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Ocean Optics Inc.
First in Photonics™

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OOINLCorrect Loading Non-Linearity Correction Coefficients Instructions

All CCD detectors exhibit a non-linearity in response to light. If left uncorrected, non-linearity will result in slight, but detectable errors in the calculation of normalized values (absorbance, transmission or irradiance). The pattern of non-linearity is different for the various detector models used in our spectrometers. The magnitude varies from detector to detector, but is the same for all pixels in the detector. Therefore, it is possible to measure linearity and correct for the errors in software.

The process of measuring a number (counts) that represent the amount of light shining on the CCD is not linear. Plotting a curve of counts versus light does not appear as a straight line. A polynomial curve is used in the spectrometer's driver to correct the count value to its theoretical relative value. The Non-Linearity Correction (OOINLCorrect) software is designed so it can be used as a simple intensity curve monitoring application as well as generating the coefficients.

We correct for the nonlinearity of the detector by running an experiment where we vary the amount of light the detector receives; we keep the intensity of the light source constant but vary the integration time. When we analyze this data, we have a number of points that are counts/sec vs. counts. We look at 9 pixels across the detector (the nonlinearity of each pixel is identical) and normalize each pixel's counts/sec to 1. When we combine the data from all 9 pixels, they overlap on a plot of normalized counts/sec vs. counts. We fit this smooth function to a 7th order polynomial. This polynomial produces a correction factor for each intensity. If we observe 2000 counts, we plug 2000 into the resulting polynomial and get a number less than 1 (typically around 0.9). We divide the number of counts by this correction factor.

After correcting for the nonlinearity of one of our spectrometers, the detector response is linear to >99.8%. Before completing the nonlinearity correction, the detector response is linear to 93%.

A non-linearity correction feature is built into our application software (both OOIBase32 and SpectraSuite) using a checkbox to activate the non-linearity correction function and text boxes for 8 coefficients. These coefficients describe a polynomial fit to the observed deviations from linearity as a function of signal strength.

The nonlinearity can be characterized at the factory, or you can do it yourself using OOINLCorrect software. Our USB spectrometers have an EEPROM; the factory evaluated linearity corrections are stored on this EEPROM and loaded to software when you plug in the device.

OOINLCorrect software, when used with SpectraSuite or OOIBase32 application software, enables you to correct for non-linearity yourself and store these 8 coefficients to the EEPROM. Contact an Ocean Optics Application Scientist to determine if OOINLCorrect is appropriate for your application.

Note

OOINLCorrect only works on Windows operating systems.

► *Procedure*

The following procedure uses the USB2000 Spectrometer as an example.

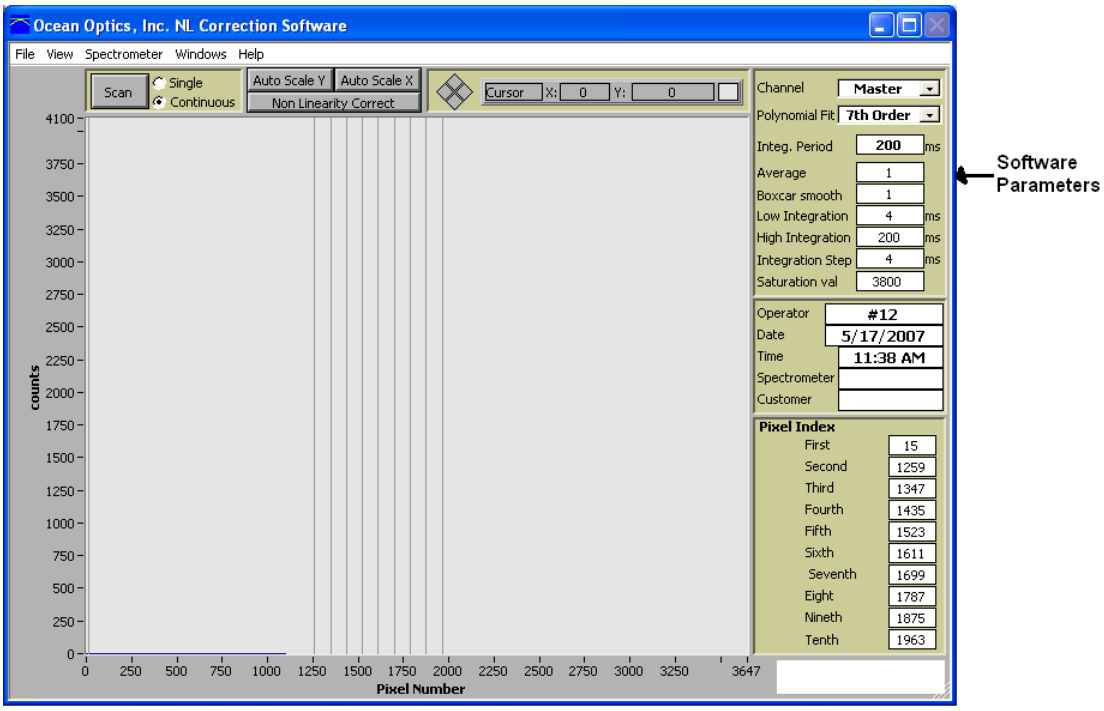
To correct for non-linearity using OOINLCorrect software, do the following:

1. Install OOINLCorrect software from the Software and Technical Resources CD or download it from our Ocean Optics website at http://www.oceanoptics.com/Technical/softwaredownloads.asp. You will need to get the password from an Ocean Optics Application Scientist to run this software.
2. Run the OOINLCorrect software by selecting **Start | Programs | Ocean Optics | OOINLCorrect | OOINLCorrect**.
3. Choose **Spectrometer | Hardware Configuration** from the menu to set system parameters for your spectrometer model as follows:

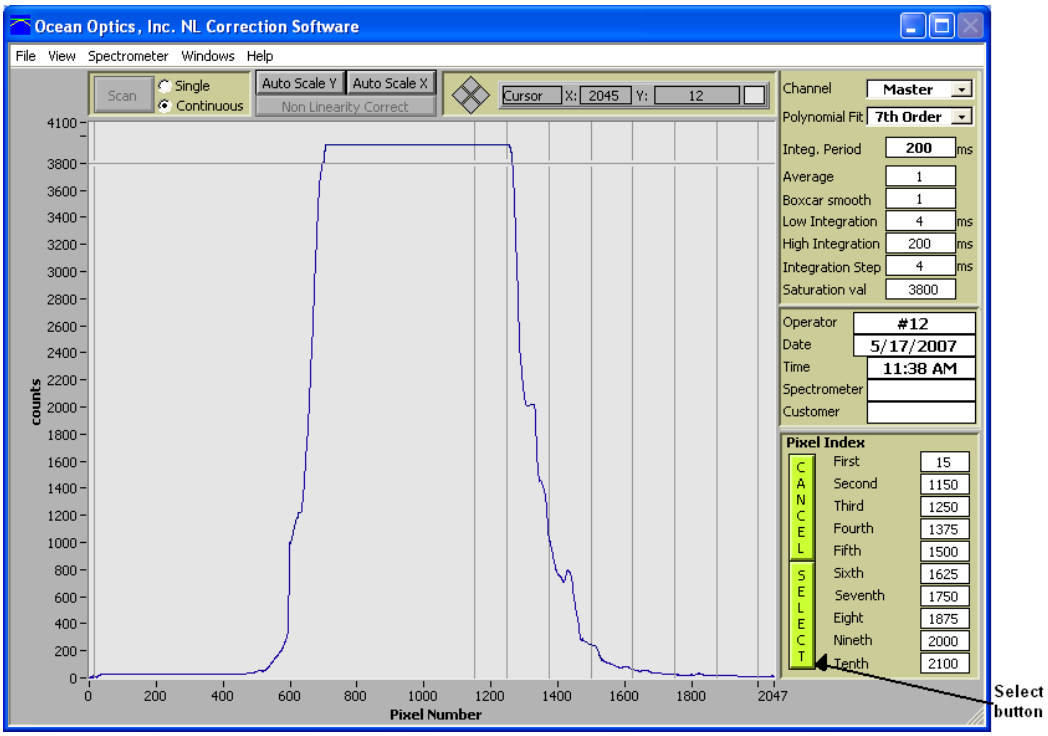
Parameter	Select ...
Spectrometer type	Your spectrometer model. For USB4000 and HR4000, select S4000.
A/D Type	The appropriate A/D Converter for your spectrometer.
USB Serial Number	The serial number corresponding to your spectrometer (if you have more than one spectrometer connected to you system)

4. Click **OK**.
5. Set the software parameters on the right side of the screen as follows:

Parameter	Setting
Channel	Master
Polynomial Fit	7th Order
Integ. Period	300
Average	8
Boxcar smooth	10
Low Integration	10
High Integration	300
Integration Step	10
Saturation val	Enter the appropriate saturation value for your spectrometer: S2000/USB2000/HR2000: 3800 HR2000+/HR4000: 15000 USB4000/QE65000: 63000

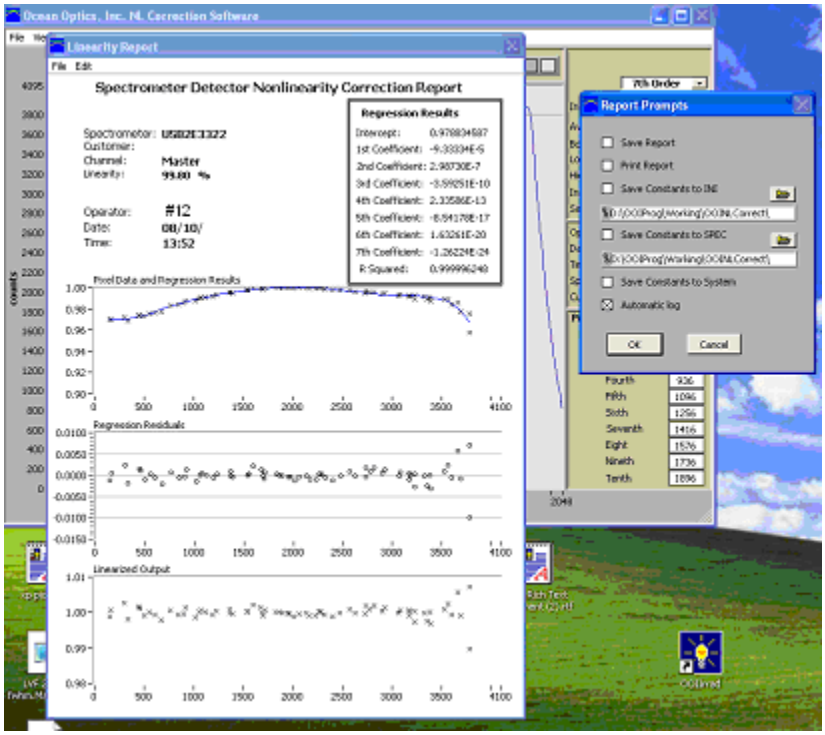


6. Choose **Spectrometer | Pixel Selection**
7. Click **OK.**
8. Adjust the light (attenuate if necessary) until the peak intensity is above the 3800 Saturation Val. You should have a nice curve above the 3800 line just saturated (goes flat) at about 4000 counts.
9. Click the **SELECT** button in lower right hand corner.



10. Choose **Spectrometer | Linearize** from the menu or click **Non Linearity Correct** to start the experiment. You will see spectra on the graph, starting from low light intensities increasing up to saturation. When the experiment is finished you will see a Linearity report displayed on the screen.

11. On the **Report Prompts** dialog box, select **OK**. If you see a *"file '#12.txt' was not found in application's directory. Would you create a new file?"* dialog box, choose **New.** Then close the **Linearity Report** dialog box by selecting **File | Close.**

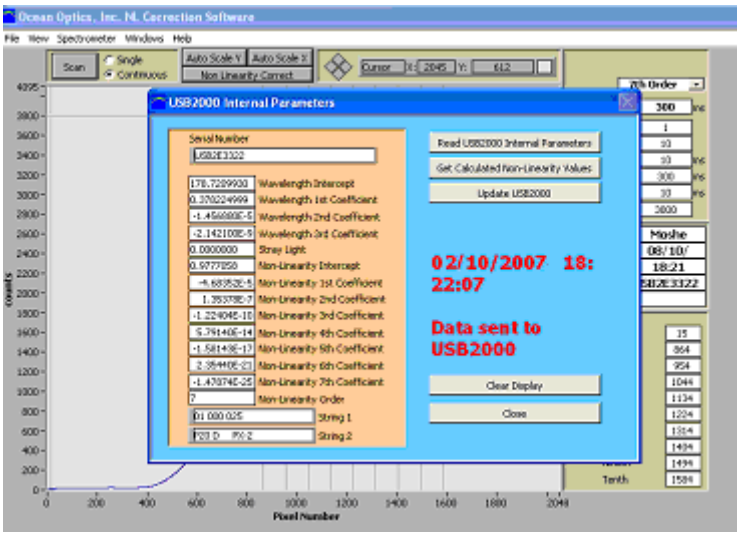


12. From the main menu choose **Spectrometer | USB2000 Data**. The ***USB2000 Internal Parameters*** dialog box appears.

13. Click the **Read USB2000 Internal Parameters** button.

14. Click the **Get Calculated Non-Linearity Values** button.

15. Click the **Update USB2000** button to write the Non-Linearity correction coefficients to the USB2000's EEPROM.



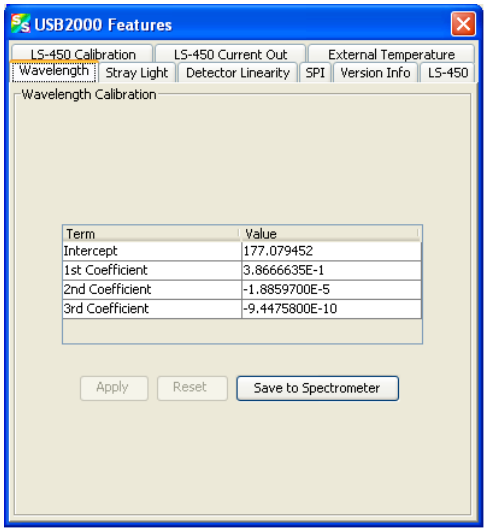
16. Now that the Non-Linearity correction coefficients have been successfully written to the spectrometer's EEPROM, you can view the coefficients with the operating software.

Using SpectraSuite Software

a. Open the SpectraSuite software.

b. Click on the desired spectrometer in the **Data Sources** pane.

c. Select **Spectrometer** | **Spectrometer Features** to view the coefficients.



Using OOIBase32 Software

a. Open the OOIBase32 software.

b. After arriving at the main menu (intensity vs. wavelength), select **Spectrometer** | **Configure** | **Detector Linearity** to view the coefficients.