

# ELECTROSTATIC CLASSIFIER MODEL 3082

USED FOR AEROSOL CLASSIFICATION AND  
SIZING IN A BROAD VARIETY OF APPLICATIONS



# HIGHLY RELIABLE AND EXTREMELY VERSATILE

Since 1976, TSI Electrostatic Classifiers have been helping scientists generate and size submicrometer particles. These instruments have been used in a broad variety of research and have earned a well-deserved reputation for being highly reliable and extremely versatile. Our latest Electrostatic Classifier - the Model 3082 - continues that tradition, but with expanded capabilities and an easy-to-use interface. The current design offers tool-free installation and auto detection of configurable components. The controller platform includes a touch-screen display and graphical user interface control that enables size distribution measurements with data logging, greatly expanding your research possibilities!

TSI's Electrostatic Classifiers select highly monodisperse, submicrometer aerosols in the range from 1 to 1000 nanometers in diameter. The Electrostatic Classifier is most often used as an integral part of a monodisperse aerosol generation system or in a submicrometer-particle sizing system.



# APPLICATIONS

The Classifier Model 3082 is a 'primary standard' instrument for aerosol measurement. This means that its performance is based on basic physical principles, and that results are highly repeatable.

The Classifier 3082 can be used for both aerosol generation and for aerosol size distribution measurement. The United States' National Institute of Standards and Technology (NIST) uses a TSI® Long DMA for sizing 0.1-micrometer standard reference materials (Kinney et al, 1991).

Further detail on these two uses is provided on the next page. Because of these two capabilities, our Electrostatic Classifiers are suitable for a variety of applications:

## **When used as an aerosol generator to produce highly monodisperse particles:**

- + Aerosol research, including the study of particle transport, diffusion, coagulation, nucleation, and condensation
- + Particle-charge and electrical-mobility studies
- + Filter media tests for filter efficiency
- + Calibration of particle instruments such as optical particle counters -enhancing the monodispersity of polystyrene latex (PSL) or other aerosols by removing residue particles and multiplets

## **When used in a TSI® SMPS™ spectrometer for high-resolution sizing of submicrometer particles:**

- + Aerosol research, including the study of nucleation and condensation
- + Atmospheric monitoring and climate studies
- + Nanotechnology research and materials synthesis
- + Combustion and engine exhaust studies
- + Characterization of aerosols generated from flames, powders, sprays, or other sources

## **When monodisperse generation is used in tandem with size distribution measurement:**

Measuring small and large changes in particle size due to coagulation, evaporation, condensation, humidification, and chemical reactions.

## **When used with a TSI Model 3068B Aerosol Electrometer:**

Primary size and concentration calibration of Condensation Particle Counters (ISO 27891) and other aerosol instruments.



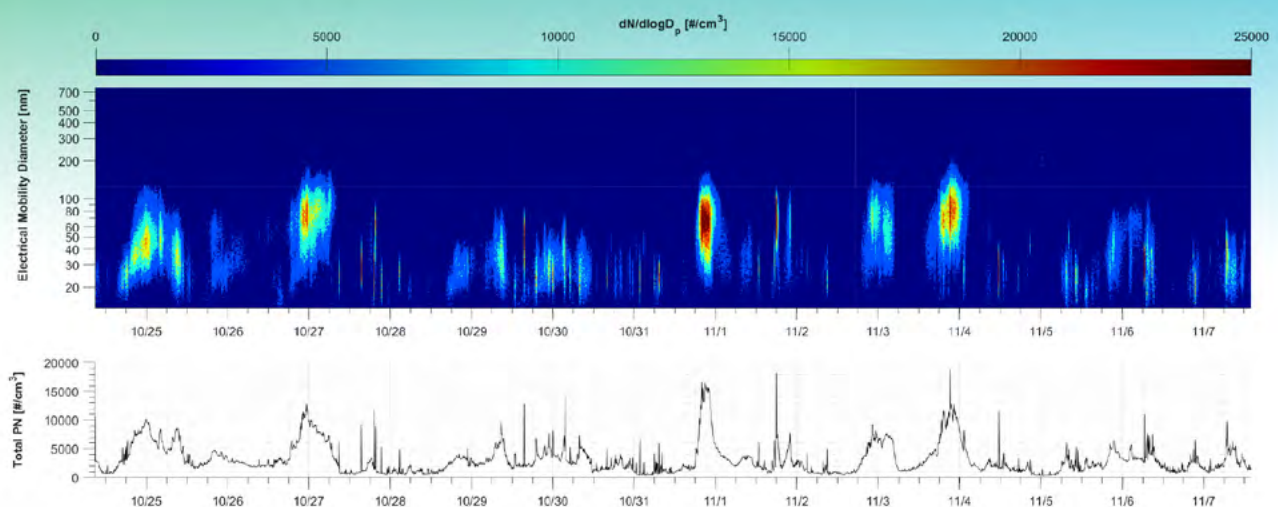
# DUAL-PURPOSE: AEROSOL GENERATION AND AEROSOL SIZING

Broadly speaking, there are two categories of applications for the Classifier: monodisperse aerosol generation, and submicrometer aerosol size distribution measurement. The Electrostatic Classifier 3082 serves as a platform for operating other user-selected components. Which components are used depends upon the user's application.

The first use of the Classifier 3082 is as a monodisperse aerosol generator for submicrometer particles. To use the Classifier as a monodisperse aerosol generator, the user installs the selected Differential Mobility Analyzer (DMA), aerosol neutralizer, and inlet impactor; all of these components are controlled and/or monitored by the Classifier.

The second - and most common - use of the Classifier 3082 is in a Scanning Mobility Particle Sizer™ (SMPS™) system. SMPS™ systems measure the size distribution of aerosols. In an SMPS™ system, monodisperse aerosol exiting the Classifier passes to a Condensation Particle Counter (CPC), which measures particle number concentration. By scanning quickly through the selected size range (which varies by configuration), the SMPS measures the size distribution of the aerosol precisely. TSI SMPS was verified to measure NIST-traceable particles accurately (Vasiliou, 2004).

The SMPS series 3938 is capable of measuring particles as small as 1 nm and as large as ~1,000 nm, depending upon which configurable components are used. Installed components are auto-detected. Scanning can be conducted directly from the front screen of the Classifier 3082 for most SMPS configurations, or via the software. Please refer to the [SMPS family specification sheet](#) for more information.



**Top:** Size distribution of atmospheric aerosol in Shoreview, MN, USA over several weeks, as measured by the TSI® SMPS.  
**Bottom:** Number concentration measurements of the same aerosol.

# INNOVATIVE DESIGN

The Classifier 3082 serves as a platform for operating other user-selected components. It contains the power supply, blowers, aerosol neutralizer, touch-screen display, and all instrument controls. The Classifier 3082 allows you to interchange aerosol neutralizers, DMAs, and impactors, with an improved design to provide tool-free installation and auto detection of these configurable components.

You have a choice of four DMAs with Classifier Model 3082:

- + Long DMA 3081A for the broadest particle size range from 10 to 1000 nm
- + Nano DMA 3085A for the high-resolution sizing of ultrafine particles from 2 to 150 nm
- + 1 nm DMA 3086 for high-resolution sizing of particles as small as 1 nm
- + Wide-Range DMA 3083 for the broadest size range possible in a single scan: 10 - 800 nm

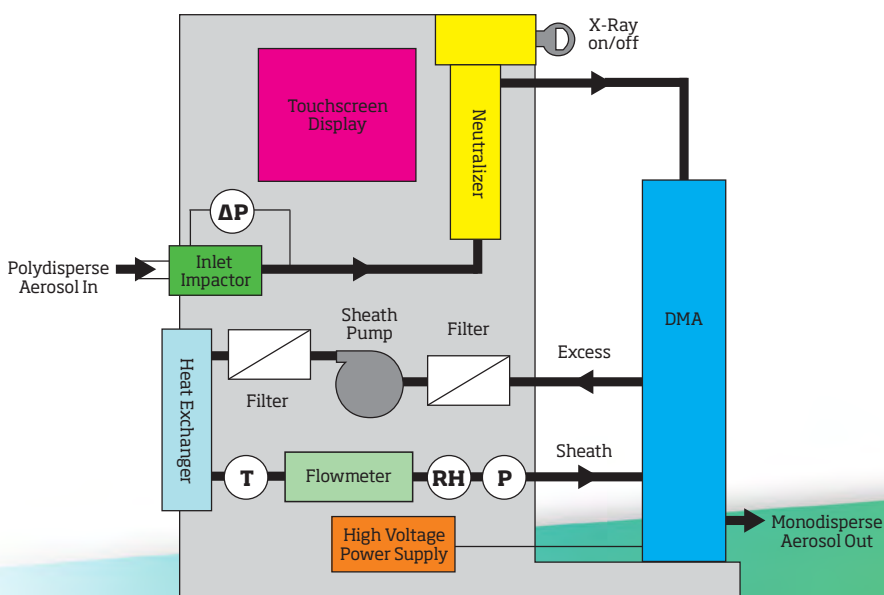
You have a choice of two types of aerosol neutralizers with Model 3082:

- + Aerosol Neutralizers 3077 and 3077A are radioactive Kr-85 bipolar diffusion chargers
- + Advanced Aerosol Neutralizer 3088 is a non-radioactive, soft x-ray bipolar diffusion charger

The DMAs and aerosol neutralizers must be purchased individually. You may also use your own custom DMA with our Electrostatic Classifier.

You have a choice of the voltage polarity used to classify particles. While the standard 3082 has negative polarity at the DMA's center electrode, a dual-polarity option is available. This dual-polarity classifier allows you to simply switch polarity as your research requires.

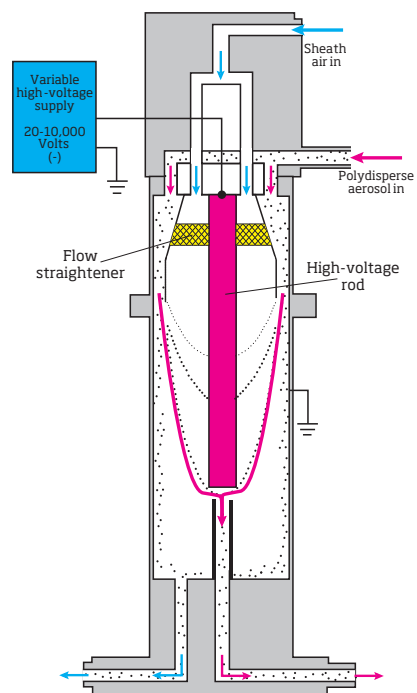
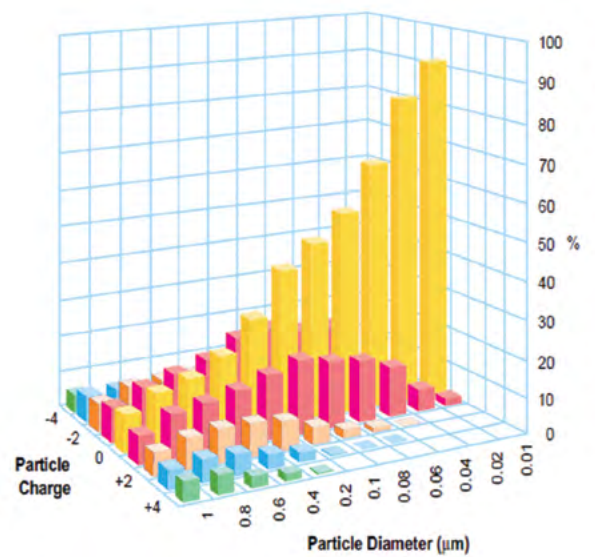
The graphical user interface enables standalone operation for most combinations of components - data logging lets you store more than 200,000 size distribution measurements! Logged data can be transferred easily via the USB port on the Classifier. The SMPS™ system is capable of fast scanning measurements, with less than 10 seconds scanning time.



# PRINCIPLE OF OPERATION

Polydisperse, submicrometer aerosol passes through a bipolar charger, establishing a bipolar equilibrium charge level on the particles. Nearly all particles from 1 to 30 nanometers in diameter receive either a single positive, single negative, or zero charge. Larger particles may carry more than one positive or negative charge. (The equilibrium charge distribution is shown in the figure at the right.) The particles then enter the DMA and are separated according to their electrical mobility. This parameter is inversely related to particle size, and it is also proportional to the number of charges on a particle. Electrical mobility is the preferred mechanism for measuring submicrometer particles, as described in ISO 15900.

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 (optional: negative or positive) power supply (10 to 10,000 VDC). The outer cylinder is grounded. This creates a precise, axially homogeneous electrical field inside the DMA. 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 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. When the optional positive power supply is used for the inner cylinder of the DMA, negatively instead of positively charged particles are selected by the DMA. The electrical mobility and the corresponding size of the particles is selected by adjusting the DMA voltage.



# SPECIFICATIONS

for Electrostatic Classifier 3082 when combined with a selected DMA



		3081A	3083	3085A	3086
<b>General Capabilities</b>	Particle Type	Solids and nonvolatile liquids			
	Particle Size Range (generation mode)	Adjustable from 10 - 1000 nm		Adjustable from 2 to 150 nm	Adjustable from 1 to 50nm
	Maximum Input Concentration*	10 <sup>7</sup> particles/cm <sup>3</sup>			
	Voltage (DC)	10 to 10,000			
<b>Flow Rates</b>	Sheath Air (L/min)	2 to 30	2 to 20	2 to 30	2 to 25
	Aerosol (L/min)	0.2 to 2		0.2 to 5	0.1 - 2.5
<b>Physical Dimensions (DMA only)</b>	Height	61 cm (24 in.)	47 cm (18.5 in.)	20.3 cm (8 in.)	18.7 cm (7.4 in.)
	Outside Diameter (excluding ports)	7.6 cm (3 in.)	13 cm (5.1 in.)	7.9 cm (3.1 in.)	
	Weight	5.5 kg (12 lb)	8.5 kg (18.7 lb)	2.2 kg (4.9 lb)	2.1 kg (4.6 lb)
<b>Aerosol Port Diameters</b>	Polydisperse	1/4-in. OD			3/8-in. OD
	Monodisperse	1/4-in. OD			
	Sheath, Excess Air	3/8-in. OD			
<b>Dimensions of Complete Instrument (3082 with DMA)</b>	Height	64.3 cm (25.4 in.)	52.8 cm (20.8 in.)	40.1 cm (15.8 in.)	
	Width	28.2 cm (11.1 in.)	40.5 cm (16 in.)	28.2 cm (11.1 in.)	
	Depth	40.5 cm (15.8 in.)			
	Weight	19.5 kg (43.0 lbs)	22.7 kg (50 lb)	16.4 kg (36.1 lb)	16.3 kg (36 kg)

\*The input particle number concentration limit is imposed by the neutralizer that precedes the DMA.

## Bibliography

Birmili W, F Stratmann, A Wiedensohler, D Covert, LM Russell, O Berg. Determination of Differential Mobility Analyzer Transfer Functions Using Identical Instruments in Series, *Aerosol Science and Technology* 27:215-223, 1997.

Caldow R and J Blesener. A Procedure to Verify the Lower Counting Limit of Optical Particle Counters, *Journal of Parenteral Science and Technology*, July/August 1989. (TSI paper A62)

Chen D-R, DYH Pui, D Hummes, H Fissan, FR Quant, and GJ Sem, Design and Evaluation of a Nanometer Aerosol Differential Mobility Analyzer (Nano-DMA), *J. Aerosol Sci.* 29(5):497-509 (1998).

Kinney PK, DYH Pui, GW Mulholland, and NP Bryner, Use of the Electrostatic Classification Method to Size 0.1µm SRM Particles—A Feasibility Study, *Journal of Research of the National Institute of Standards and Technology* 96(2):147, March/April 1991. (TSI paper A74)

Liu BYH and DYH Pui. A Submicron Aerosol Standard and the Primary, Absolute Calibration of the Condensation Nuclei Counter, *Journal of Colloid and Interface Science* 47(1), April 1974. (TSI paper A81)

Liu BYH, DYH Pui, and KY Rubow, Performance of HEPA and ULPA Filters, Proceedings of the 1985 annual technical meeting of the Institute of Environmental Sciences. (TSI paper A47)

Pourprix M and J Daval, Electrostatic Precipitation of Aerosols on Wafers, a New Mobility Spectrometer, Proceedings of the 3rd International Aerosol Conference 2:797-800 (1990)

Vasiliou J., An Evaluation of a Scanning Mobility Particle Sizer with NIST Traceable Particle Size Standards, Technical Note-012A, Duke Scientific Corporation (2004).

## TO ORDER

### Electrostatic Classifier Components

Specify	Description
3082	Controller Platform (includes inlet impactor set) without Aerosol Neutralizer or DMA
308202	3082 equipped with dual polarity high voltage

### DMA's (Nominal Size Ranges)

Specify	Description
3081A	Long DMA (10 to 1,000 nm)
3083	Wide-Range DMA (10 to 800 nm)
3085A	Nano DMA (2 to 150 nm)
3086	1 nm DMA (1 to 50 nm)

### Neutralizers

Specify	Description
3088	Advanced Aerosol Neutralizer (soft x-ray)
3077	Aerosol Neutralizer Kr-85, 74 MBq (2 mCi)
3077A	Aerosol Neutralizer Kr-85, 370 MBq (10 mCi)
6005931	Shielding Column (Lead) for use with 3077/3077A neutralizers with 3082 Classifier

### Condensation Particle Counters (CPCs)

Specify	Description
3750	Standard CPC
3752	High-Concentration CPC
3756	Ultrafine CPC
3789	Water-based CPC
3757-50	1nm CPC

### Optional Accessories

#### For Aerosol Generation

Specify	Description
3012	Aerosol Neutralizer
3062	Diffusion Dryer
3074B	Filtered Air Supply
3076	Constant Output Atomizer (recommended to be used with 3074B, 3062, and 3012)
3480	Electrospray Aerosol Generator (recommended to be used with 3074B and Po-210 Aerosol Neutralizer 348002)
3482	Advanced Electrospray Aerosol Generator (recommended to be used with 3074B; contains a soft x-ray aerosol neutralizer)
3940A	Submicron Aerosol Generation System. Includes 3082, 3081A, 3077A, 3012, 3074B, 3076, 3062 and tubing

#### Experimental

Specify	Description
4143	Flow Calibrator
3001788	1/4-inch Conductive Tubing
3001789	3/8-inch Conductive Tubing
3708	Flow Splitter
3068B	Aerosol Electrometer

#### Services

TSI offers maintenance kits, services and service contracts. TSI calibrates the Electrostatic Classifier 3082 in accordance with ISO 15900.

Ask your TSI representative about recommended component configurations.

Specifications subject to change without notice.

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