

# PRODUCT

## INFORMATION

### Model 3936-Series Scanning Mobility Particle Sizer

**T**SI Scanning Mobility Particle Sizer (SMPS) systems are technologically advanced instruments for measuring submicrometer aerosols in the range from 3 to 1000 nanometers in diameter. They employ an Electrostatic Classifier to determine particle size, and a Condensation Particle Counter (CPC) to determine particle concentrations. A new, innovative platform concept for the Electrostatic Classifier provides the ability to select one of two Differential Mobility Analyzers (DMAs), or even interchange DMAs, based on your sizing needs. Systems may also be configured with one of three Condensation Particle Counters (CPCs). This versatility helps you configure the best SMPS system for your particular application.

Key benefits of SMPS systems include:

**Fast Results.** Complete scans of particle size distributions in 60 seconds or less.

**High-Resolution Data.** Scans are made continuously, so there are no gaps in the data distribution. With 162 size channels and up to 64 channels per size decade, SMPS systems offer the highest accuracy and resolution of any submicrometer sizing instrument.

**High-resolution sizing of submicrometer particles in 60 seconds or less**

**Broad size range.** Using the versatile 3080-series Electrostatic Classifiers and our family of Condensation Particle Counters, SMPS systems offer a collective size range from 3 to 1000 nanometers. (See "Specifications" for size ranges of individual SMPS configurations.)

**Wide concentration range.** Collectively, SMPS systems span the concentration range from 1 to  $10^8$  particles per cubic centimeter. (See "Specifications" for individual concentration ranges.)

**Simple control of operation.** The Electrostatic Classifier contains a built-in front panel display and control knob, which allows you to scan through settings quickly, and monitor or control instrument functions.

**Real-time data displays.** SMPS software works with the Microsoft® Windows® operating systems. (See "Computer Requirements.") It features pull-down menus and dialog boxes to simplify setup and operation.



Computer sold separately

Model 3936N25

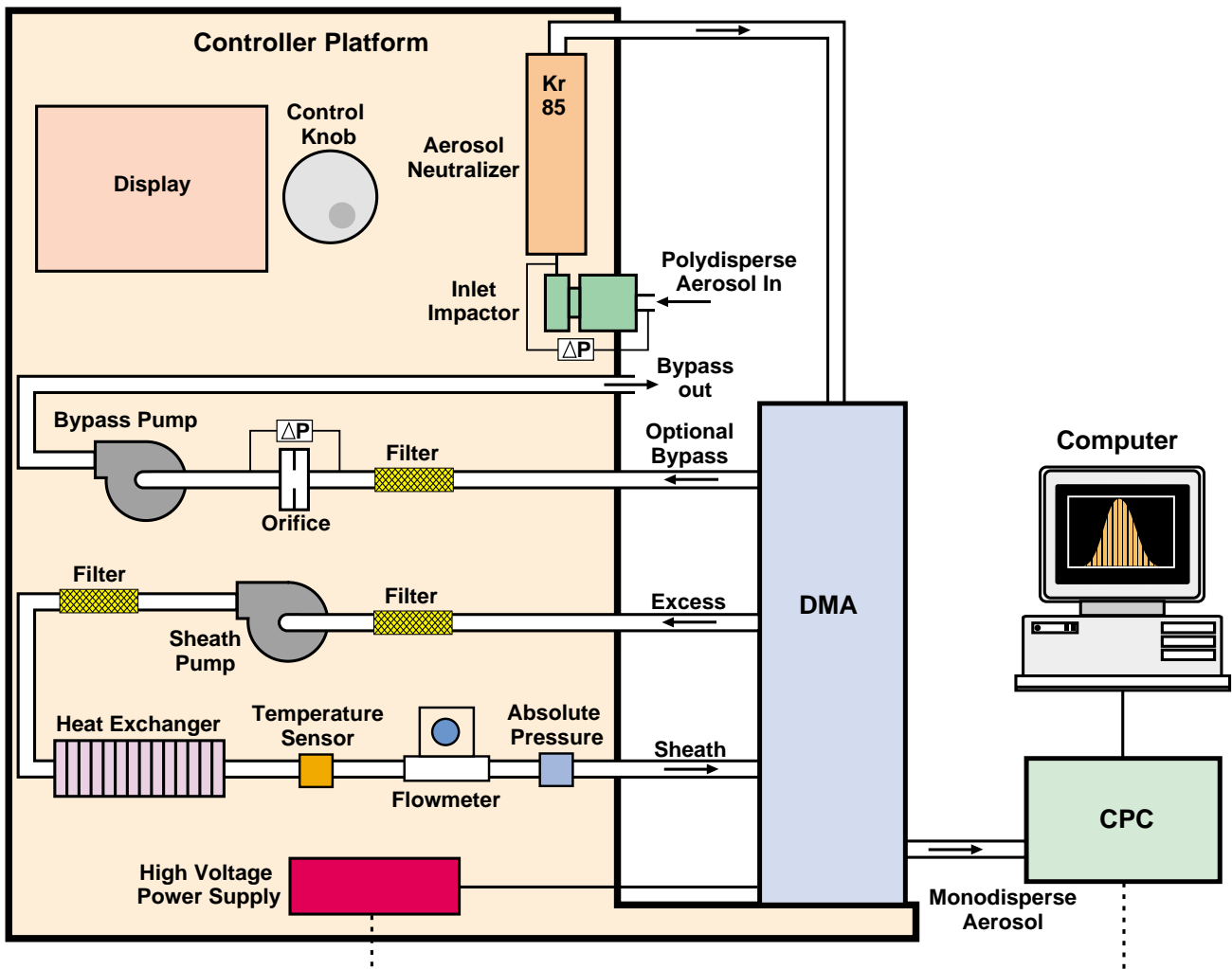


### SMPS CONFIGURATION MATRIX

DMA \ CPC	3010-S	3022A-S	3025A-S	
<b>3081</b> (Long)	Size range: 10 to 1000 nm Optimal sizes: 20 to 800 nm Concentration: 1 to 10 <sup>7</sup> particles/cm <sup>3</sup> Response time: Fast <b>Model 3936L10</b>	Size range: 10 to 1000 nm Optimal sizes: 20 to 800 nm Concentration: 2 to 10 <sup>8</sup> particles/cm <sup>3</sup> Response time: Slow <b>Model 3936L22</b>	Size range: 10 to 1000 nm Optimal sizes: 20 to 800 nm Concentration: 20 to 10 <sup>7</sup> particles/cm <sup>3</sup> Response time: Fast <b>Model 3936L25</b>	<b>Model 3936NL25</b>
<b>3085</b> (Nano)	Size range: 10 to 150 nm Optimal sizes: 10 to 150 nm Concentration: 1 to 10 <sup>7</sup> particles/cm <sup>3</sup> Response time: Fast <b>Custom</b>	Size range: 7 to 150 nm Optimal sizes: 7 to 150 nm Concentration: 2 to 10 <sup>8</sup> particles/cm <sup>3</sup> Response time: Slow <b>Custom</b>	Size range: 3 to 150 nm Optimal sizes: 3 to 150 nm Concentration: 20 to 10 <sup>7</sup> particles/cm <sup>3</sup> Response time: Fast <b>Model 3936N25</b>	

Standard systems are identified on this matrix by model number. Contact your TSI representative before ordering a custom system.  
 CPC = Condensation Particle Counter. DMA = Differential Mobility Analyzer.

### MODEL 3936-SERIES SCANNING MOBILITY PARTICLE SIZERS



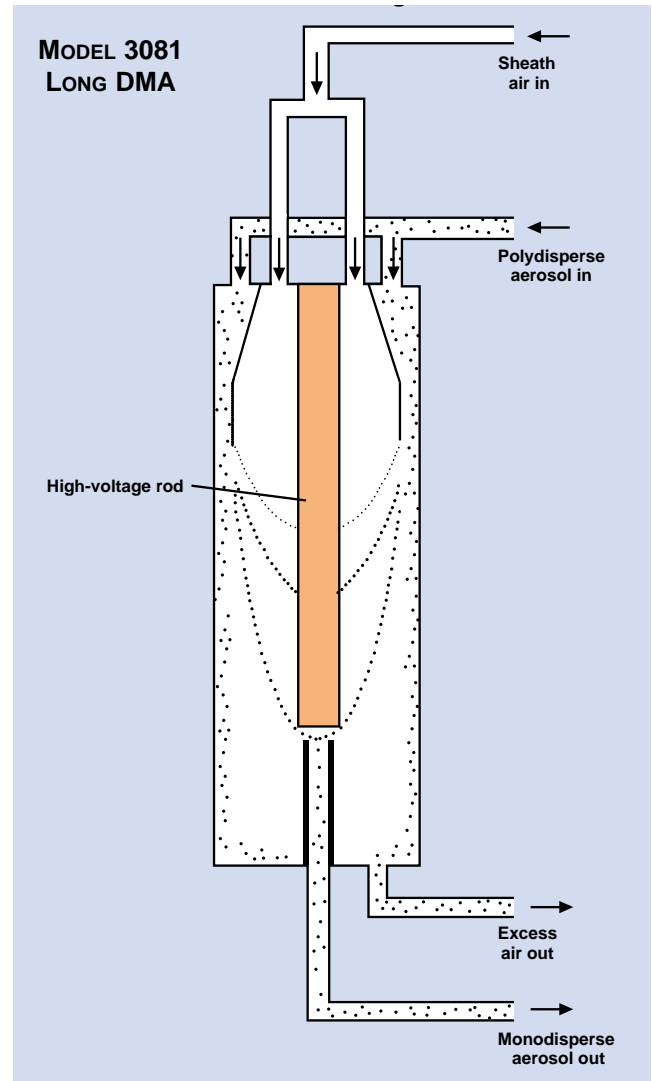
TSI offers five standard SMPS configurations, but custom systems are also available. Particle size and concentration ranges will vary depending upon the DMA and CPC selected. To decide which SMPS is best for you, refer to the configuration matrix on the opposite page and the “To Order” section later in this brochure.

## OPERATION

The Scanning Mobility Particle Sizer (SMPS) uses an electrical-mobility detection technique. During operation, the aerosol sample first passes through a single-stage, inertial impactor. This serves to remove large particles outside the measurement range that may contribute to data inversion errors caused by multiple charging. Next, the aerosol passes through a bipolar ion neutralizer, which imparts a high level of positive and negative ions. The neutralizer brings the aerosol charge level to a Fuchs’ equilibrium charge distribution.

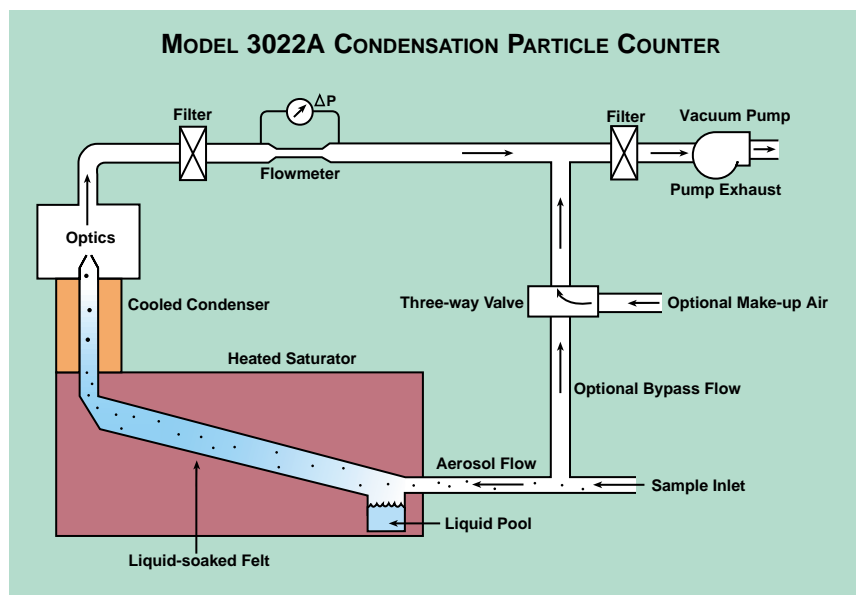
The charged and neutral particles now enter the Differential Mobility Analyzer (DMA). It is at this point that particles are separated according to their electrical mobility. An electric field inside the DMA influences the flow trajectory of the charged particles. The DMA contains an inner cylinder that is connected to a negative power supply (0 to 10,000 VDC). This charged element provides a precise negative potential. Particles with negative charge are repelled towards and deposited on the outer wall. Particles with a neutral charge exit with the excess air. Particles with a positive charge move rapidly towards the negatively charged element.

Only particles within a narrow range of electrical mobility have the correct trajectory to pass



through an open slit near the DMA exit. Electrical mobility is inversely related to particle size. After exiting the DMA, the classified particles enter a

Condensation Particle Counter (CPC), which provides a measurement of particle concentration. By exponentially ramping the voltage of the charged rod or disk over a user-selected period of time, the entire particle size distribution is measured to a high degree of accuracy. The Aerosol Instrument Manager® software controls the sampling and counting process, as well as data calculation, display, and storage. The software also corrects for multiple-charge effects and detection efficiency.



## APPLICATIONS

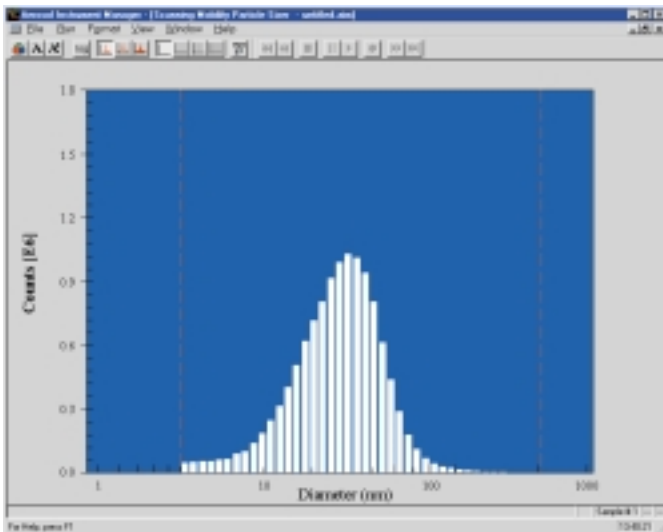
All standard SMPS configurations provide accurate particle-size distributions of submicrometer aerosols. This makes them ideal for:

- Basic aerosol research
- Nanometer-particle research
- Atmospheric aerosol studies
- Pollution studies
- Smog chamber evaluations
- Aerosol dynamics
- Combustion studies
- Engine exhaust studies
- Materials synthesis
- Filter efficiency testing
- Nucleation/condensation studies
- Inhalation toxicology studies
- Characterizing sprays, powders, and other generated aerosols
- Detecting small changes in rapidly changing aerosol systems

The major SMPS system components may be used as stand-alone instruments in a variety of applications. For example, the Electrostatic Classifier functions as a monodisperse aerosol generator; the CPC as a particle concentration detector.

## SOFTWARE

The Model 3936-series Scanning Mobility Particle Sizers include the Aerosol Instrument Manager® software, a 32-bit program designed for use with most of the later Microsoft® Windows® operating systems.



The SMPS gives you high-resolution particle-size distributions in 60 seconds or less.



When configuring your SMPS, you have a choice of three Condensation Particle Counters.

(See "Computer Requirements" below.) The Aerosol Instrument Manager software controls instrument operation and provides impressive file management capabilities. It also gives you numerous choices for data display, including tables and statistical lists. A variety of graphing options makes it easy to view channel data and raw data. Graphs offer the highest resolution from 4 to 64 channels per decade.

Data can be weighted by number, surface, or volume. An export function allows easy transport of data files to spreadsheet or other applications for customized data handling. Additional software capabilities include multiple scan average, a buffer for subtracting or comparing data sets, multiple charge correction for up to 10 charges, programmable start/stop times, automatic file storage and printout options, impactor and CPC efficiency correction factors, and a fully selectable size range.

## COMPUTER REQUIREMENTS

Computers are not included with SMPS systems. To use the powerful Aerosol Instrument Manager software provided with your SMPS, you will need to purchase a personal computer with these minimum features:

- A Pentium® Processor
- Microsoft Windows 9x, ME, NT4, or Windows 2000 operating system
- A hard drive with at least 10 Mb of free disk space (data files require additional disk space)
- A CD-ROM drive
- 16 Mb or more of random access memory (RAM)
- A pointing device
- A serial interface port

## SPECIFICATIONS

Refer to separate product sheets for descriptions and specifications of individual system components.

### Major SMPS components:

3080N or 3080L Electrostatic Classifier (includes Controller Platform, Differential Mobility Analyzer, 3077 Aerosol Neutralizer\*, and 1035900 Inlet Impactor)

3010-S, 3022A-S, or 3025A-S Condensation Particle Counter

3032 (110 VAC) or 3032-1 (220 VAC) Vacuum Pump (for systems with 3010-S CPC only)

390087 interconnecting hardware and SMPS software (AIM3936)

### Particle size and concentration:

System	DMA	Particle size range	CPC	Concentration range	Response
3936NL25†	3085 Nano & 3081 Long	3 to 150 with 3085 DMA, 10 to 1000 nm (20 to 800 nm optimal) with 3081 DMA	3025A-S	20 to 10 <sup>7</sup> particles/cm <sup>3</sup>	Fast
3936N25	3085 Nano	3 to 150 nm	3025A-S	20 to 10 <sup>7</sup> particles/cm <sup>3</sup>	Fast
3936L25	3081 Long	10 to 1000 nm (20 to 800 nm optimal)	3025-S	20 to 10 <sup>7</sup> particles/cm <sup>3</sup>	Fast
3936L22	3081 Long	10 to 1000 nm (20 to 800 nm optimal)	3022A-S	2 to 10 <sup>8</sup> particles/cm <sup>3</sup>	Slow
3936L10	3081 Long	10 to 1000 nm (20 to 800 nm optimal)	3010-S	1 to 10 <sup>7</sup> particles/cm <sup>3</sup>	Fast

**Charger:** Bipolar, Kr-85, 2 millicurie, half-life of 10.4 years (3077 Aerosol Neutralizer‡ supplied with the system)

**Cycle time:** 60 to 600 sec, selected by user

**Measurement time:** 50 to 300 sec

**Sample averaging:** One sample can average 1 to 999 scans

**Data collection rate:** CPC count data sent to computer every 0.1 sec

**Total size channels:** 162 (Varies by system. Collectively, SMPS systems span 162 channels from 3 nm to 1 µm.)

**Displayed resolution:** 4, 8, 16, 32, or 64 geometrically equal channels per decade

**Aerosol temperature range:** 10 to 35°C

**Operating aerosol pressure range:** 100 ± 20 kPa (1.0 ± 0.2 atm), Electrostatic Classifier must not be subjected to pressures above 35 kPa gauge (5 psig)

### Power requirements:

100/115/230/240 VAC, 50/60 Hz, single phase

3080L: 200 W    3080N: 200 W

3010-S: 40 W    3022A-S: 200 W    3025A-S: 200 W

3032: 280 VA

\*Model 3077 Aerosol Neutralizer is shipped separately from other system components. To order an SMPS system without a neutralizer, contact your TSI representative.

†Model 3936NL25 includes two DMAs (models 3081 and 3085). The Controller Platform accommodates only one DMA at a time.

‡TSI is authorized by the United States Nuclear Regulatory Commission to distribute these Aerosol Neutralizers. If your location is within the United States, no other federal license is required. Check local regulations for your own protection. End-user name and address are required.

The design of the Model 3085 Nano DMA is covered under U.S. Patent Number 6,230,572. Specifications are subject to change without notice. TSI, the TSI logo, and Aerosol Instrument Manager are trademarks of TSI Incorporated. Microsoft and Windows are trademarks of Microsoft Corporation. Pentium is a trademark of Intel Corporation.



You may choose between two Differential Mobility Analyzers, or you may interchange DMAs to meet different measurement needs.



## TO ORDER

### Ordering a New SMPS

Each Scanning Mobility Particle Sizer includes an Electrostatic Classifier, a Condensation Particle Counter (CPC), the Aerosol Instrument Manager software (SMPS module), and interconnecting hardware. When selecting an SMPS system, particle size range, particle concentration, and instrument response time should be your main considerations.

The matrix on page 3 shows the various combinations of DMA and CPC, along with some general specifications. We offer five standard SMPS configurations, identified on the matrix by a model number. Ask your TSI representative for more information on custom configurations. For detailed specifications on major SMPS components, see separate product sheets on the Model 3080-series Electrostatic Classifiers and the Model 3010, 3022A, and 3025A Condensation Particle Counters.

### Upgrading an Older System

Owners of SMPS systems based on Model 3071 or 3071A Electrostatic Classifiers may upgrade their sys-

tems to experience the full benefits of the new design. You should be able to keep your existing CPC and have us place your Long DMA and Model 3077 Aerosol Neutralizer in a 3080-series platform. The upgrade also includes the new Aerosol Instrument Manager software and updated interconnecting hardware. Upgrade requirements may vary by system. Call your TSI representative for details.

## ACKNOWLEDGMENTS

The TSI Particle Instrument Division gratefully acknowledges the significant contributions of Richard C. Flagan of the California Institute of Technology for development of the scanning algorithm and Kevin Horton of AEA Technology for his support in developing the original software.

## BIBLIOGRAPHY

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Wiedensohler A, An Approximation of the Bipolar Charge Distribution for Particles in the Submicron Range, technical note, *J. Aerosol Sci.* 19(3):387-9 (1988).

### STANDARD SMPS CONFIGURATIONS

Specify	Description
3936NL25	SMPS system that combines our best CPC (lowest detection limit and fastest response) with two interchangeable DMAs for the broadest size range possible. Includes 3080N Electrostatic Classifier (with 3085 Nano DMA, 3077 Aerosol Neutralizer, and 1035900 Inlet Impactor), 3081 Long DMA, 3025A-S Condensation Particle Counter, and 390087 software and interconnecting hardware.
3936N25	SMPS system for optimal performance at the smallest sizes. Includes 3080N Electrostatic Classifier (with 3085 Nano DMA, 3077 Aerosol Neutralizer, and 1035900 Inlet Impactor), 3025A-S Condensation Particle Counter, and 390087 software and interconnecting hardware.
3936L25	SMPS system (with our best CPC) that offers a broad size range and fast response. Includes 3080L Electrostatic Classifier (with 3081 Long DMA, 3077 Aerosol Neutralizer, and 1035900 Inlet Impactor), 3025A-S Condensation Particle Counter, and 390087 software and interconnecting hardware.
3936L22	SMPS system that provides broad size and concentration range, but with slower response time. Includes 3080L Electrostatic Classifier (with 3081 Long DMA, 3077 Aerosol Neutralizer, and 1035900 Inlet Impactor), 3022A-S Condensation Particle Counter, and 390087 software and interconnecting hardware.
3936L10	SMPS system (with our low-cost CPC) that offers a broad size range and fast response. Includes 3080L Electrostatic Classifier (with 3081 Long DMA, 3077 Aerosol Neutralizer, and 1035900 Inlet Impactor), 3010-S Condensation Particle Counter, 3032 Vacuum Pump, and 390087 software and interconnecting hardware.



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