

The Partisol Filter Sampler: Redesign of a Workhorse

Jeffrey L. Ambs

R&D Product Development Manager

Thermo Fisher Scientific • Franklin, Massachusetts

Introduction

The original Partisol 2000 Sampler was designed and released to the market in 1994. This was followed by the Partisol 2000-FRM sampler, a version of the sampler that was designed to meet the requirements as specified in 40 CFR Part 50, Appendix L, and was designed specifically to meet US EPA $PM_{2.5}$ network sampling requirements. These samplers were followed by the Partisol-Plus 2025 Sequential Ambient Air Sampler, a multi-event sampler that gained wide acceptance in the market due to its robust design and ease of use. The Partisol 2000-FRM and Partisol-Plus 2025 collect a single sample per event and can be configured with different inlet systems for the sampling of TSP, PM_{10} , $PM_{2.5}$, or PM_1 .

In addition to the single sample versions of the Partisol 2000-FRM and Partisol-Plus 2025, dichotomous sampler versions of both models are available. The dichotomous versions of the samplers use a virtual impactor to split the sample into two fractions at a cut point of $2.5 \mu m$. This allows the dichotomous samplers collect both $PM_{2.5}$ and $PM_{10-2.5}$ samples simultaneously on two sample filters.

All Partisol and Partisol-Plus 2025 samplers are US EPA approved samplers for PM_{10} , $PM_{10-2.5}$, and $PM_{2.5}$.

Sampler Redesign

Due to the age of the components in the existing Partisol and Partisol-Plus samplers, Thermo Scientific initiated a project to redesign the entire line of Partisol samplers. After reviewing the sampler history, we determined that there were three main goals for the redesign project: improve serviceability and reliability, simplify data retrieval from the samplers, and improve the overall operator experience.

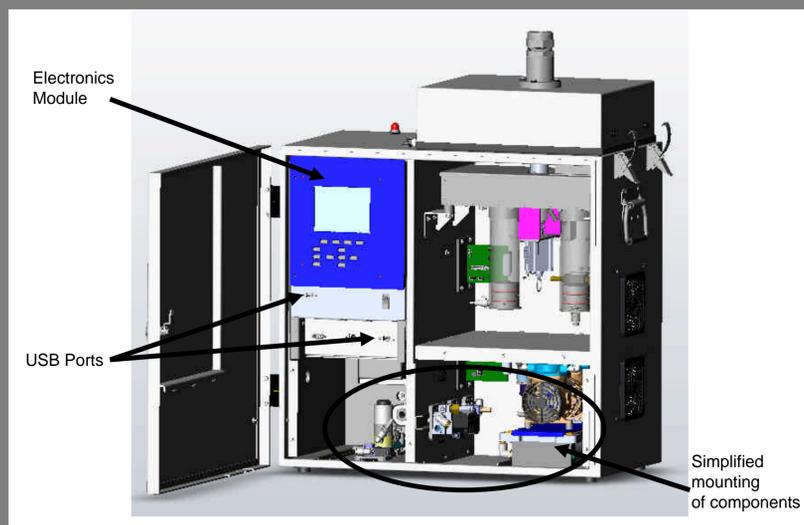
To improve the overall operator experience, we standardized on a common electronics package to be used in all different Partisol models. The new Partisol samplers were moved to the well known iSeries electronics with some important improvements. By having all Partisol samplers on the iSeries electronics allowed for common software across the Partisol models, so an operator trained on one model, will easily make the transition to another model since the look and feel are the same. In addition, operators who are familiar with the Thermo Scientific iSeries platform with the gas analyzers will immediately feel comfortable on the new design.

The improvements to the iSeries platform include an upgraded processor with greater memory capacity and improved connectivity options, including the use of USB ports for data retrieval. In addition to the standard serial connection on the current Partisol samplers, Ethernet and USB ports were added to the sampler. Networks that currently use serial devices to communicate with the Partisol samplers can continue to do so, or migrate to the Ethernet connection. Data can be downloaded via RPComm or through the use of a USB flash drive. Plug the drive into the sampler and quickly download the data to the drive.

Field service and maintenance was greatly improved through the use of modular components and simple mounting in the instrument enclosures. The flow controllers and solenoid valves are mounted on DIN rails which allows for simple installation and removed without tools. The electronics module is also easily removed for service. Replacing the entire module can be performed in just a few minutes, and after recalibrating the sampler, it is ready to go. The pump installation was also greatly improved. The sample pump is now mounted on a plate and secured in place with two easy to access screw clamps. Loosen the screws and the pump slides out easily.



FIGURE 1. Model showing new iSeries Partisol 2025i Ambient Air Sampler.



Hardware Improvements:

- Modular Design
- Improved Electronics
- Ease of Maintenance and Servicing
- Common Parts Across Entire Product Family
- Ethernet
- USB Data Ports

Software Improvements:

- Download Data via USB Flash Drive
- Export Audit History
- Store and Retrieve Sampler Configurations

Test Results

In order to verify that the updates to the Partisol samplers do not effect the collected samples, testing of prototype iSeries Partisol samplers was performed at the Thermo Scientific facilities in Franklin, MA. Two types of testing were performed, environmental chamber testing and ambient comparison testing. The environmental chamber testing was performed to verify that the components and controls were not effected by the upgrades to the samplers and that the basic performance of the electronics, pump, flow controllers, and valves are not effected by changes in operating temperatures. The ambient sampling was performed to provide collocated sampling of the new iSeries samplers along side the existing Partisol samplers.

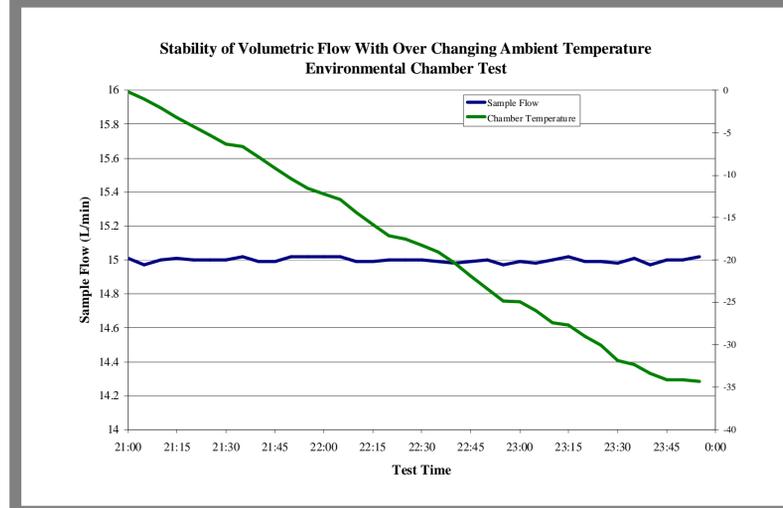
Environmental Chamber Testing

New iSeries Partisol samplers were tested in an environmental chamber to verify the performance of the sampler to maintain constant volumetric flow rate over changing ambient temperature conditions, to satisfy the leak check criteria, and to verify the performance of the sampler to initiate a sample at the temperature extremes of $-40^{\circ}C$ to $+50^{\circ}C$. This testing shows the results of testing a new Partisol 2025i-D Dichotomous Ambient Sampler, but since the electronics, flow controllers, and sample pump are the same for all models of samplers, the results apply to all models.

The samplers were installed in an environmental chamber and allowed to soak at $-40^{\circ}C$ and at $+50^{\circ}C$ for 8 hours with the sampler power off. The sampler was then turned on to verify the sampler started and was able to initiate a sample at the correct time as expected. Leak checks were also performed at the extreme temperature conditions.

In addition to the cold and hot soak tests, the sampler flow controllers were tested to verify the ability to maintain constant volumetric flow control over extreme temperature changes. Ramp tests were performed in the environmental chamber where the chamber temperature was ramped from $0^{\circ}C$ to $-40^{\circ}C$ and a second test where the chamber temperature was ramped from $+50^{\circ}C$ to $0^{\circ}C$. The volumetric flow was monitored during these tests. The results of the flow control test from $0^{\circ}C$ to $-40^{\circ}C$ are shown in Figure 3. In both cases, the sampler control system was able to maintain constant volumetric flow control over the entire temperature range of the testing performed.

FIGURE 2. Performance of the iSeries Partisol Sampler flow control over extreme temperature changes.



Ambient PM Sampling

In addition to the environmental chamber testing, the new Partisol iSeries sampler was compared to the existing Partisol sampler. The new iSeries Partisol 2025i-D sampler was collocated with two current Partisol 2000-FRM samplers, one configured for $PM_{2.5}$ sampling and one configured for PM_{10} sampling.

For this test, the samplers were collecting $PM_{2.5}$ over a period of approximately 30 days, and PM_{10} samples were collected over a period of 15 days. All tests were performed at the Thermo Scientific facility in Franklin, MA. The $PM_{2.5}$ results are presented in Figure 4, with the PM_{10} results in Figure 5. The samples were collected for periods of 22-23 hours, allowing sufficient time for filter changes prior to starting the next sample period. As shown in these performance comparisons, the use of the new iSeries Partisol samplers for the collection of ambient $PM_{2.5}$ and PM_{10} is essentially identical to the currently designated sampler.

FIGURE 3. Comparison between the new iSeries Partisol 2025i Sampler and a collocated Partisol 2000-FRM Sampler for $PM_{2.5}$ sampling.

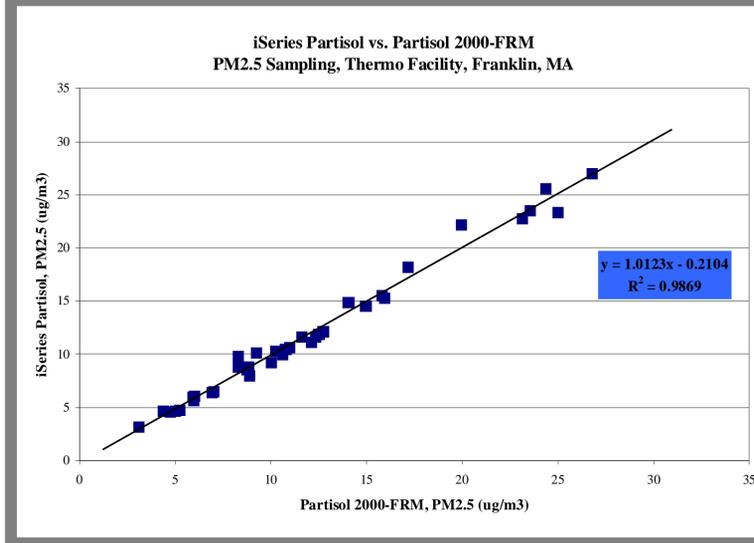


FIGURE 4. Comparison between the new iSeries Partisol 2025i Sampler and a collocated Partisol 2000-FRM Sampler for PM_{10} sampling.

