11
A2	X2.4	N17.12
EN1	X2.5	N17.9

5.3. RIS Control PCBA

The main function of Control PCBA is to supply the voltages needed by the sensor, and also support different sensor operations and communications between different units of the sensor.

Figure 5-2 RIS Control PCB

5.3.1. Supply Voltage of RIS Control PCBA

The supply voltage (VDD) of the RIS Sensor is +24 VDC.

Table 5-6 Supply voltages of RIS Control PCBA

Voltage	Input	Output
VDD IN +24 VDC	X2.1	-
GND	X2.2	-
VDD IN +24 VDC	-	X5.9
VDD IN +24 VDC	-	X5.10
GND	-	X5.11
GND	-	X5.12
DETECTOR BIAS +40VDC	-	X16.1
GND	-	X16.2

5.3.2. LEDs on RIS Control PCBA

You can check the various functional operation of the RIS Control PCBA through the LEDs that are attached on the card. All these LEDs are located near the circuitry in question. Table 5-7 lists the various available LEDs.

Table 5-7 Green LEDs on the RIS Control PCBA

Voltage	LED
Supply +15 VDC	X
Supply -15 VDC	X
Supply +5 VDC	X
Raw Bias 40 VDC	X
RS-422 TxD	X
RS-422 RxD	X

5.3.3. Digital I\O

Digital IO is used to control the RIS Sensor operations.

Table 5-8 The input and output pins of digital I/O

Signal	Input D25-F	Output D15-F	Output	Description
DIO0	X12.14	X5.1		CS/LD
DIO1	X12.16	X5.2		A0
DIO2	X12.17	X5.3		A1
DIO3	X12.19	X5.4		A2
DIO4	X12.20	X5.5		EN1
DIO5	X12.22		X6.1	STD SAMPLE
DIO6	X12.23		X6.3	WATER (optional)
DIO7	X12.25	-	-	POWER ON/OFF

5.3.3.1. Programmable Power ON/OFF

The supply voltages of IR source, chopper, and thermoelectric cooler can be switched ON/OFF by using line DIO7 of Digital I/O Module (slot S7). This power ON/OFF function is controlled by the measurement program.

5.3.4. IR Source Measurement and Control

Stable IR Source is essential for the operation of the RIS sensor. To ensure good control and stable operation of the IR source both voltage and current values are measured simultaneously. This information is used to regulate the operation of IR source.

Table 5-9 The inputs and outputs of IR source control.

Signal	Input	Output
LAMP	-	X4.1
GND	-	X4.2
IRSCR CTL	X8.5	-
GND	X8.6	-
IRSRC UMEAS	-	X14.1
GND	-	X14.2
IRSRC IMEAS	-	X14.3
DIO7	-	X14.4

5.3.4.1. IR Source Voltage and Current Measurement

The voltage of the IR source is measured by using 16-Bit Analog Input Module.

The IR source current is also measured with 16-Bit Analog Input Module by measuring the voltage drop caused by the IR source current over known constant resistor. This resistor is located at the Control PCB near the IR source supply voltage switcher.

5.3.4.2. IR Source Control

The IR source regulation is based on the IR source voltage and current measurements. This is done by the processor unit using closed loop PI controller function. The controlled driving DC voltage is sent by 16-Bit Analog Output Module to the Control PCBA, where it drives the output voltage of the lamp power source. The maximum DC output voltage is limited below the nominal value of the IR source.

5.3.5. Chopper Control

Chopper rotation is regulated by measuring the rotation speed. This information is used for the control of motor driving voltage. The rotation speed of the chopper wheel is detected by using transmissive optoschmitt sensor. The output pulses of the optoschmitt sensor are buffered and sent to TTL Digital I/O module (slot S8).

Table 5-10 Wiring of transmissive optoschmitt sensor

Pin	Wire Color	Designation
X10.1	Red	Source Vcc
X10.2	Black	GND
X10.3	-	-
X10.4	White	Detector Vcc
X10.5	Blue	Detector Output
X10.6	Green	GND

Table 5-11 Copper phase information

Input	Output D9- F	Designation
X10.5	X13.8	CHOPPER PHASE
X10.6	X13.9	GND

Closed loop PI controller function at processor unit is used to regulate the chopper rotation based on the measured pulse values. The controlled chopper driving voltage is sent by 16-Bit Analog Output Module to the Control PCBA, where it drives the output voltage of chopper power source.

5.3.5.1. Chopper Motor

The chopper motor is a DC motor with integral electronic commutation and preloaded ball bearings. Maximum supply voltage is rated to 7.5VDC. Table 5-12 provides the wiring details of the motor.

Table 5-12 Wiring of chopper motor

Pin	Wire Color	Designation
X1.1	Brown	GND
X1.2	Red	Power supply voltage
X1.3	Orange	Direction CCW/CW
X1.4	Yellow	Enable start/stop
X1.5	Green	Logic supply voltage
X1.6	Blue	Speed signal

5.3.6. Thermoelectric Cooler Control

5.3.6.1. TEC Temperature and Current Measurements

Thermoelectric cooler (TEC) is used for cooling and stabilizing the IR detector array temperature. The cooling power is regulated by measuring the temperature of IR detector chip with thermistor and this information is used for the control of TEC driving current.

Table 5-13 Current measurement of TEC

Signal	Input	Output
TEC IMEAS	-	X11.5
GND	-	X11.6

The current value of TEC is measured, although, it is not used directly for cooler control. For preventing possible damages to TEC the measured current value is important for monitoring the state of cooling and in keeping the cooling current below the limit of maximum value. The maximum limit of current is 4.0A. The measurement program automatically turns the programmable power switch OFF, when the maximum value is reached. After this the sensor does not turn ON automatically. The operator must turn the power switch ON manually from the measurement program.

Possible reason for the high cooling current value can be missing water circulation. Before turning the sensor ON the reason for the high cooling current must be located and fixed.

5.3.6.2. TEC current regulation

The closed loop PI controller function of the processor unit is used to regulate the TEC current based on measured IR detector array temperature. The controlled TEC driving voltage is sent by 16-Bit Analog Output Module to the Control PCB, where it drives the output current of TEC power source (Table 5-14).

Typically the detector operation temperature varies from -40 ºC to - 60 ºC. The PI controller normally reaches this temperature within five minutes with accuracy of ± 0.1ºC.

Table 5-14 TEC control connectors

Signal	Input	Output
TEC CTL	X8.3	-
GND	X8.4	-
TEC	-	X3.1
GND	-	X3.2

5.3.7. Temperature measurements

In addition to the temperature measurement of TEC three temperature values are read during the normal operation of RIS Sensor. Fourth temperature reading is optional.

Table 5-15 Temperature measurements

Signal	Input	Output	Description
PELTIERTHERM+	X5.7	-	Temp sensor inside the detector
PELTIERTHERM-	X5.8	-	
PELTIERTEMP	-	X11.3	
GND	-	X11.4	
TEMP1	-	X11.1	Temp sensor on Control PCBA
GND	-	X11.2	
TEMP2 V+	X15.1	X14.5	For external temp sensor (optional)
TEMP2 V-	X15.2	X14.6	
TEMP CHASSIS	-	-	Temp sensor in Processor unit
GND	-	-	

5.3.7.1. Detector Array Temperature

The IR detector array has a thermistor attached on the chip. This temperature reading is used for the thermo electrical cooler control. The electrical circuit, which converts the thermistor's resistance values to corresponding voltages, is located at the Control PCB. The measured voltages are read by 16-Bit Analog Input Module and the results are displayed as degrees of Celsius.

5.3.7.2. Control PCB Temperature

The Control PCB contains a temperature detector for the monitoring of the temperature inside the measuring head box. The electrical circuitry for this measurement is located at the Control PCB. The measured values are read by the 16-Bit Analog Input Module and the results are displayed as degrees of Celsius.

5.3.7.3. Optional Base Plate and Cooling Water Temperature

The cooling water temperature can be measured at the water cooled bottom plate of the sensor. The electrical circuitry for this measurement is located at the Control PCB. The measured values can be read by the 16-Bit Analog Input Module. Normally the temperature sensor is not installed.

5.3.7.4. Processor Unit Chassis Temperature

Processor Unit has temperature sensor attached to the chassis. This temperature is measured for monitoring the operation condition of the processor. The results are displayed as degrees of Celsius.

5.3.8. Standardization Sample Control

The RIS Sensor uses a standardization sample for the normalization of the measured spectrum. The standardization sample is a gold plated diffusing reflector, which is driven to the sample position during the time of standardization. The mechanical movement is done by small air cylinder.

Due to the construction of the standardization mechanics the standardization can be done both off –line and on-line. The measurement program controls the standardization procedure. TTL Digital I/O module sends the standardization command to the Control PCBA, which has driver circuit for the magnet valve of standardization air cylinder.

Table 5-16 Standardization sample control

Signal	Input	Output
STD SAMPLE	X12.22	X6.1
GND	X12.26	X6.2

The movement speed of the air cylinder can be adjusted. There are valves attached to the cylinder unit for both directions of movement (see Chapter 6, Figure 6-4).

5.3.9. Optional Flow Control of Cooling Water

You can control the flow of cooling water using the measurement program by using TTL Digital I/O module. The Control PCB has driver circuit and output contacts reserved for cooling water magnet valve. If this is used, the magnet valve must be assembled outside the sensor head. The contacts for outside sensor box wiring are available on Assembly PCB.

Table 5-17 Optional water control

Signal	Input	Output
Water	X12.23	X6.3
GND	X12.27	X6.4

5.3.10. Isolated RS-422 Link

The measurement results of the RIS Sensor to system are communicated by using isolated RS-422 link.

Table 5-18 Isolation of RS-422 Link

Signal	Input	Isolation	Signal	Output
RxD	X13.2		RxD+	X7.1
GND	X13.10		RxD-	X7.2
TxD	X13.3		TxD+	X7.3
GND	X13.11		TxD-	X7.4

5.4. RIS Assembly PCBA

The PCBA Assembly is interface between RIS Sensor electronics and the scanner (ProLine 2080). This card is needed because of the wiring structure of PowerTrack and power consumption of the sensor. The electrical current of 24 VDC supply is divided to four separate pins of the contactor. Also the serviceability is kept in mind with the design of power switch and Ethernet connector.

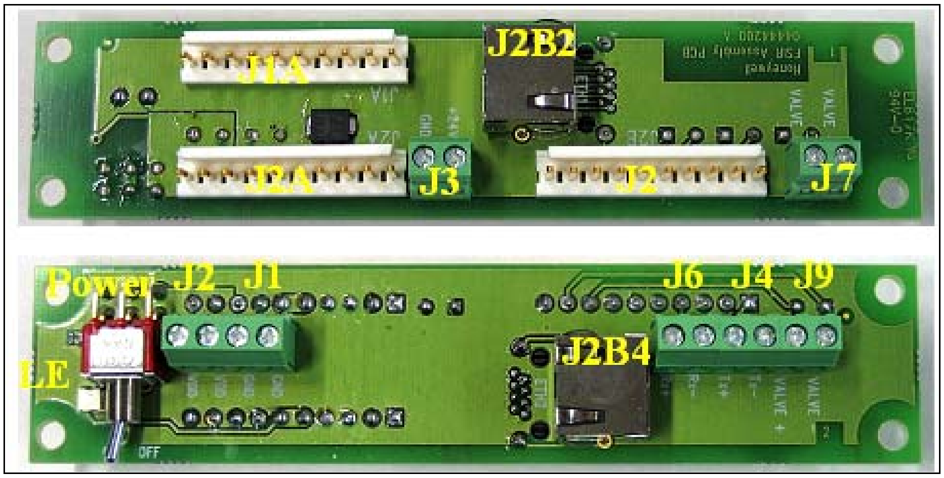


Figure 5-3 RIS Assembly PCB

5.4.1.Supply Voltages

The power consumption of RIS Sensor requires several wires (4 × 24V + 4 × GND) of PowerTrack (Connectors J1A and J2A) to be taken into use for the supply voltage.

Table 5-19 Supply Voltages In

Voltage	Input
VDD +24VDC	J1A-3
VDD +24VDC	J1A-4
VDD +24VDC	J2A-3
VDD +24VDC	J2A-4
GND	J1A-5
GND	J1A-6
GND	J2A-5
GND	J2A-6

Table 5-20 Supply Voltages Out

Voltage	Output	Designation
VDD +24VDC	J2-1	Processor VDD
VDD +24VDC	J2-2	Control PCBA VDD
GND	J1-1	Processor GND
GND	J1-2	Control PCBA GND
VDD +24 VDC	J3-1	WLAN VDD
GND	J3-2	WLAN GND

5.4.2. Power Switch

The 24 VDC supply voltages for Processor unit and Control PCBA are behind power ON/OFF switch for serviceability reasons. The power ON is indicated with a Green LED, which is near the power switch. The supply voltage for WLAN is not controlled with the Power Switch.

5.4.3.RS 422-link

Four wires of the PowerTrack (Connector J2B) are used for the RS422-link. There are four screw terminals (Tx-, Tx+, Rx-, Rx+) for these on Assembly PCBA. The connecting wires come from corresponding screw terminals of Control PCBA.

Table 5-21 RS-422 Link

Signal	Input	Output
RxD+	J6-1	J2B-4
RxD-	J6-2	J2B-5
TxD+	J4-1	J2B-1
TxD-	J4-2	J2B-3

5.4.4.Ethernet Connector

Ethernet connector is assembled for the serviceability of the sensor. The sensor processor is connected inside the sensor to the Ethernet connector

(ETH2). With this option the updating of the sensor programs and monitoring the sensor operation during on-line operation using WLAN is made possible.

Table 5-22 WLAN and Ethernet

Signal	Input	Output
WLAN	ETH2	ETH1

5.4.5.Optional Valve Control for Cooling Water

Two wires of PowerTrack (Connector J2B) are reserved for optional magnetic valve control of cooling water. Also screw terminal connectors (Valve - and Valve +) are assembled on both sides of the Assembly PCBA.

Table 5-23 Optional magnet valve control for cooling water

Voltage	Input	Output
VALVE +	J9-1	J2B-8 and J7-2
VALVE -	J9-2	J2B-9 and J7-1

5.5. Sensor Processor

The sensor processor is National Instruments CompactRIO (cRIO). It is reconfigurable embedded system which consists of the cRIO controller, cRIO reconfigurable embedded chassis and cRIO I/O modules.

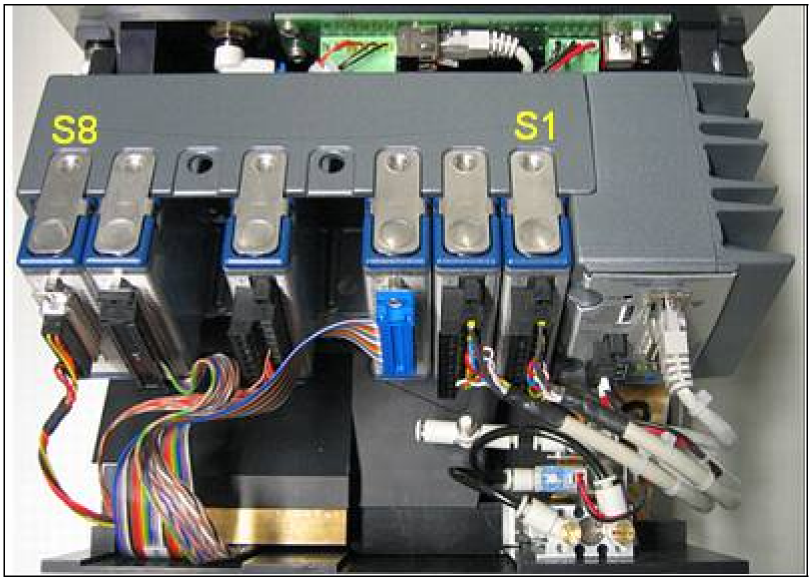


Figure 5-4 Sensor processor with the I/O modules

5.5.1.Controller

Controller module is cRIO-9012. This unit has 400 MHz processor and it contains 128 MB disc on chip storage and 64 MB DRAM.

5.5.2.Reconfigurable Embedded Chassis

The reconfigurable embedded chassis is cRIO-9104. This unit contains reconfigurable FPGA, which is used for the fast real-time data acquisition and sensor control. This unit has 8-slot chassis for the assembly of the I/O modules.

5.5.3.Interface

5.5.3.1. I/O Modules of Processor Unit

S1	S2	S3	S4	S5	S6	S7	S8
NI 9215 / 4-Ch Analog Input	NI 9215 / 4-Ch Analog Input	NI9401 / 8-Ch TTL Digital I/O		NI9263 / 4-Ch Analog Output		Ni9205 / 32-Ch Analog Input	NI9401 / 8-Ch TTL Digital I/O

5.5.3.2. FPGA I/O Definitions

Table 5-24 Definitions of FPGA I/O modules

Location	Module Type	Module Name	Channel / Description	
4-Ch +/- 10V 16-Bit Simultaneous Analog Input			Differential connection	
Slot 1	NI 9215	NI 9215	Terminal 0	AI0+, Pixels 0-15
			Terminal 1	AI0-, Pixels 0-15
			Terminal 2	AI1+, Pixels 16-31
			Terminal 3	AI1-, Pixels 16-31
			Terminal 4	AI2+, Pixels 32-47
			Terminal 5	AI2-, Pixels 32-47
			Terminal 6	AI3+, Pixels 48-63
			Terminal 7	AI3-, Pixels 48-63
4-Ch +/- 10V 16-Bit Simultaneous Analog			Differential connection	

Location	**Module Type**	**Module Name**	**Channel / Description**	
Input				
Slot 2	NI 9215	NI 9215 2	Terminal 0	AI0+, Pixels 64-79
			Terminal 1	AI0-, Pixels 64-79
			Terminal 2	AI1+, Pixels 80-95
			Terminal 3	AI1-, Pixels 80-95
			Terminal 4	AI2+, Pixels 96-111
			Terminal 5	AI2-, Pixels 96-111
			Terminal 6	AI3+, Pixels 112-127
			Terminal 7	AI3-, Pixels 112-127
8-Ch High-Speed TTL Digital I/O				
Slot 3	NI 9401	NI 9401	Initial Line Direction = Output	
			DIO 0	CS/LD (Gain control)
			DIO 1	Gain (Gain control) / Pixel address
			DIO 2	Pixel address
			DIO 3	Pixel address
			Initial Line Direction = Output	
			DIO 4	Clock (Gain control) / Pixel address
			DIO 5	Stdz Sample Control
			DIO 6	Water Circulation Control
			DIO 7	Power ON/OFF
Slot 4				
4-Ch +/- 10V 16-Bit Analog Output				
Slot 5	NI 9263	NI 9263	AO0	Chopper Control
			AO1	TEC Control
			AO2	Lamp Control
			AO3	
Slot 6				

Location	Module Type	Module Name	Channel / Description	
32-Ch +/- 10V to +/- 200mV 16-Bit Analog Input			Differential connection	
Slot 7	NI 9205	NI 9205	AI0	Housing Temp, Signal +
			AI1	U Therm, Signal +
			AI2	I TEC, Signal +
			AI3	U Lamp, Signal +
			AI4	I Lamp, Signal +
			AI5	(Cooling Water Temp, Signal +) optional
			AI6	
			AI7	
			AI8	Housing Temp, Signal -
			AI9	U Therm, Signal -
			AI10	I TEC, Signal -
			AI11	U Lamp, Signal -
			AI12	I Lamp, Signal -
			AI13	(Cooling Water Temp, Signal -) optional
			AI14	
			AI15	
			AI16	
			AI17	
			AI18	
			AI19	
			AI20	
			AI21	
			AI22	
			AI23	
			AI24	
			AI25	
			AI26	
			AI27	
			AI28	
			AI29	
			AI30	
			AI31	
8-Ch High-Speed TTL Digital I/O				
Slot 8	NI 9401	NI 9401 2	Initial Line Direction = Input	
			DIO 0	Chopper Pulse
			DIO 1	
			DIO 2	
			DIO 3	Serial Link Communication Input

Location	Module Type	Module Name	Channel / Description	
			Initial Line Direction = Output	
			DIO 4	
			DIO 5	
			DIO 6	
			DIO 7	Serial Link Communication Output

5.5.4.I/O modules

5.5.4.1. Analog Input Modules

4-Channel Differential Simultaneous Analog Input Modules

The RIS Sensor has two NI-9215, ±10 V, 16-Bit Simultaneous Analog Input Modules for the fast measurement of the IR spectrum (slots S1 and S2). The maximum sampling rate is 100 kS/s/ch.

16-Channel Differential Analog Input Module

For the control of RIS Sensor operations there is one NI-9205, ±10 V, 16-Bit Analog Input Module (slot S3). The maximum aggregate sampling rate is 250 kS/s. This unit is used to measure:

- IR source voltage
- IR source current
- TEC current
- IR Detector temperature
- Housing temperature (on Control PCBA) and
- (Cooling water temperature), optional

5.5.4.2. Analog Output Module

4-Channel Analog Output module

For the control of RIS Sensor operations there is one NI-9263, ±10 V, 16-Bit Analog Output Module (slot S5). The maximum update rate is 250 kS/s. This unit is used to drive the power supplies of

- IR Source
- Chopper motor
- Thermoelectric cooler.

5.5.4.3. Digital I/O Modules

8-Channel 5V/TTL Digital I/O Modules

The RIS Sensor has two NI-9401, 5V/TTL, Digital I/O Modules. The unit is direction-configurable by nibble (4-bits).

The unit in the slot S7 is configured to output for the control of the senor operations as:

- DIO0-DIO4, Pixel addresses (multiplexers of detector module)
- DIO0-DIO4, Programable gain (Detector PCB)
- DIO5, Standardization sample ON/OFF (Control PCB)
- DIO6, (Water flow ON/OFF, optional (Control PCB))
- DIO7, power ON/OFF (Control PCB)

The Digital I/O module in the slot S8 is configured to both input (4-bits) and output (4-bits). The input (DIO 0) reads the chopper speed. The input DIO 3 and the output DIO 7 are for the communication of the sensor with the system by using RS-422 link.

6. Mechanics, Pneumatics and Cooling

6.1. Mechanical structure

The long optical path of the sensor is packed in a small sensor head. Due to this, the mechanics and optics are effectively integrated in one package. This construction also supports the need to use reflective optics as a wavelength range of the measured IR light. The reflector that is used is specially designed and they form an essential part of the integrated mechanical construction.

The effective cooling need of the detector unit also dictates the structure of the RIS Sensor. For this reason the detector is located directly in contact with the water cooled plate of G-Head.

The other units of the RIS Sensor such as PCBAs, standardization mechanics, wiring, and processor unit are located around this basic mechanical construction.

6.1.1.Mechanical Support Frame of Processor Unit

Due to the small available space inside the sensor head the processor unit is mounted in such a position that the installing of I/O modules is not possible. However, if these I/O modules must be replaced, it can be done by removing two locking screws of the support frame and by partly loosening the two other screws, which are mounted in the slots. After this procedure is completed, the processor unit support frame can be slided along the slots, and its position can be tilted to work with the I/O modules.

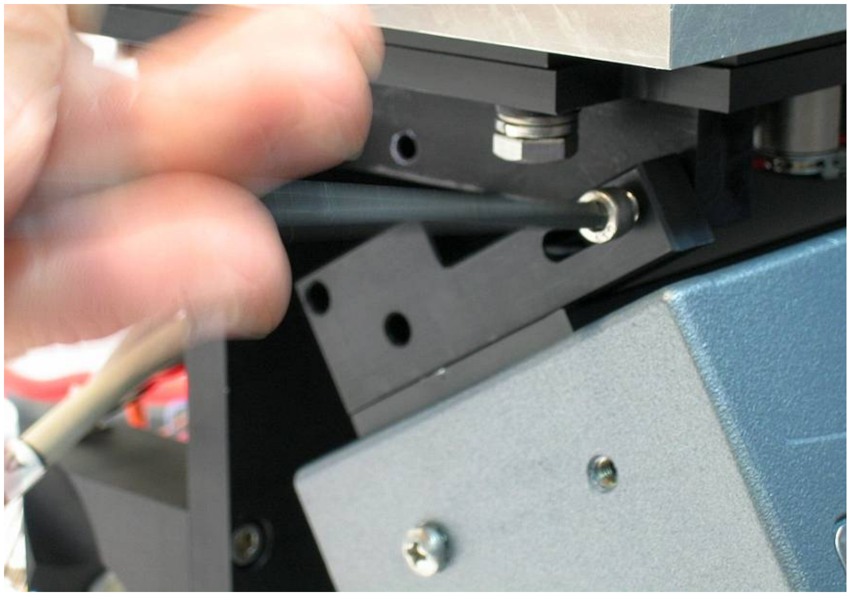


Figure 6-1 Mechanical support structure of processor unit

6.1.2.Cable Pipelines inside the Mechanics

The RIS Sensor has two main cable pipelines routed inside the mechanical construction.

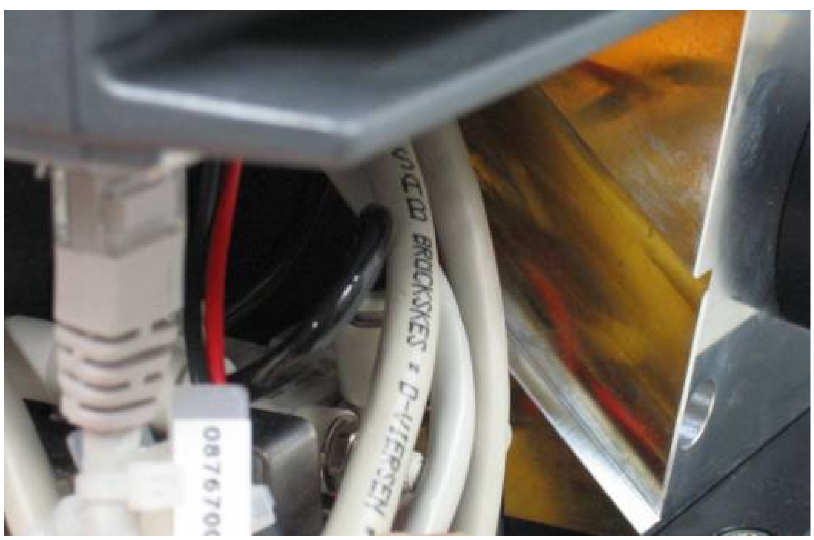


Figure 6-2 Cable pipeline number one

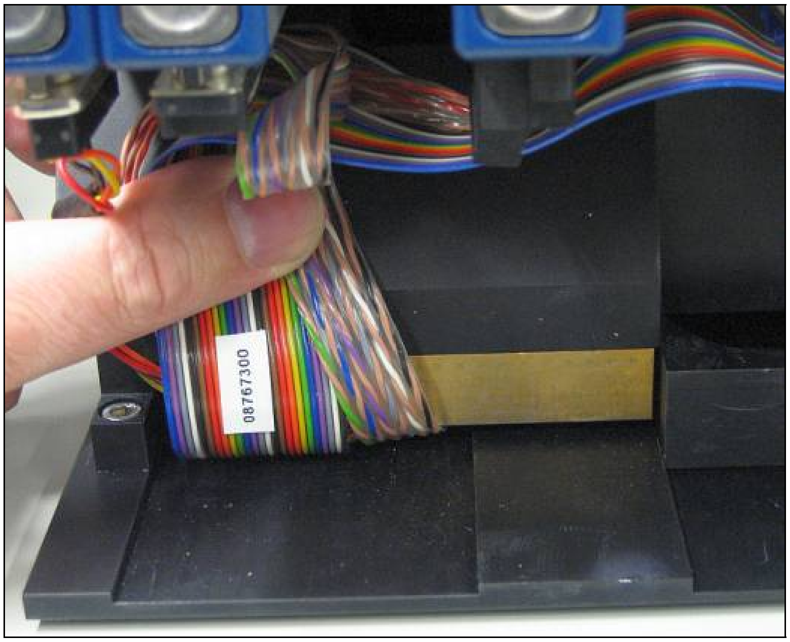


Figure 6-3 Cable pipeline number two

The pipeline number one is built mainly for cables connecting the spectrum signals coming from Detector PCBA to Analog Input Modules of the processor unit. The air hose connecting the air inlet of the sensor head to the air cylinder of standardization sample uses this route as well.

Control PCBA is connected to the transmittive optotrigger and the wires to magnetic valve of the air cylinder using the pipeline #1. The Ethernet cable from processor unit to Assembly PCB uses the pipeline #1 as well. As the space inside the pipeline is limited, the cables must be well straightened and bundled to fit into the pipeline.

The pipeline number two is built for the ribbon cables connecting the processor unit I/O modules to the connectors of Control PCBA.

6.2. Pneumatics of Standardize Sample and Air Purge

During normal on-line measurement, the Standardize sample is at home position. The pulsed IR light is directed through the source window on measured web, and the reflected rays coming through the receiver window are collected in the receiver optics and detected. During standardization procedure the sample is moved to Standardization position and the Standardization sample goes in the place of the web at the same distance, however, inside the sensor.

Using air cylinder, the back and forth translation movement of Standardize sample can be done. This operation is controlled by using magnet valve attached to the air cylinder. Measurement program controls the magnet valve operation through digital I/O module (slot S7, DIO5). This digital line drives the magnet valve driver circuit at the Control PCBA.

Adjustable needle valve is used to limit the air flow to the air cylinder. Optimal adjustment is obtained when the standardize sample moves smoothly from home position to standardize position and visa versa with the same speed.

Air purge valve is also attached to the air hose. Light air flow is sufficient for this purpose.

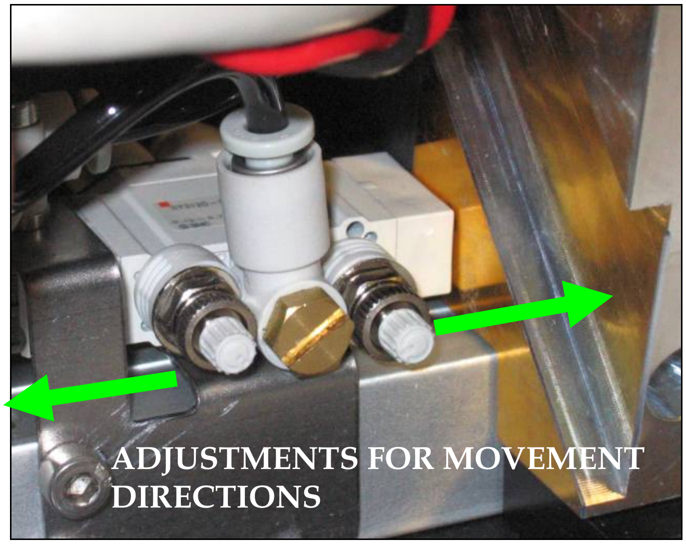


Figure 6-4 Air valves for adjustments of standardization sample movements

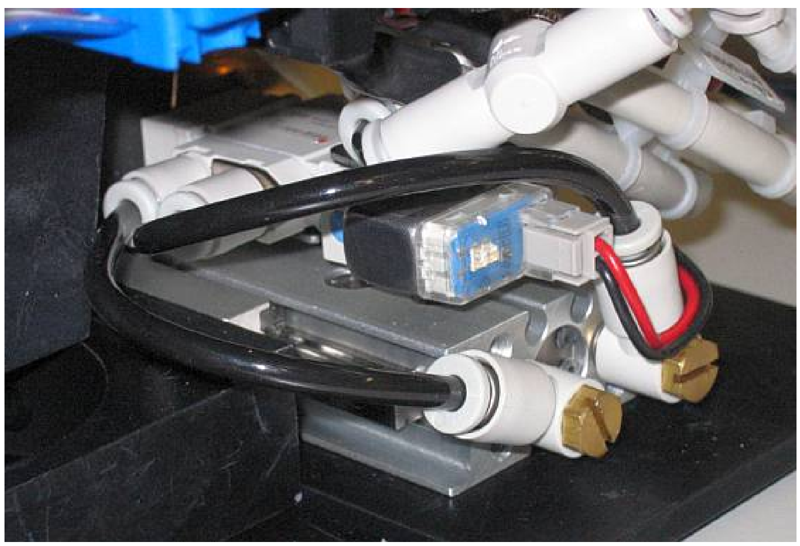


Figure 6-5 Magnetic valve and air cylinder of standardization sample mechanics

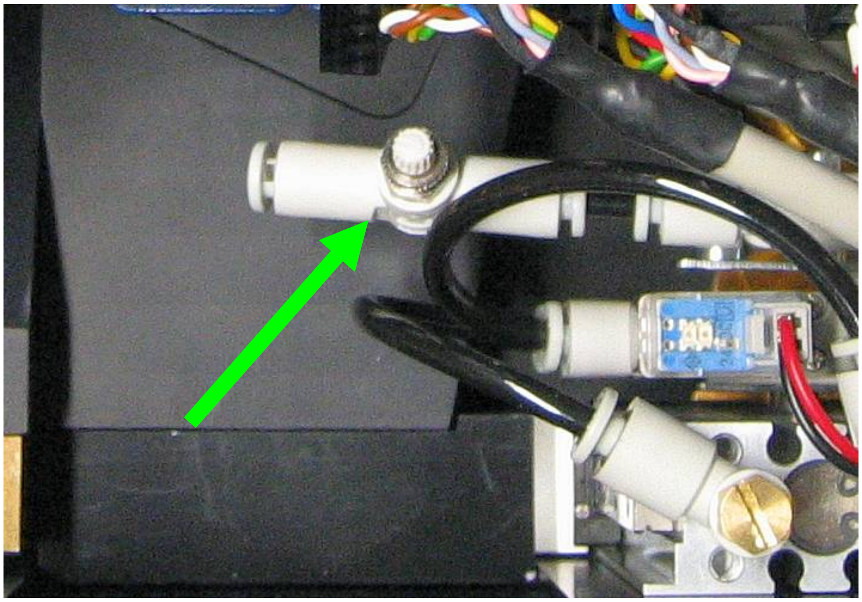


Figure 6-6 Air purge adjustment

6.3. Water Cooling

The RIS Sensor has TEC (thermoelectrically cooled) detector module. For the operation of this cooling method it is important that the hot surface of TEC is kept at low and stable temperature. The hot surface of the TEC is mounted at the bottom of the detector module housing. The detector module is mounted on the water cooled bottom plate of sensor head. The water circulation of the cooled plate has direct effect on the detector operation temperature.

NOTE: The water circulation must be always on when the TEC is in use.

Closed loop PI controller is used for TEC cooling. This controller effectively compensates the shifts of cooling water temperature to the temperature of the detector element.

NOTE: Never use pure water in circulation. Always add antifreeze compound as mentioned in the scanner service manuals and/or in technical bulletins and training materials

6.3.1.Water Flow Requirements

The minimum flow rate of the Coolant is 1 l/min. The recommended water temperature is +22 ºC. However variation in temperature between +10 – +25 ºC is acceptable depending on the environment conditions. While adjusting the coolant temperature one must keep in mind that the temperature must not go below the dew point of the environment.

6.3.2.Cooling of IR Source Housing

The IR Source (halogen lamp) gradually heats the source housing. The temperature inside the sensor can become high if this heat is not transferred outside the sensor. To reduce the temperature in the source housing a copper heat conductor is designed to connect the source housing and the water cooled bottom plate of the sensor. To ensure a maximal heat conduction, the contact surfaces are mounted with heat conducting silicon grease.

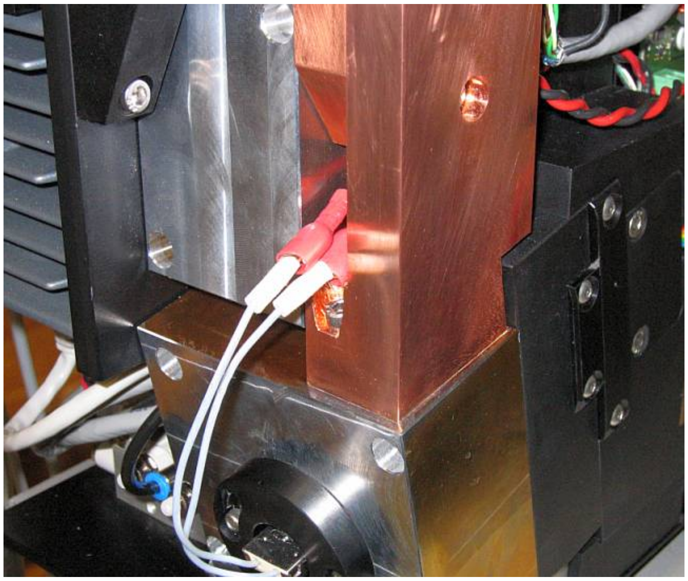


Figure 6-7 Cooling of IR source housing.

7. Maintenance and Troubleshooting

7.1. Routine Maintenance

While designing the sensor, it was aimed to keep the need for maintenance work as less as possible. The only routine maintenance work required is the cleaning of the sensor windows.

7.1.1.Cleaning

One basic maintenance work, which is almost impossible to avoid in the optical sensors is the checking and cleaning of the optical windows, which separate the sensor optics from mill environment.

There is a slight overpressure inside the sensor housing due to air purge. The air escapes the sensor through the same opening, which is also used for measurement. Although there is an air purge in the sensor the windows must be checked and cleaned on a regular basis. The time interval between the cleaning operations depends on the usage of sensor. Cleaning the sensor once a week is sufficient for a typical installation. You may require cleaning the sensor on a daily basis at sites with exceptionally dirty environments.

To clean the sensor, perform the following steps:

1. Take the sensor off the sheet.
2. Release the clutch on the scanner and split the heads which allows you to access the windows of the sensor.
3. Apply isopropyl alcohol to a clean cloth and wipe gently to clean the windows.

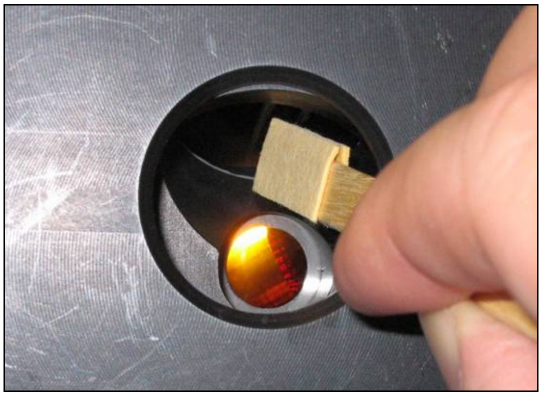


Figure 7-1 Cleaning of the windows

7.2. Symptoms and Diagnoses

Table 7-1 Symptoms and diagnoses.

Symptom	Diagnoses
The green LED near POWER ON/OFF switch does not turn on although the POWER is turned on.	There is no +24 VDC supply voltage connected to the sensor.
The green LEDs of Control PCBA does not turn on although the POWER is on and the green LED near the POWER switch shows light.	The supply voltage connection is broken between Assembly PCBA and Control PCBA
There is no visible light coming from the measurement opening during measurement	Broken IR source lamp. Replace the lamp.
Sensor has automatically turned OFF the cooling current (ITEC) of the thermoelectric cooler	The cooling water circulation is OFF or damaged and sensor has turned OFF the ITEC to prevent damage of thermoelectric cooler due too high current values.
The standardization sample does not move to other position during standardization.	The pressurized air is not connected to the sensor, or the air pressure is too low, or the connection is damaged.
Unstable or zero reading of chopper frequency.	Broken chopper motor. Replace the motor.

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7.3. Replacing Parts

Some parts of the sensor need to be replaced periodically. Due to the operation principle it is necessary to replace some parts of the sensor from time to time. This section outlines the procedures recommended for replacing the infrared source and the chopper motor.

7.4. Infrared Source

The infrared source, is a halogen lamp, which runs below the nominal voltage. This increases the duration time of the source. However it is recommended to replace the lamp after three months of operation time.

1. For replacing the lamp, the power of sensor should be turned OFF (power switch on the Assembly PCBA).
2. Loosen the two screws of the lamp holder a few turns just enough to rotate the lamp holder counter clock wise so that the lamp housing is removed.
3. Switch off the ABIKO connectors of the lamp wires and remove the lamp.

Install the new lamp in the counter order as described earlier. Notice the dent of the lamp base to fit with the pin of the lamp housing during installation. Ensure you do not touch the quartz bulb during installation.

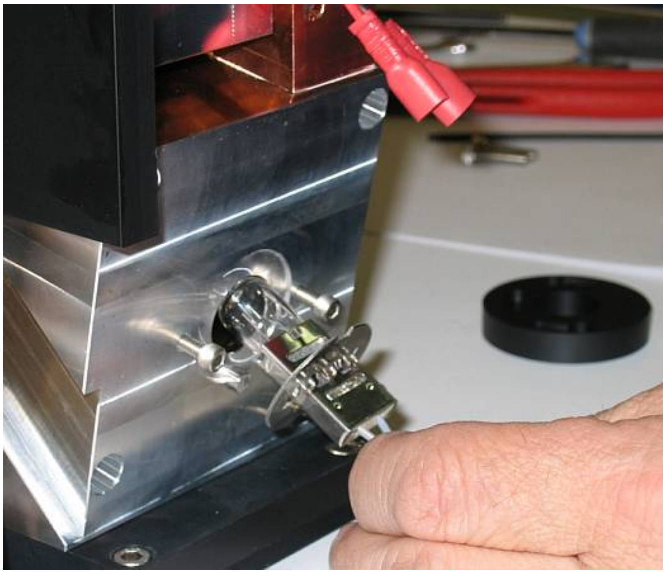

Figure 7-2 Replacement of infrared source

7.5. Chopper Motor

Chopper motor must be replaced only when needed. You can replace the motor when it is broken, or if the rotation speed of the chopper is unstable.

1. To replace the chopper motor, first turn off the power to the sensor (power switch is located on the Assembly PCBA).

2. Loosen the screws of chopper connector at the Control PCBA and remove the chopper wires from the connector.

3. Open the screws and remove the two parts covering the chopper wheel. Open the screws and remove the chopper cover.

4. Take off the chopper motor and the wheel from the slot. Open the two screws that hold the chopper wheel on the motor axis and remove the motor.

5. Replace new motor into the chopper wheel and tighten the screws.

6. Install the motor and wheel into the chopper slot. Also install the chopper motor cover and the screws. Ensure you do not turn the screws too tight.

7. Ensure that the chopper wheel can rotate properly in the middle of the slot. Tighten the motor cover screws carefully. Do not turn the screws too tight. If you turn the screws too tight, it may cause the chopper chassis to bend, which in turn damages the motor.

8. Install the wheel covering parts.

9. Install the chopper wires to the chopper connector and tighten the screws.

10. If you turn on the sensor power , the motor starts automatically. When the screws of motor cover are not too tight the running motor makes a whistling sound and you find that the rotation speed is stable. If the screws are too tight the rotation sound has additional noises and the rotation stability is poor.

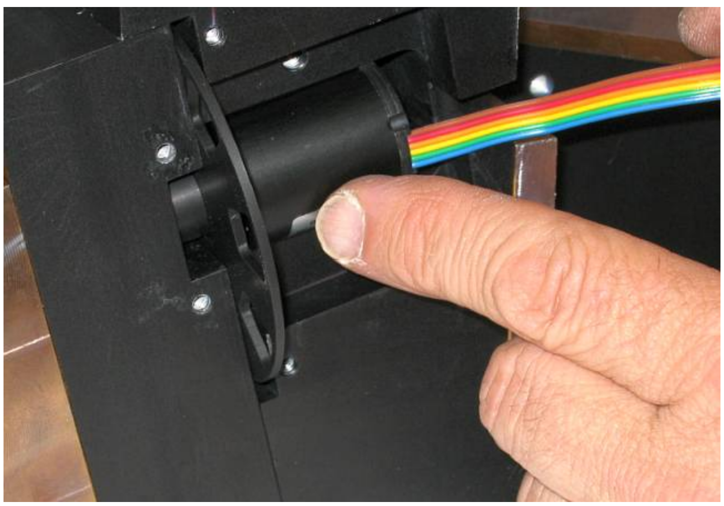

Figure 7-3 Replacement of chopper motor

8. Transportation, Storage and End of Life

8.1. Storage and transportation environment

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

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

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 reused, recycled or disposed of in accordance with local environmental requirements or guidelines.

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

Except where identified within this section, the scanner does not contain hazardous or restricted materials.

Guidelines for disposal of equipment by Honeywell or the customer for scanner-specific materials are:

8.2.1. Solid materials

- Remove all non-metallic parts (except plastic) from the sensor 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 (for example, solder, circuit boards, batteries, and oil-filled capacitors) should be recycled or handled as special waste to prevent them from being put in a landfill, as there is potential for lead and other metals leaching into the ground and water.
- Metals should be recycled, and in many cases have value as scrap.

8.2.2. Disposal of radioactive sources

- Contact Radiological operations and they will advise and facilitate safe disposal.

8.3. Storing radioactive sources

If a sensor containing a radioactive source has to be stored for a period of time before it can be mounted on the scanner, it must be placed in an area to which access is controlled by licensed personnel. This generally means that the sensor head must be stored in a locked room or cabinet. If such storage will be for a period of weeks or months, arrangements often can be made to have Honeywell store the sensor. Contact Honeywell Radiological Operations.

The main contact numbers for Radiological Operations are

First level of support:

- The Americas, Asia Pacific and India are supported directly by Phoenix at 602-313-3330.
- Europe, Middle East and Africa are supported by Waterford at + 353 (0) 51 372 151.

Second level of support (world-wide) is Phoenix at 602-313-3330. Phoenix also has a toll-free number for the U.S. and Canada at 866-811-0312.

WARNING: While in storage, a shipping shield must be bolted to each sensor head containing a radioactive source.

9. Glossary

cRIO	Compact RIO, National Instruments
CWL	Center Wavelength
DIO0 – DIO7	Digital I/O lines
FPGA	Field Programmable Gate Array
RIS	Reflectance Infrared Spectrometer
Housing Temp	Temperature at Control PCBA
I Lamp	Lamp Current
ITEC	Thermoelectric Cooler Current
Mes	Measurement Channel
Peltier	Thermo Electric Cooler
r^2	Correlation Coefficient
Ref	Reference Channel
RMSE	Root Mean Squared Error
Rx+, Rx-	RS-422 Communication lines
S1 – S7	Slot numbers for IO-modules
TEC	Thermo Electric Cooler
Tx+, Tx-	RS-422 Communication lines
U Lamp	Lamp Voltage
U Therm	Thermistor Voltage
WLAN	Wireless LAN

10. Appendix

10.1. Default Values of Time-Zero Data

Table 10-1 Default values of Time-Zero Data

Name	Default	Description	Unit

10.2. Default values of limit data

Table 10-2 Default values of limit data

Name	Default	Description	Unit