RESONANCE LTD

Optical Solutions & Technologies

S-40-SPF

Software Manual

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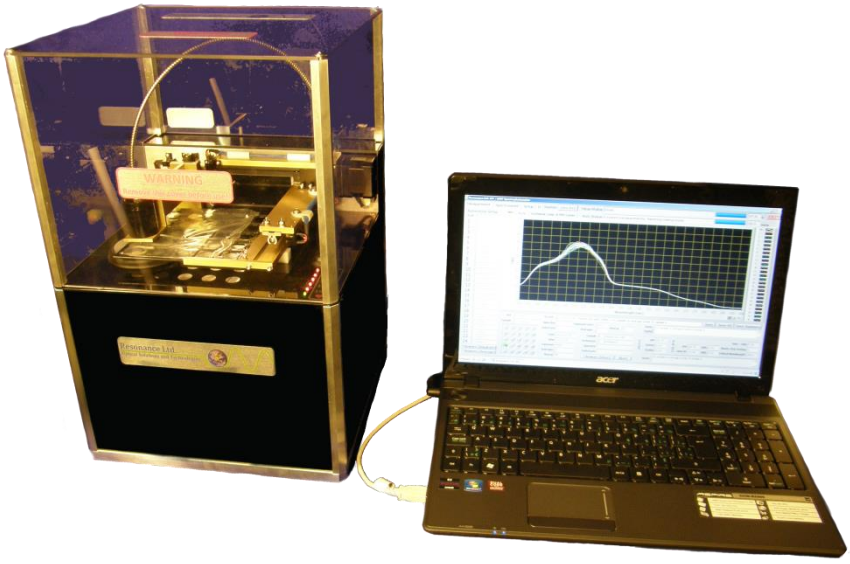

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Overview

The software for the Resonance SPF measurement is an intuitive yet powerful platform. On top of producing measurements that conform to the AASTCC and COLIPA standards (including UPF, SPF, Boots Star Rating and more) the system has built-in automated capability for multiple-measurements using its XYZ sample positioning table. The user has complete control over all system settings and parameters, and is presented with a tabbed graphical user interface for data display, file saving, and settings/setup.

All measurements are stored in the program's buffer and can be displayed or exported as spreadsheet files at the user's discretion. The software also allows access to the internal parameters directly relating to measurements – found in the "Spectrometer" tab. This tab is for more advanced users and is covered at the end of this manual in the "Spectrometer Tab" section. Settings such as the integration time (exposure), and boxcar averaging can be changed, and the raw spectra can be viewed. The spectrometer tab itself has its own file saving and display capabilities, which expands the software's capabilities into the diagnostic and research area, if the user wishes.

Initialization/Zeroing

Before the software executable is launched, make sure the USB cable has been plugged in and the USB light on the top panel is lit. Also plug the main AC power cord into the instrument and verify the AC light is on. The instrument should then be switched on, at which point all the top panel LEDs should illuminate except for the green LED labeled with a heart. This “heartbeat” LED indicates that the software is communicating with the instrument and turns on and off at 1 second intervals. The executable can now be launched, and you will be presented with a screen shown below in figure 1:

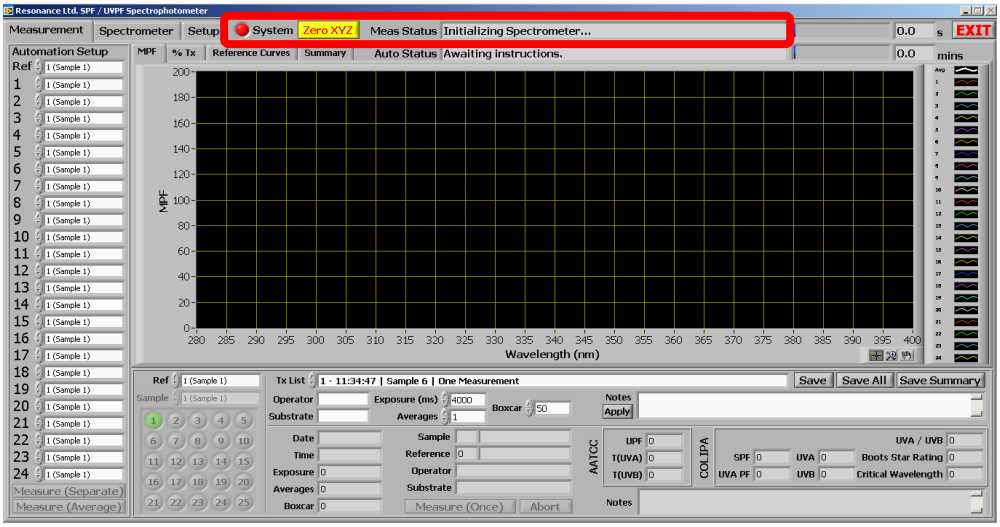

Fig. 1: The initial software screen upon executing.

At this point the spectrometer will initialize, and its status can be viewed in the “Meas Status” box at the top. The “Zero XYZ” button will flash between yellow and grey, and the “System” light will change from red to green when all initial handshaking and communication routines between the software and the instrument have been made. If the system cannot be successfully initialized, you will be presented with the dialog in figure 2 below:

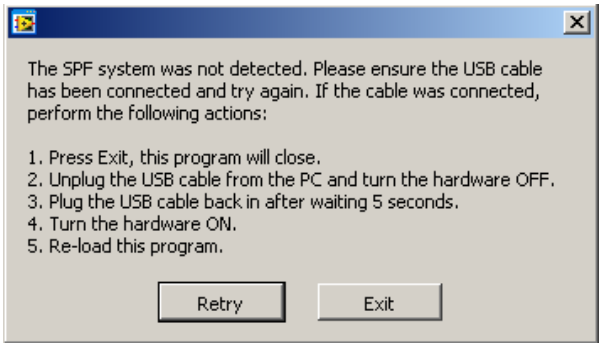

Fig. 2: The “system not detected” dialog.

Initialization/Zeroing (continued)

After following the recommended steps in the dialog, the system should connect upon the next initialization attempt. Note that the “Retry” button rarely works and the software should be exited and restarted to ensure success.

Once the system has been successfully initialized, you may “zero” the XYZ stage by pressing the “Zero XYZ” button. This is necessary to ensure that the stage knows exactly where it is every time the instrument is used to ensure repeatability, accuracy, and precision. During this process all axis will move to their inner limit and calibrate themselves. The software displays the status of the procedure in the “Meas Status” box. Figure 3 below, for example, was taken while the software was zeroing the Z axis. Note that all controls are greyed out and disabled during the process to prevent any accidental interruptions in this important process.

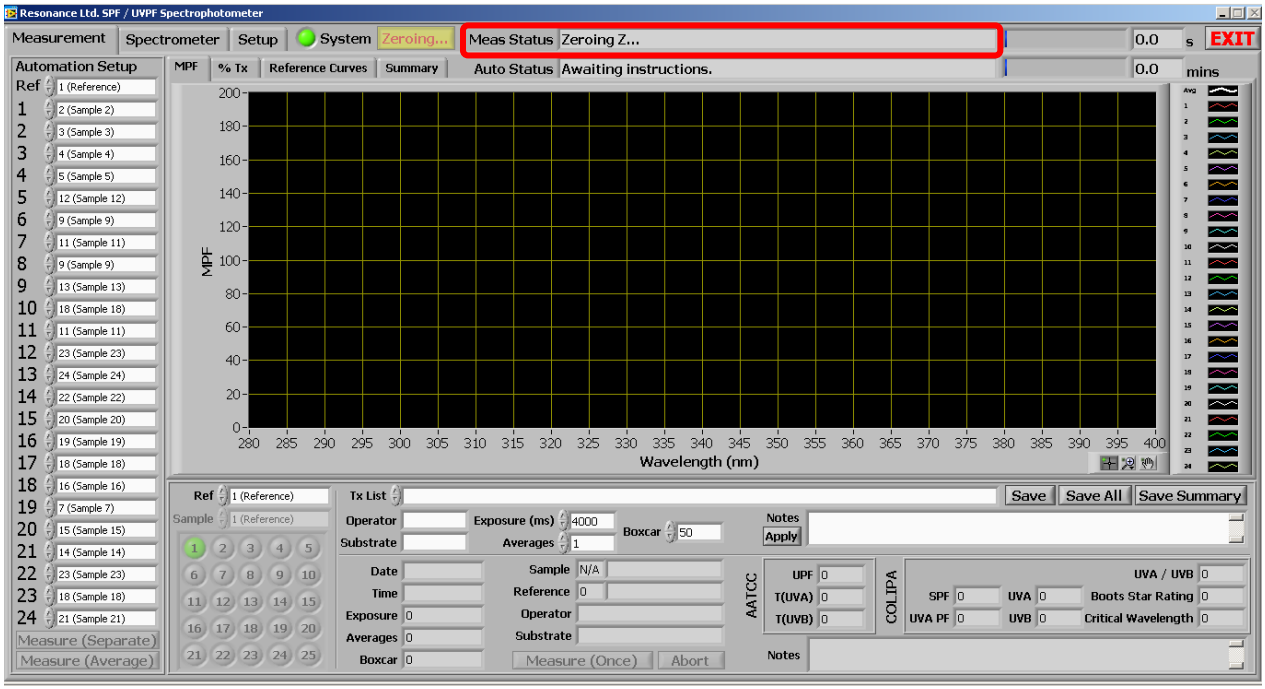

Fig. 3: The software during the “zeroing” routine. Note the “Meas Status” box.

Once the zeroing routine has completed the software is ready to be used for measurements.

Setup Tab

The “Setup” tab is where important settings can be viewed, changed, and saved. There are multiple sections that pertain to different areas of the software. Refer to figure 4 below for a screenshot of this section, which will be referred to by following sub-sections.

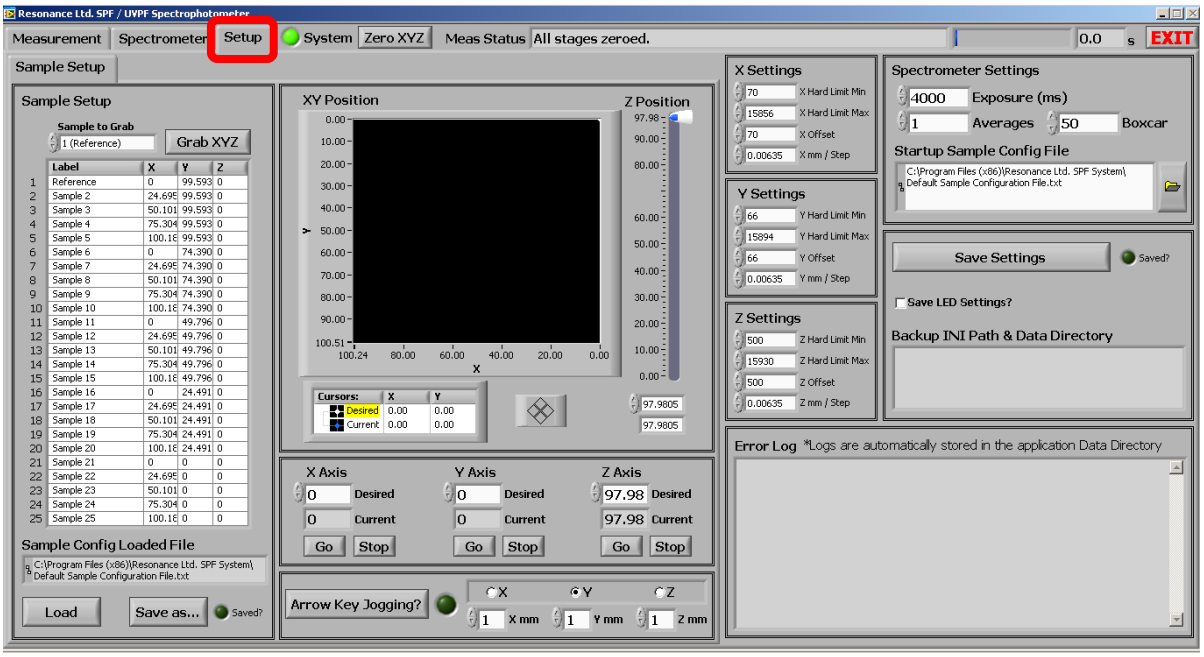

Fig. 4: The “Setup” tab.

XYZ Positioning

Once all 3 stages have been zeroed (X, Y and Z), they can be moved to any location in multiple ways. The “XY Position” plot in the middle of figure 4 allows the user to drag a white cursor around the black area, which represents the two-dimensional XY plane the sample stage can traverse. Wherever the white crosshair is placed, the stage will move there. The blue crosshair shows the current position. This same style of operation applies to the “Z Position” slider as well, where the large white arrow can be dragged up and down the slider to move the Z position (collecting optics) up and down. The blue arrow shows its current location.

The “Desired” and “Current” boxes below the “XY Position” plot can also be used to directly tell the sample stage to go to a position. All values are in millimeters, where 0 mm is defined as the initial position after it is done zeroing. Enter a value and press “Go” to move to that position. “Stop” can be pressed to abort any movement. The stage will simply halt wherever it was when the button was pressed.

The arrow keys can also be used to jog the 3 stages around for convenient fine positioning. Refer to figure 4 and look at the bottom-center of the screenshot to find the “Arrow Key Jogging” button. In this section any one of the three stages can be selected at a time and moved back and forth at a set increment. For example, if the increment is set to 1 mm, every time either the left or right arrow key is pressed, the system will move the stage 1 mm in either direction, depending on the key pressed. If the key is held down the stage will move repeatedly at the set increment until the key is released.

Sample Setup

This section allows the user to set up exact coordinates for a given sample holder. It is possible to have multiple physical sample holders with different shaped apertures in different positions. That is, the software has been provisioned to deal with custom sample holders at the customers' request, if they are to be made in the future. A configuration file can be paired with each sample holder piece and loaded into the program either manually or on startup. The "Sample Setup" section, found at the left if referring to figure 4, is a setup table which pairs XYZ coordinates with a sample position. Simply give a position a label and a set of coordinates in millimeters and the program will go to those coordinates when that position is loaded. By default there are 25 positions in the standard sample holder. The following is a description of the buttons found in this section:

Grab XYZ

This takes the current X, Y, and Z positions and copies them into the set-up table for the position chosen in the "Sample to Grab" selector directly to the left of this button. This allows for quick and easy setup of positions, as the user can use the arrow keys to move to an exact position and then simply hit this button to apply it to the sample set-up table.

Save as…

This saves the currently entered information in the sample set-up chart to a *.txt file. Upon saving, the software will ask you whether you want this newly saved file to load by default the next time you start the program. If so, the path to this new file is copied to the "Startup Sample Config File" parameter box in the upper-right corner of figure 4, under "Spectrometer Settings". When the software initializes it looks for a file at this path and attempts to load its parameters into the sample setup table. By default there is a file in the same directory as the executable called "Default Sample Configuration File". It contains the label and XYZ coordinates for all 25 sample positions (24, if you reserve an empty hole for the reference position!). The configuration file also saves the "Automation Setup" order on the "Measurement" tab. Even if the sample positions remain identical, different automation orders or batches can be saved by having multiple configuration files.

Load

This loads a sample configuration file and copies the label and XYZ positions to the "Sample Setup" table, as well as the order of positions to the "Automation Setup" on the "Measurement" tab. This function is extremely useful when there are multiple saved configuration files with different automation setups.

Settings.ini File

The software saves its settings to a “Settings.ini” file which can be found in the same directory as the executable. On startup it reads this file and loads any settings it finds to their appropriate controls. The following settings are saved in the file and are explained below:

***Note:** Only change these settings is you absolutely know what they are. Improper settings can result in improper operation of the instrument.

Hard Limit Min

This is the absolute minimum number of steps from the zero position the stage is allowed to go. This has been tuned at Resonance Ltd. and should not be touched.

Hard Limit Max

This is the absolute maximum number of steps from the zero position the stage is allowed to go. This has been tuned at Resonance Ltd. and should not be touched.

Offset

The number of steps from the zero position that will be defined as 0 mm. This number is usually the same as the “Hard Limit Min”. It has also been tuned at Resonance Ltd. For the default sample tray and should only need to be changed if another tray is used.

mm / Step

The number of millimeters of travel for every step of the motor driving each stage. This setting should never be touched.

Exposure (ms)

The integration time of the spectrometer, in milliseconds. Too long of a value will result in saturation of the signal and result in inaccurate measurements.

Averages

The number of spectra to be averaged internally by the spectrometer. More averages result in greater signal to noise at the expense of taking longer.

Settings.ini File (continued)

Boxcar

This is another name for the running average. It specifies the number of pixels to be averaged by the spectrometer before outputting spectra. Bigger values result in more smoothing of the curves, however too much smoothing will affect the accuracy of the measurements.

Save LED Settings?

A residual setting meant for saving the LED intensities for the integrating sphere, however these intensities have been perfected and should not (and cannot) be adjusted without manually editing the Settings.ini file.

Save Settings

Saves the above listed settings to the “Settings.ini” file.

Note: Every time the settings are saved, a backup copy of the Settings.ini file is made. A timestamp is prepended to it, and it is moved to the program’s data directory - which is found in the same directory as the executable.

Error Log

The software displays and saves a log of all errors which may occur during its operation. This is primarily used to diagnose any future problems that may occur. Sometimes minor errors occur in the communication between the instrument and software which are immediately rectified, but still logged. If you see any such messages and the instrument is functioning normally they can be disregarded. The error log is stored in the program's data directory, found in the same directory as the executable. It is prepended with a date stamp and will contain all the errors for a given day.

Measurement Tab

This is the main area of the software, where all measurements are taken and all data is displayed and exported / saved. There are three main modes of measurement: a single measurement, an automated measurement where every reading is its own measurement, or an automated measurement where every reading is averaged with all the previous ones to create one final resulting measurement. Refer to figure 5 below for a screenshot of the software after taking some measurements.

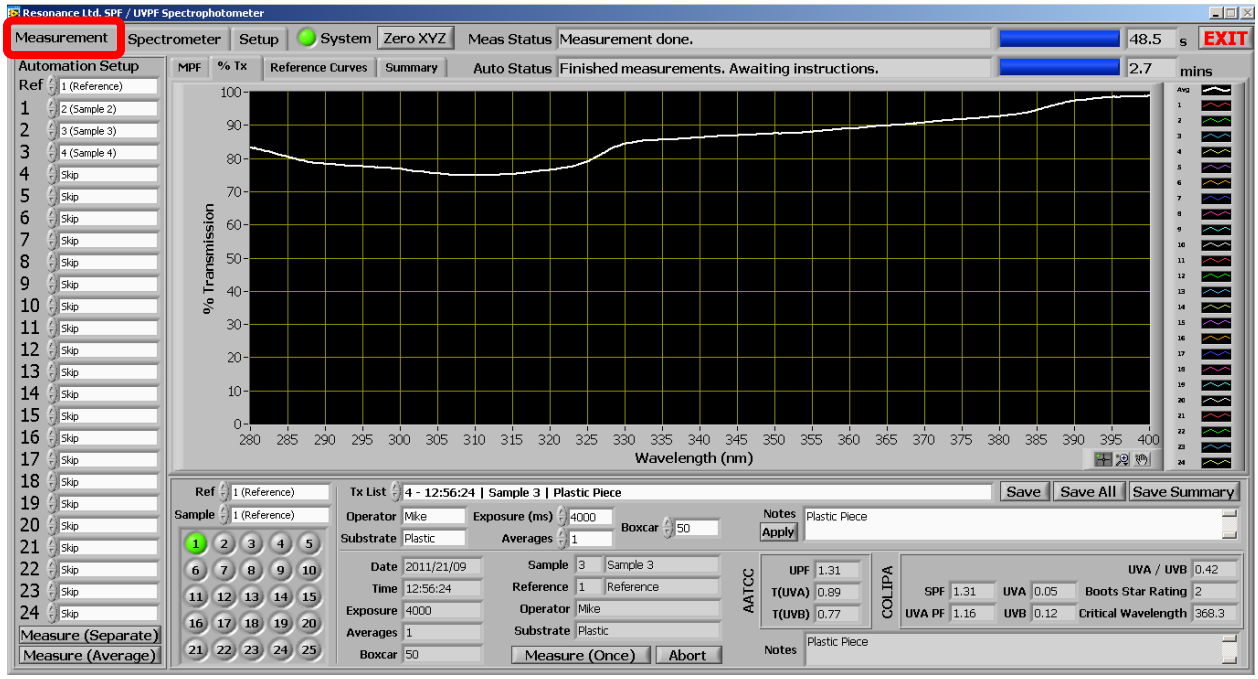

Fig. 5: The "Measurement" tab.

Perform a Measurement

To perform a single measurement move the sample stage to the desired position using the grid as seen in the bottom-left corner of figure 5. Simply click on a position (1 – 25) and the system will move to that position (according to the sample setup table, of course). Make sure you have designated a position to be blank for the reference, and select that position I the “Ref” box just above the grid. The sample position can also be chosen and moved to by selecting it from the drop-down menu called “Sample” directly above the grid as well. Once the sample and reference positions have been chosen click on “Measure (Once)” and a 7-step process will begin to produce a measurement. A progress bar and elapsed time indicator are activated, which can be seen in figure 5 in the top-right. During this process the sample stage will move between the sample and reference position automatically. You can abort this process by clicking the “Abort” button. The current measurement will be discarded and the software will wait for further instructions from the user.

Measurement Data & Display

Once a measurement has been taken, it will appear in the “Tx List” drop-down box found directly under the graph as seen in figure 6 below.

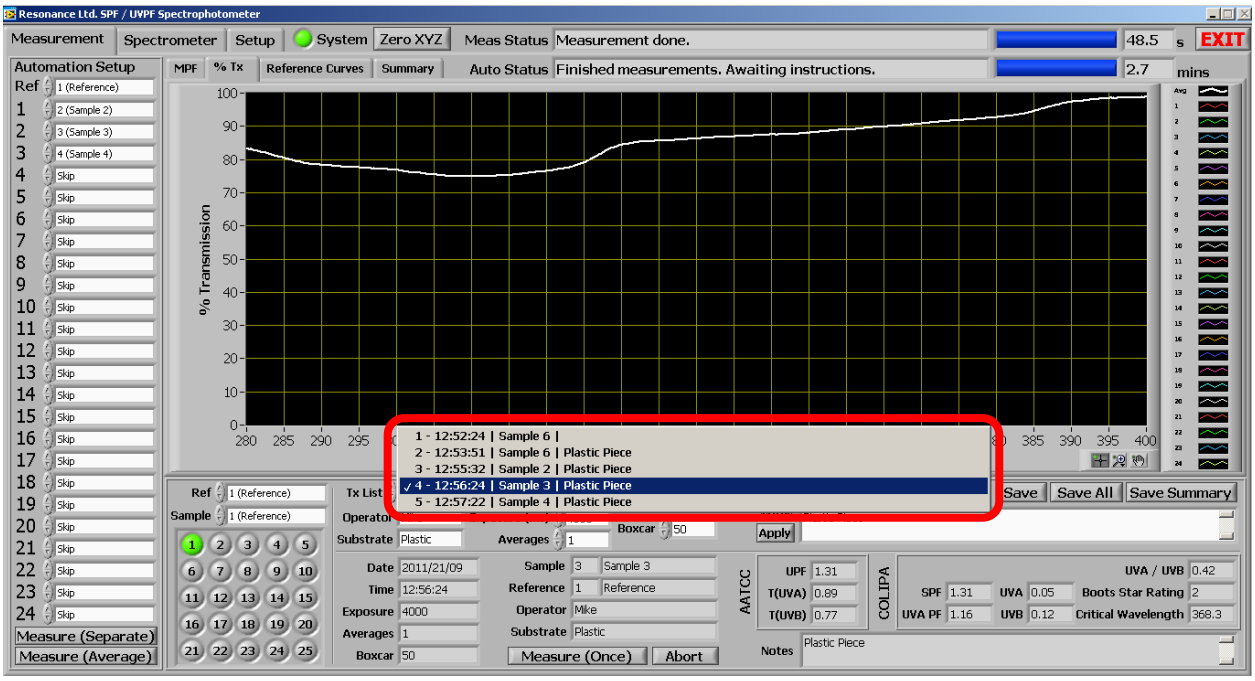

Fig. 6: The “Tx List” in the “Measurement” tab.

You can use this list to scroll through all previous measurements taken in the current session. Only one measurement can be viewed at a time in this mode. When a measurement is selected, all the parameters associated with the measurement are loaded into the indicator boxes below the graph, including the UPF and SPF values, among other useful information. Notes can be edited after a measurement has been taken. With a measurement selected, enter a new note in the white entry box (figure 5 is easier to see this area) and click “Apply” to save it to that specific measurement. These notes are automatically saved in the spreadsheet file if data is exported, and therefore quite useful for tagging data.

Both X and Y scales of the graph can be changed manually and also independently support an “autoscale” function. Right-click on the axis you want to change and either check or un-check the autoscale option. In order to manually set the scale limits, autoscale must be off. To change the limits themselves, simply double-click the extreme value of the scale (intermediate values can be edited but will snap back to what they were when they are applied) and edit the value. Press “enter” when finished to apply the value, and the scale will adjust to the new limit.

The graph visible in figures 5 and 6 are showing the % transmission (% Tx) curve of the sample. The MPF (monochromatic protection factor), reference curves (explained later) and summary section (figure 7 below) can also be selected in the tabs directly above the graph.

Measurement Data & Display (continued)

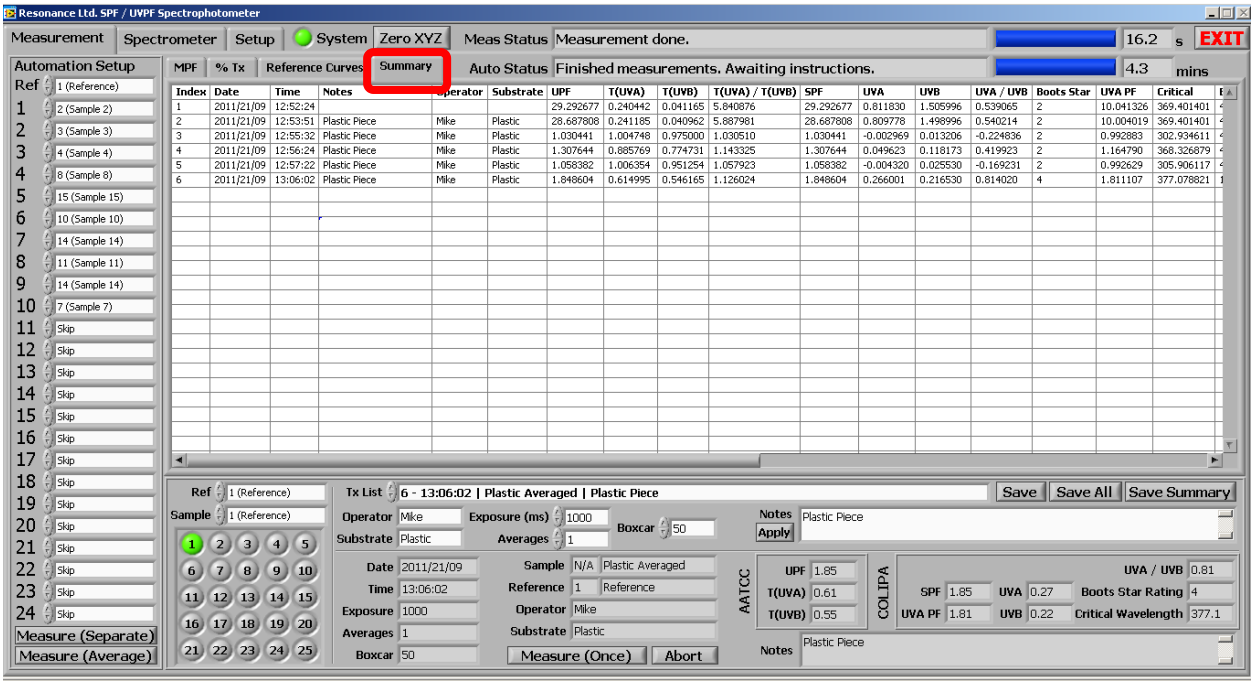

Fig. 7: The “Summary” option in the “Measurement” tab.

The summary section shows a list of detailed parameters for every measurement taken, in spreadsheet style. This is a very useful view for comparing a series of measurements to one another.

Automated Measurements

The Resonance Ltd. SPF system has the capacity to perform up to 25 automated measurements at a time. Referring to figure 6, look to the very left at the “Automation Setup” section. In order to use this feature, all you have to do is select a reference position (Ref) with the very first drop-down box. All the subsequent boxes can then be used to select the positions, in the numbered order on the left, of the samples to be measured, one after another, at the set exposure, boxcar, and averages. Note that there is also a “skip” option, which will tell the software to immediately move to the next measurement. The user can therefore select exactly which positions are to be measured for a given prepared sample tray. Remember that the automation order, mentioned in the section titled “Sample Setup”, can be saved to the sample configuration file.

There are two buttons at the bottom of the section called “Measure (Separate)” and “Measure (Average)”. These are explained below. Note also that any measurement can be aborted by pressing the “Abort” button to the right of the “Measure (Once)” button. The measurement in progress will be discarded.

Measure (Separately)

This mode performs a measurement on each position selected in the “Automation Setup” and treats them as individual measurements, independent of one another. This is useful for sampling multiple different materials. After each measurement has been completed, they are added to the “Tx List” and their parameters are displayed in the indicator boxes. Tis mode is essentially the same as clicking “Measure (Once)” an equivalent number of times for the desired sample positions, except it does so automatically.

Measure (Average)

This mode of operation measures all the positions in the “Automation Setup” list and averages them together to form one final measurement and one sole entry into the “Tx List” box. This mode is meant for measuring different parts of the same sample, which for fabric is very important due to differences in the pattern that may exist. All measurements are graphed over each other and are colour-coded as per the legend to the right of the graph. Figure 8 below shows this capability.

Automated Measurements (continued)

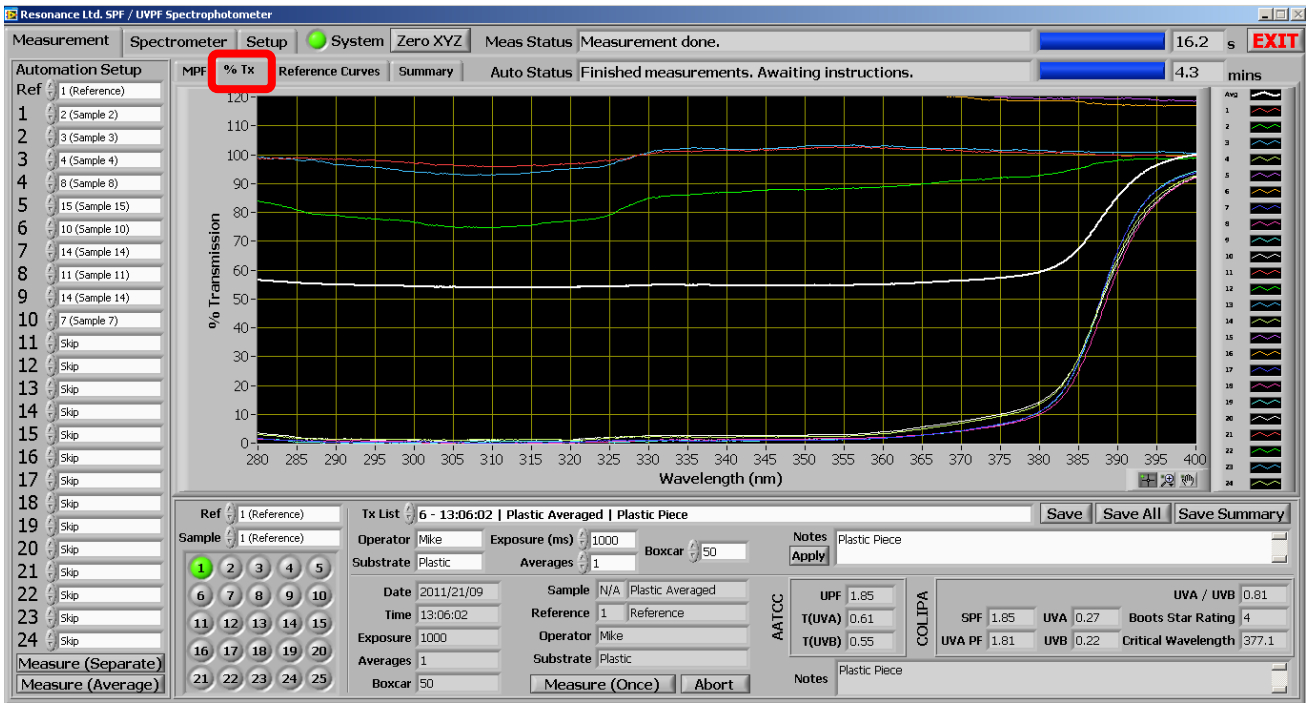

Fig. 8: Constituent "% Tx" plots from a Measure (Average) mode.

After every constituent measurement a new plot is added to the graph. The thicker white plot is always the average. This applies for the "% Tx" and "MPF" displays. As with the single measurement mode, the progress bar in the upper right (figure 8) shows the status for each measurement, along with elapsed time. Directly beneath it is another progress bar for the overall process, with its own elapsed time in minutes. One note users should be aware of is that the SPF and other measurement values are not calculated every time a sample is measured, and is only done at the end. Any SPF values in the indicator boxes present during the operation were there before the measurement started. These values will update when the last measurement has been taken.

Saving Data

Data can be output to a tab-delimited *.csv file. The *.csv extension, however, has been replaced with a *.xls extension so data files can directly open in Excel when double-clicked. There are three ways to export data, each with its own button:

Save

This outputs the currently displayed / selected measurement from the “Tx List” box to a file with a header and all constituent spectra used for the SPF calculations. The header contains all the information shown in the indicator boxes plus more, to ensure the user receives the most accurate information regarding the measurement.

Save All

Similar to the “Save” button, except this outputs a file for every entry in the “Tx List” box. The software will ask for a name for the batch, and will automatically append an (x of y) identifier to each file, where x is the index of the measurement, and y is the total number of measurements.

Save Summary

This mode outputs a spreadsheet file formatted exactly like the “summary” tab in figure 7. This is a quick and convenient way to dump all the data for multiple measurements into one file.

Reference Curves

This section of the “Measurement” tab is meant to show advanced users the curves used in the algorithms to calculate UPF, SPF, and the other ratings. Figure 9 below shows the “Reference Curves” tab.

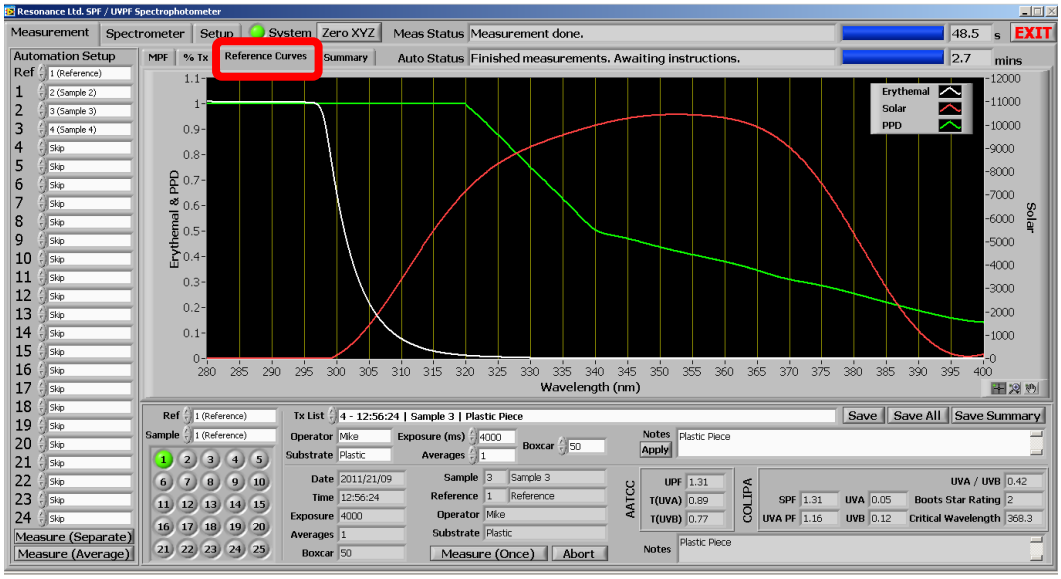

Fig. 9: The reference curves used for the calculation of SPF and other standards.

The three curves are as follows:

Erythemal

This is the McKinlay-Diffey Erythema action spectrum (also known as CIE action spectrum from 1987) which is used to weight the solar curve relative to the effects of UV wavelengths on human skin for the UPF and SPF calculations. You can see from the curve that the shorter wavelengths are many times more potent in terms of causing sunburns (or erythema) than longer wavelengths, and therefore are weighted heavily.

Solar

This is an intensity curve which shows the typical relative intensities of light from the sun plotted against wavelength on a typical afternoon with no cloud cover. This curve is multiplied by the erythemal curve to produce a weighted result that is used in the calculation of UPF and SPF.

PPD (Persistent Pigment Darkening)

Similar to the erythemal curve, this action spectrum is a weighting function used for the calculation of the UVA PF value as a measure of UVA blocking performance. It is multiplied by the solar curve in the same way the erythemal is for other values.

Spectrometer Tab

This tab is meant for advanced users and allows the user to control the spectrometer directly. You can acquire, save, graph, and manipulate spectra from the instrument. This is extremely useful for calibration, exposure time adjustments, linearity calibration, and evaluating the LED broadband light source to verify its spectral characteristics - among many other things. Figure 10 below shows this tab.

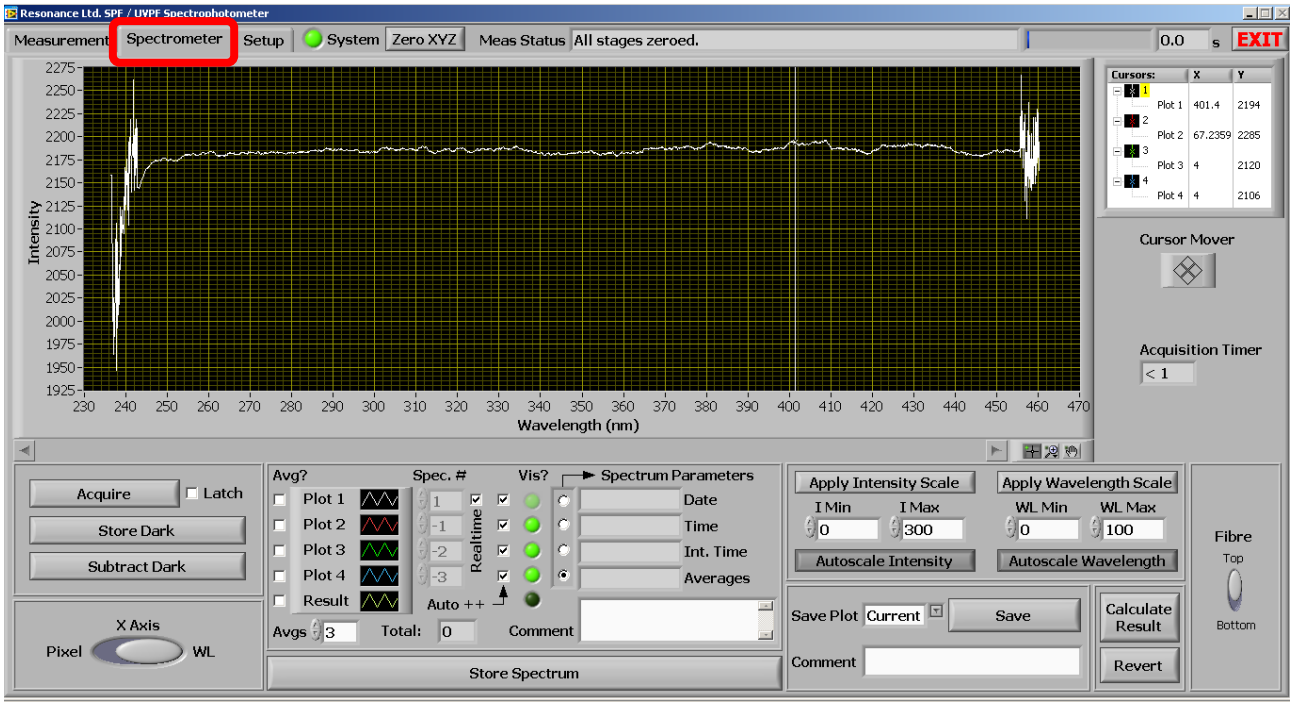

Fig. 10: The “Spectrometer” tab.

Graphing Controls

The software is tailored for repeating scans and therefore allows the user to plot up to 4 scans on the same graph, as well as a “Result” plot, which is explained later in the section “Data Manipulation”.

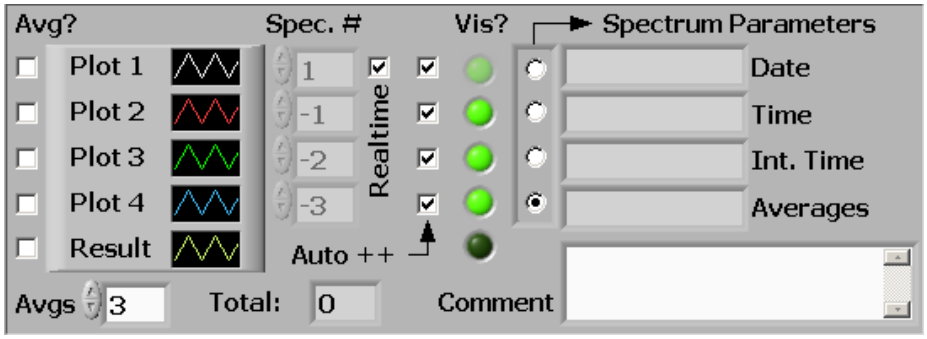

Fig. 11: The graphing & plot controls on the “Spectrometer” tab.

Refer to figure 11 above. The graphing area is structured around 4 static plots, each assigned a colour. Note that the colour and other parameters such as line width and point style can be changed by directly clicking on the black box with the plot colour icon; to produce a menu. Each plot displays a spectrum, as denoted in the spectrum box directly to its right, in the “Spec. #” column. Whenever the user acquires a spectrum, even if it is stopped, the application holds it in memory and assigns it an index, from 1 to infinity. Therefore, if 100 spectra were acquired, Plot 1 can display a spectrum from 1 to 100. The “Vis?” column directly to the right selects whether the plot is visible or not. By clicking the round green button the user can choose which plots to display (and therefore which spectra). The “Spectrum Parameters” to the right of the “Vis?” column displays the parameters associated with a given spectrum, selectable by the vertical radio selection box. These parameter fields will show the values for the selected plot. If the 3rd radio button is selected, the parameters for the 3rd plot will be shown, and remember, the 3rd plot is not necessarily the 3rd spectrum, it is whatever spectrum is selected in the respective “Spec. #” column.

The “Auto ++” column, when checked, will automatically increment the spectrum number box to its immediate left after a spectrum has been acquired. This will bump out the previous spectrum and increment to the next. When all boxes are checked, it will make sure only the 4 latest spectra are always shown. Deselecting a box will mean that unless the user changes it manually, acquiring a new spectrum will never increment the spectrum assigned to its respective plot. This is very useful to designate a certain plot to hold a reference spectrum.

Graphing Controls (continued)

The “Avg?” column selects whether to apply a boxcar (also known as a running average) to the respective plot. The sample length, or “Avgs” as denoted in the software, is how many samples are to be averaged together to produce a point. This parameter can only be an odd integer, and the software will filter even entries.

The bottom-right of the “WL Scan” panel allows the user to set the autoscale or manually applied limits for the wavelength and signal axes (figure 12 below).

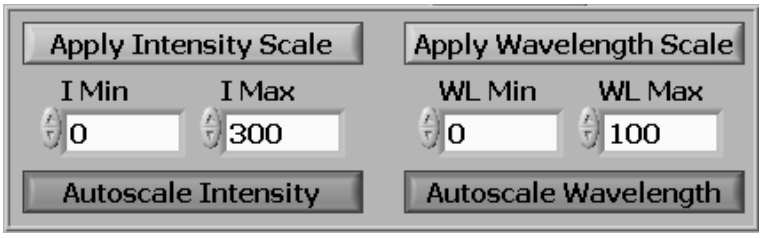

Fig. 12: The graphing scale controls on the “Spectrometer” tab.

When in manual mode, the limits can be changed using the increment arrows on the controls themselves or a new value can be typed in. When focus is lost from the control (preferably by pressing “enter”) the new values are instantly applied to their respective axis. Note that for usability purposes, the values are not checked to see if they make sense. Therefore, for example, the user could enter in a maximum value that is actually lower than the current minimum value, which will cause the graph to incorrectly display data. Changing the lower value to something lower will naturally solve this problem.

Data Manipulation

The software allows the user to perform mathematical operations on any of the 4 displayed plots. You can access this function by pressing the “Calculate Result” button shown in figure 10. Refer to figure 13 below for the data manipulation window that pops up.

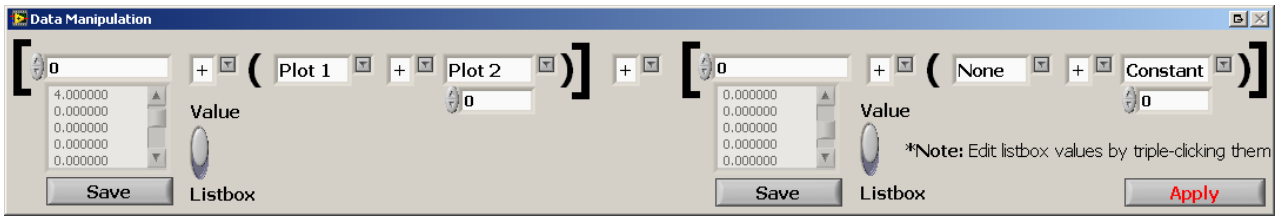

Fig. 13: The data manipulation pop-up once the “Calculate Result” button is pressed

All 4 plots can be involved in the operation, or just 1 or more plots with or without constants. The calculation follows the mathematical order of operations, respecting the parentheses around the values. There are two list boxes that hold savable constants in case the user needs to add, subtract, multiply, or divide by the same number from session to session. The list boxes can be edited by triple-clicking the values and typing a new number. Pressing the “Save” buttons beneath them will write the constants to a file in the application data directory (executable root directory) called “constant1.txt” and “constant2.txt”. These are simple text files which can be manually edited if needed. The sliding switch to the right of each box allows the user to use a value from the list box or a manually entered temporary constant above.

The operators themselves are selectable via drop-down boxes, and 4 choices are given: add, subtract, multiply, and divide. When the “Calculate Result” button is pressed, the operations are carried out on the 4 plots and a “Result” plot is created and graphed. All other plots are hidden initially and only the result plot is displayed, however you may make any other plots visible at this point and manipulate the display as you see fit. Pressing the “Revert” button hides the result and restores any plots that were previously graphed.

The result spectrum is padded according to the source scans used in the operations. That is, if the start and end wavelengths of the scans do not match the result spectrum will range from the lowest of the scan wavelengths to the highest of the scan wavelengths, and will pad the scans so they all match this range before operating on them.

Button & Function Descriptions

The following is a description of every button and function found on the “Spectrometer” tab.

Acquire

Sends the set exposure time, averages, and boxcar (set on the “Measurement” tab) to the spectrometer and receives a single spectrum.

Latch

Used in conjunction with the “Acquire” button. As long as this this latch is checked-off it will keep the “Acquire” button depressed and therefore allow for continuous acquisition of spectra.

Store Dark

This button grabs the currently displayed spectrum and stores it in a buffer. It is useful for subtracting background noise when the spectrometer is shuttered, hence the name “dark”.

Subtract Dark

Subtracts the stored dark spectrum (if any) from the currently displayed spectrum.

Pixel / WL

Switches the x-axis of the graph between pixel (integer indices from the spectrometer) and wavelength (a scale produced by a 3rd-order polynomial applied to the pixel indices).

Store Spectrum

Stores the currently displayed spectrum in a buffer. The user can then display this spectrum on the graph at any point in the future using the graphing controls explained in a previous section.

Realtime

A toggle to designate whether plot 1 should display the current spectra from the spectrometer or the spectrum identified by the “Spec. #” box.

Avgs (Averages - Boxcar)

The sample length for the boxcar function (running average) applied to the plots when their respective “Avg?” column box is checked-off.

Button & Function Descriptions (continued)

Save

Prompts the user to select a directory and filename to export the spectrum selected by the “Save Plot” box. The file format is a tab-delimited *.csv, however the file extension has been renamed to *.xls for convenient, direct opening in Excel when the file is double-clicked.

Fibre

Activates the fibre switch to select what the spectrometer sees. The “Top” position refers to the collecting optics on the vertical Z axis, and the “Bottom” position refers to the fibre entering the bottom of the integrating sphere.

Calculate Result

As explained in the “Data Manipulation section, this button opens a pop-up box (figure 13) which allows the user to perform mathematical operations on any or all of the 4 displayed plots.

Revert

Also explained in the “Data Manipulation” section, this button restores the graph to the displayed plots before the result plot was generated. This is handy because the result plot hides any displayed plots when it is initially calculated and plotted.

Contact

Resonance Ltd. stands behind every product we sell. We welcome feedback and encourage any of our customers to contact us with questions, or concerns. You may contact us through e-mail, our website, telephone, or fax!

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