

MicroNIR Spectrometers Fast Spectral Acquisition

Introduction

A key advantage of near-infrared (NIR) spectroscopy is the ability to nondestructively acquire spectra within milliseconds. While Raman spectra typically require seconds to minutes, a NIR spectrum can be acquired in milliseconds. The MicroNIR® family of compact handheld and process spectrometers is designed to acquire high quality diffuse reflectance and transmission spectra in as little as a few milliseconds. This note describes how to perform fast continuous spectral acquisition with a MicroNIR PAT instrument in VIAVI MicroNIR Pro v3.2 software. The PAT family of MicroNIR spectrometers from VIAVI Solutions includes the USB-connected PAT-U and PAT-L and the WiFi-connected PAT-W. HazLoc rated versions of all three MicroNIRs are also available for customers who require intrinsically safe instruments.



Figure 1. PAT-U (left) and PAT-W (right).

Integration Times and Spectral Acquisition

Every MicroNIR is configured at the factory with a default integration time that is chosen such that, under standard conditions for acquisition of a diffuse reflectance spectrum, the reference spectrum signal strength is a maximum of approximately 50,000 counts. Default integration times for PAT-U and -W instruments are typically 5-10 ms, or closer to 3 ms for the transmission PAT-L immersion probe instruments. The default integration time is defined for a single scan, and VIAVI recommends using the default integration time in nearly all circumstances.

Figure 2 (at right) shows the spectrometer setup menu for a PAT instrument in MicroNIR Pro v3.2. The default integration time for this instrument is 6.2 ms per scan, and the scan count has been set to 100. This means that acquiring a spectrum will scan the sample 100 times, averaging the results and displaying a single spectrum in the software. Using continuous mode will automate the acquisition for a defined time or number of spectra, or until the user stops the process. In Figure 2 the interval between individual spectra has been set to 1 ms, the minimum possible value .

Scan Count and Signal-to-Noise Ratio

The scan count may be set to as few as 1 or to more than 10,000 as shown in Figure 2. One might infer that a single spectrum can be acquired with this instrument in 6.2 ms. However, Windows and USB overhead add some additional time to the process of setting up a scan. The amount of overhead time depends on the computer and operating system used, but in general is on the order of 200-300 ms with MicroNIR Pro software. This means that a single spectrum with a scan count of 1 can be acquired in that time. Hence, a MicroNIR PAT spectrometer operating under MicroNIR Pro v3.2 can acquire 3-5 single scan spectra per second. Typical use cases for such fast scanning speeds include material sorting and production line QC. MicroNIR Pro can use chemometric models to classify or quantify samples, and models requiring significant calculation may slow the rate of spectral acquisition. Analytical rates will depend on details of the model used and the PC graphics and processor speed. When using a Spectral Match Value (SMV) classification library the MicroNIR is entirely capable of sorting polymers and other materials at rates of 1-2 per second.

Increasing the scan count to larger values such as 10, 100 or more will improve the instrumental signal-to-noise ratio (Figure 3), but also reduce the acquisition rate. With a scan count of 10 the scan rate is nearly as fast as with a scan count of 1. With a scan count of 100 spectra can still be acquired at a rate of around 1 per second. As the scan count increases, the MicroNIR spends a larger fraction of the time analyzing samples rather than in unproductive setup. VIAVI recommends using scan counts of 1000 or

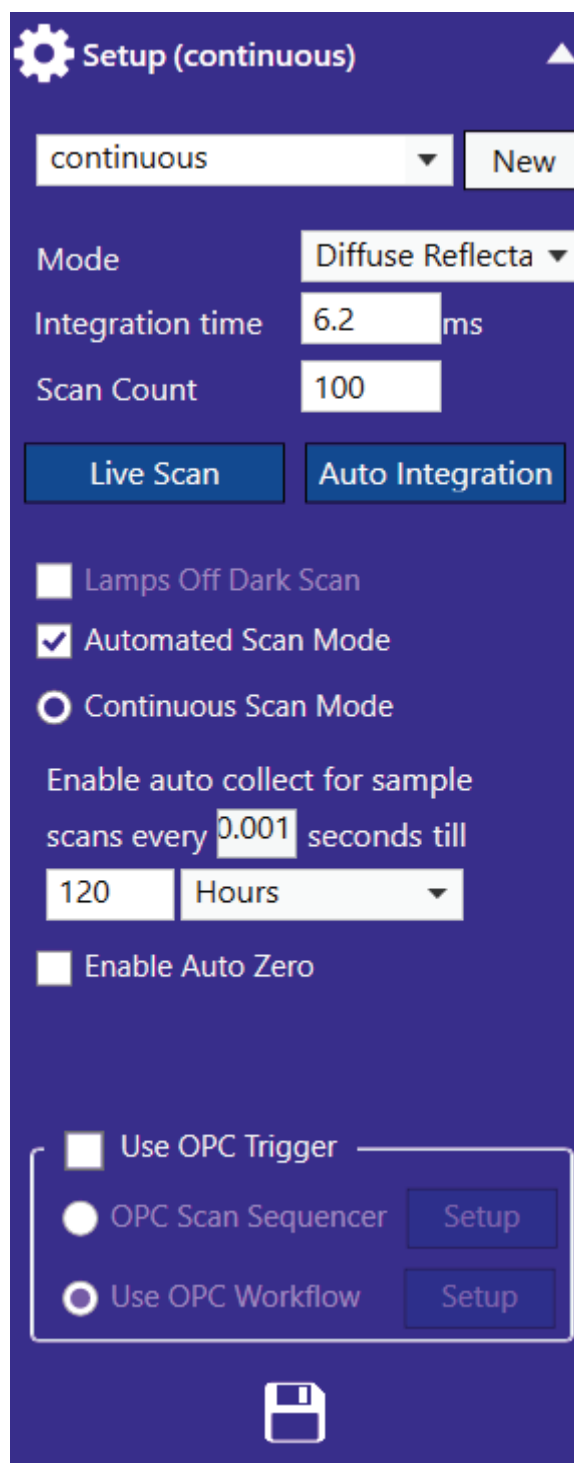


Figure 2. Spectrometer configuration in MicroNIR Pro.

more when continuously analyzing bulk materials such as grain, where it is important to observe as much of the sample as possible. Fast scanning is recommended for time-sensitive or rapidly varying samples such as recycled plastics. Larger scan counts may be required when scanning highly absorbing samples such as iron ore, canola seeds or black plastics. With dark samples such as these, less light returns to the detector and the noise level increases.

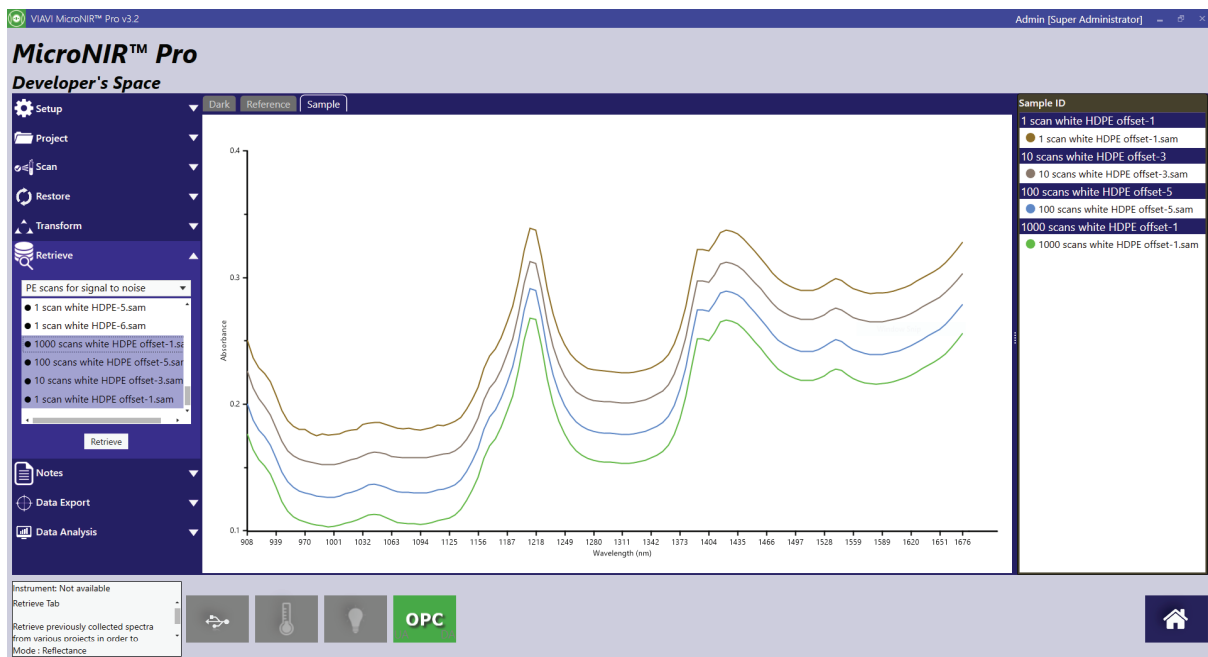


Figure 3. Spectra of white HDPE with scan counts of 1 to 1000. Spectra have been vertically offset for clarity. Instrumental noise is negligible for scan counts of 10 or more.

Software Configuration

- MicroNIR Pro includes a setting to limit the number of cached spectra. Setting this value to a small number may increase the maximum spectral acquisition rate, particularly when using a computer with a slow graphics processor. It takes time to redraw 100 spectra onscreen.
- MicroNIR Pro stores spectra in project folders. Create a new project for fast scanning to reduce the amount of time that Windows spends sorting files as they are acquired.
- Earlier versions of MicroNIR Pro required longer intervals between spectra. VIAVI recommends that affected customers upgrade their software to the latest version.
- VIAVI offers an SDK to its OEM customers. Spectral acquisition can be configured to run at rates of up to ~10 per second using the SDK.