Knowledge Beyond Measure.

TSI® Particle Technology

Particle Instruments

TSI® Particle Technology

TSI® Incorporated has been a leading developer of aerosol research instrumentation since 1966. TSI® offers a line of particle instruments that is second to none. Our products for sizing, counting, generating, and dispersing aerosol particles are well known—and well respected—all over the world. We are dedicated to providing our customers with the most innovative particle technology available.

This catalog contains TSI's full line of proven particle instruments. Our particle technology is at the forefront of research, enabling our customers to investigate their cutting-edge research questions. Together with our customers, TSI moves aerosol science – and many associated fields – forward.

Browse through the following pages and let us know how we can help you achieve your research goals.

Shoreview | USA
+1 651 483 0900

Aachen | Germany
+49 241 52303 0

High Wycombe | United Kingdom
+44 1494 4 59200

Marseille | France
+33 11 41 19 21 99

Singapore
+65 65956388

Beijing | China
+86 10 8219 7688

Shanghai | China
+86 21 8031 1866

Bangalore | India
+91 80 67877201

Additional contact information appears on the back cover.
Visit our website for the most current product information available:

www.tsi.com

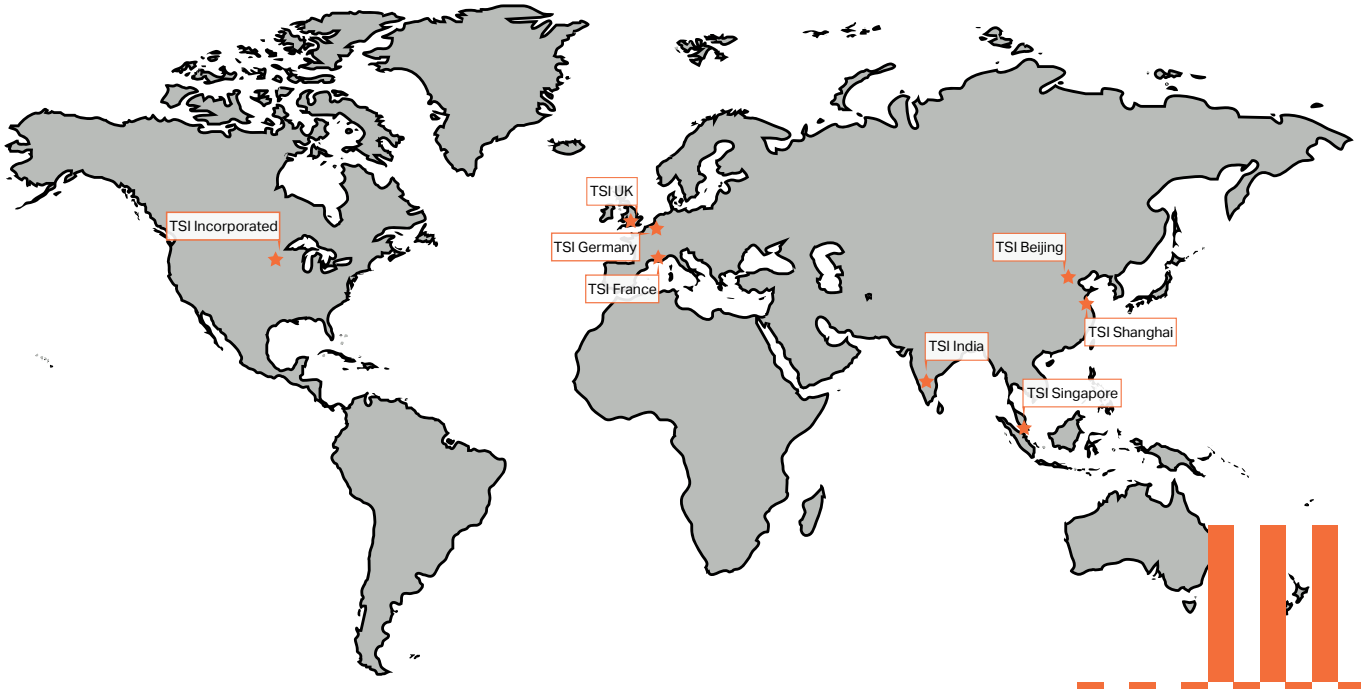


Table of Contents

Applications

Collectively, our line of particle instruments spans the size range from 0.001 to 20 micrometers. This unique and comprehensive family of products is used all over the world in a variety of important and interesting applications.

- Environmental studies
- Filter testing
- Diesel and gasoline engine emissions measurements
- Climate change research
- Particle formation and growth studies
- Indoor air quality testing
- Health effects studies
- Instrument calibration and standards
- Basic aerosol research
- Inhalation or exposure chamber studies
- Parts cleanliness and high-purity process gas testing in semiconductor manufacturing

Ask your TSI® representative for information about specific applications, instrument operation, specifications, or new instruments not included in this catalog. To request additional literature or to place an order, call:

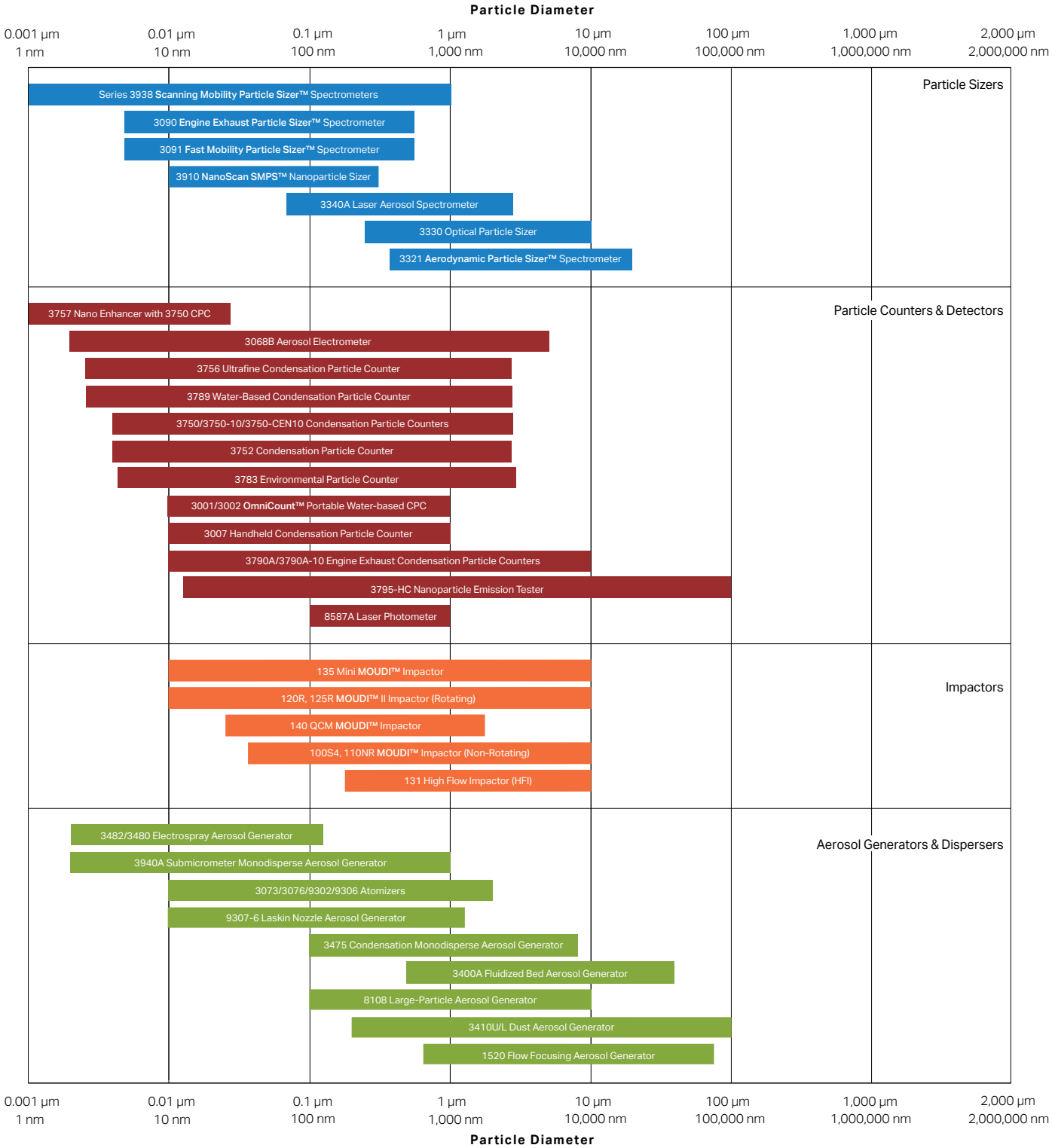
US & Canada:
+1 800 874 2811

Europe:
+49 241 523030

Additional contact information appears on the back cover. Visit our website for the most current product information available:

www.tsi.com

Operational Ranges for TSI® Particle Instruments



Particle Sizers

The most comprehensive selection of instruments for sizing submicrometer and supermicrometer particles
Please see the specification sheets for individual instruments for further details. Other combinations may be available. Contact TSI for more details.

	Sizer	Particle Size Range (µm)	DMA	CPC	Working Liquid	Particle Concentration (Particles/cm³)	Measurement Time (sec)	Resolution (Total Channels Measured)	Channels per Decade	Key Feature
SMPS	3938L50	0.01 to 1.0	3081A	3750	Butanol	1 to 10^7	10 to 600 (Selectable)	Varies by Model, 384 Possible Channels from 0.001 to 1.0 µm Collectively	4, 8, 16, 32, 64, 128 (Selectable)	Highest Resolution; Individual Components Provide Greatest Flexibility
	3938L52	0.01 to 1.0	3081A	3752						
	3938N52	0.004 to 0.15	3085A							
	3938NL52	0.004 to 1.0	3081A & 3085A							
	3938L56	0.01 to 1.0	3081A	3756						
	3938N56	0.0025 to 0.15	3085A							
	3938NL56	0.0025 to 1.0	3081A & 3085A							
	3938L89	0.01 to 1.0	3081A	3789	Water					
	3938N89	0.0022 to 0.15**	3085A							
	3938NL89	0.0022 to 1.0**	3081A & 3085A							
	3938E89	0.0022 to 0.05**	3086							
	3938EL89	0.0022 to 1.0**	3081A & 3086							
	3938E57	0.001 to 0.05	3086	3757 & 3750	Diethylene Glycol & Butanol					
	3938EL57	0.001 to 1.0	3081A & 3086							
	3938W50	0.01 to 0.8*/***	3083	3750	Butanol					
	3938W52	0.01 to 0.8***	3083	3752	Butanol					
	3938W89	0.01 to 0.8***	3083	3789	Water					
NanoScan SMPS	3910	0.01 to 0.42	Built In	Built In	Isopropyl Alcohol	100 to 10^6	60	13	8	Portable
Fast Sizers	3091 FMPS	0.0056 to 0.56	N/A	N/A	N/A	<10^7	1	32	16	Fast Distributions
	3090 EEPS						0.1			
APS	3321	0.52 to 20				0.001 to 1,000	1 Sec to 18 Hours (Variable)	52	32	Aerodynamic Size
OPS	3330	0.3 to 10				1 to 3,000	1 Sec to 24 Hours (Variable)	Up to 16	Variable	Portable
LAS	3340A	0.09 to 7.5				1 to 18,000	1 Sec to 60 Hours (Variable)	Up to 100		Optical to Smaller Sizes

N/A Not Applicable

*The 3938W50 SMPS™ system is available with various combinations of DMA polarity, CPC D50 cutpoint (7 vs. 10 nm), and calibration compliant with CEN/TS 17434. Please contact TSI® for further details.
**User-adjustable D50; 2.2 nm and 7 nm verified by TSI®, but others may be possible.
***Widest range of 10 – 800 nm in one scan; maximum upper size of 1 µm with reduced scan range possible.

Scanning Mobility Particle Sizer™ Spectrometers

Model 3938
Our most versatile submicrometer particle sizers provide the highest resolution and accuracy available.

TSI® Scanning Mobility Particle Sizer™ (SMPS™) systems have advanced to the standard reference in sizing and counting of airborne nanoparticles. The US National Institute of Standards and Technology (NIST), and many other reference laboratories worldwide use the TSI® SMPS™ spectrometers.

It is routinely installed in environmental monitoring stations, filter testers, academic and industrial laboratories. The model 3938 features a selection of modules, which are automatically recognized during setup. It can achieve scan times of as short as 10 seconds while providing a very high size resolution.

Collectively, our series 3938 SMPS spectrometers measure particles from 1 to 1,000 nm. They display data up to 128 channels per decade, having hundreds actual size channels in a single scan. A very wide concentration range is covered, from 1 to 10,000,000 particles/cm^3, depending on CPC model.

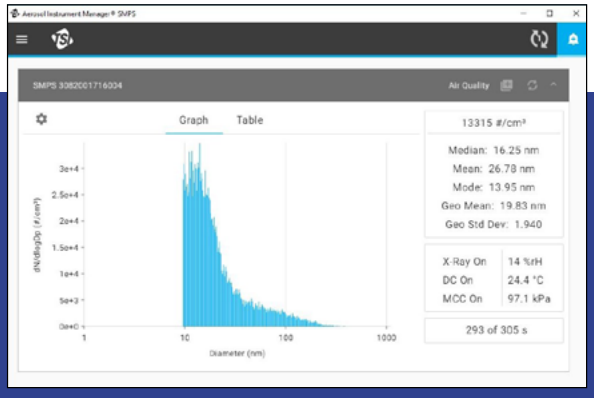
Users may choose among four DMAs, five CPCs, and two different neutralization techniques. This versatility enables you to select a system that best fits your sizing requirements. The Electrostatic Classifier actively measures sheath flow temperature and pressure so that the sheath flow rate stays stable under a variety of conditions.

The components can be combined into a standalone electrostatic classifier for experiments involving monodisperse aerosol generation or measuring the size distribution and counting the total number of particles.

The end result is an unmatched, proven solution for research involving combustion, atmospheric aerosols, indoor air quality, filter testing, and much more.

When an SMPS is coupled with an OPS or APS, the continuous measurement range can be extended up to 10 µm or 20 µm, respectively. Paired with a QCM MOUDI™ real-time impactor, the density of a particular size fraction of particle can be determined in certain scenarios.

1nm SMPS 3938E57



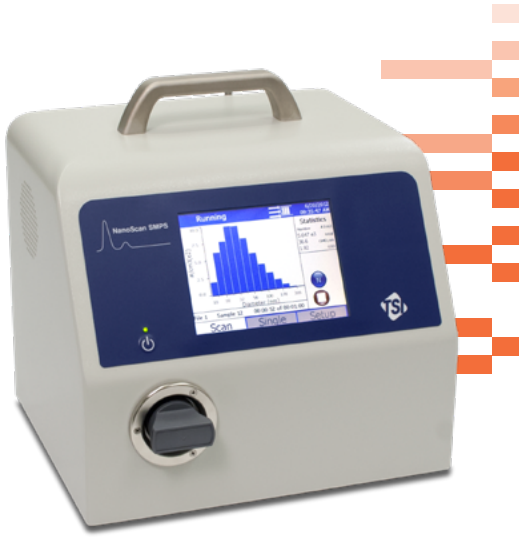
SMPS component systems give you the highest-resolution particle size data available with AIM 11 SMPS software.

SMPS Accessories (available separately)

Specify	Description
3077/3077A	Aerosol Neutralizer
3088	Soft X-Ray Neutralizer

NanoScan SMPS™ Nanoparticle Sizer

Model 3910
Affordable, portable nanoparticle sizer for particles down to 10 nm.

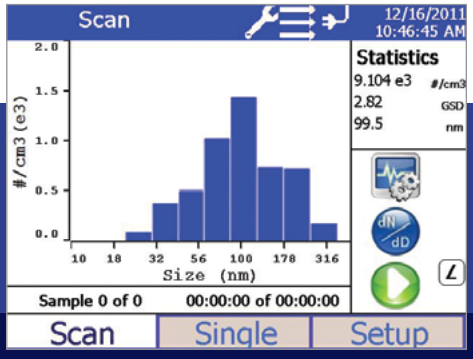


TSI's NanoScan SMPS™ Nanoparticle Sizer opens the door to routine nanoparticle sizing measurements for everyone. This revolutionary sizer adapts the TSI® SMPS™ principle into an affordable, portable package that is about the size of a basketball. Easy to use, lightweight, and battery-powered, the NanoScan SMPS™ Nanoparticle Sizer enables investigators to assess airborne nanoparticle concentration and size in workplaces, schools, hospitalxs, without complicated setups. Size distributions are measured from down to 10 nm for concentrations up to 1,000,000 particles/cm^3. Derived from TSI® core technologies, the NanoScan SMPS is an innovative, cost-effective solution for real-time nanoparticle size measurements.

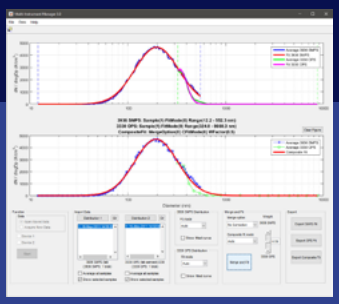
Data collection begins with a touch of the instrument display - no need for a dedicated computer to set up the instrument or save data. The user interface is intuitive and easy for new users to operate. The NanoScan SMPS displays real-time number, calculated surface area, or mass size distributions, concentrations, and statistics. From the front panel, users can program start time, number of samples, and other parameters. A full suite of instrument diagnostic data gives the user security and ensures data quality.

In addition to nanoparticle size distributions, the NanoScan SMPS can collect second-by-second concentration data at a single mobility diameter. For example, if the nanoparticle source of concern generates 50 nm particles, it is possible to easily monitor 50 nm mobility diameter with 1 second time resolution to keep a real-time record of concentration levels.

Combine the NanoScan SMPS and the Optical Particle Sizer 3330 to measure three orders of size magnitude from 10 nm to 10 µm using Multi-Instrument Manager (MIM) software.



Screen shot of NanoScan SMPS during nanoparticle size distribution measurement.



Screenshot of Multi-Instrument Manager (MIM) Software

NanoScan SMPS™ Accessories (available separately)

Specify	Description
3062	Diffusion Dryer
3062-NC	Diffusion Dryer (desiccant does not contain cobalt)

Optical Particle Sizer

Model 3330
Portable and easy-to-use particle sizer for particles 0.3 - 10 µm in size.

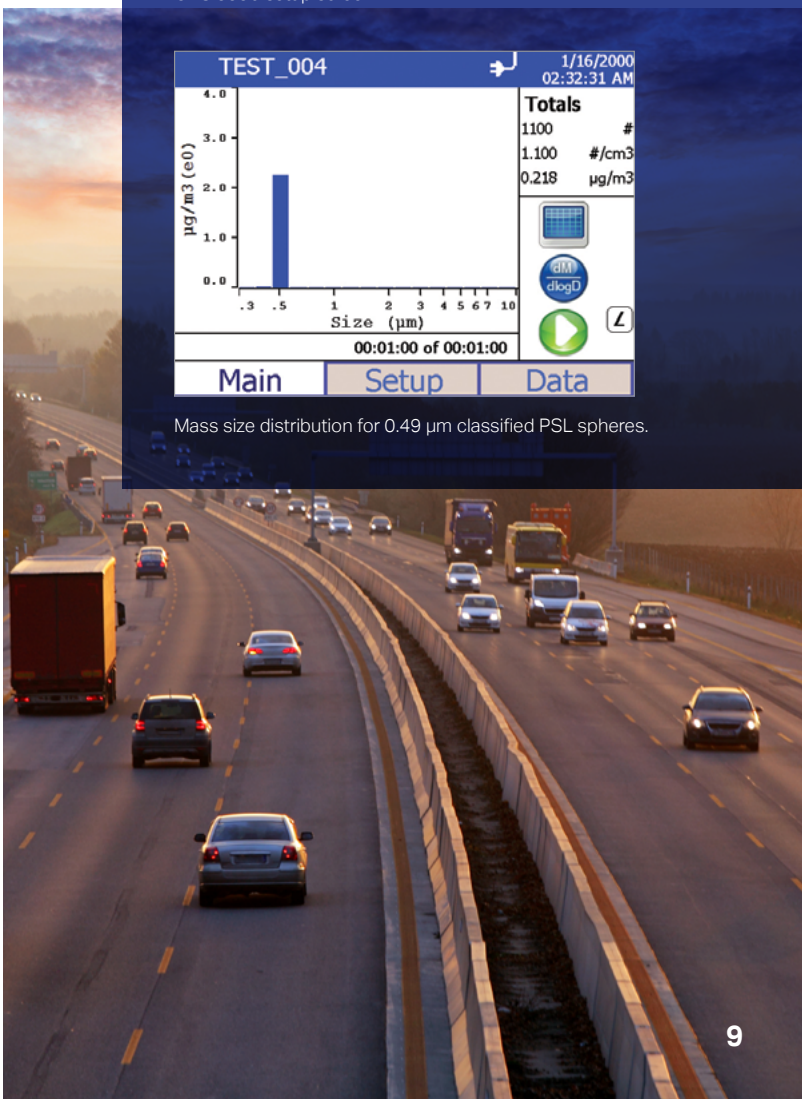
The Optical Particle Sizer 3330 (OPS) is a light, portable unit that uses single-particle counting technology to provide fast, accurate measurement of particle concentration from 0 to 3,000 particles/cm^3 and particle size distribution for 0.3 to 10 µm in up to 16 user-configurable channels. Backed by over 40 years of aerosol instrumentation design experience, the OPS uses state-of-the-art optics with 120° light collection and sophisticated electronics processing resulting in precision, high-quality data. The affordable, easy-to-use package features a color touch screen with an intuitive user interface. Rigorous factory calibration standards ensure measurement accuracy.

The model 3330 includes the ability to enter the index of refraction and shape factor of the aerosol into the software to provide more accurate size distributions. The size boundaries can be adjusted using both real and imaginary components of refractive index through Mie theory calculations. A unique density for every size channel can also be entered into the software to further improve mass concentration measurements.

The model 3330 is manufactured at TSI's ISO 9001 certified facility. It is calibrated according to ISO 21501-1 using NIST traceable PSL spheres and TSI's Electrostatic Classifier and Condensation Particle Counters. PSL is the industry-wide calibration aerosol of choice because it is traceable to national standards throughout the world. Each OPS that leaves the factory is built for longevity, backed by TSI's commitment to quality, and supported by our worldwide network of committed TSI® professionals.

OPS 3330 setup screen.

Mass size distribution for 0.49 µm classified PSL spheres.



Applications

- Filter Testing
- Industrial Measurements
- Hotspots

OPS Accessories (available separately)

Specify	Description
3332-10	10:1 Diluter
3332-100	100:1 Diluter
1130011	Isokinetic Probe for Filter Testing Ducts

Aerodynamic Particle Sizer™ Spectrometer

Model 3321
The way to determine a particle's true airborne behavior is to measure its aerodynamic diameter.

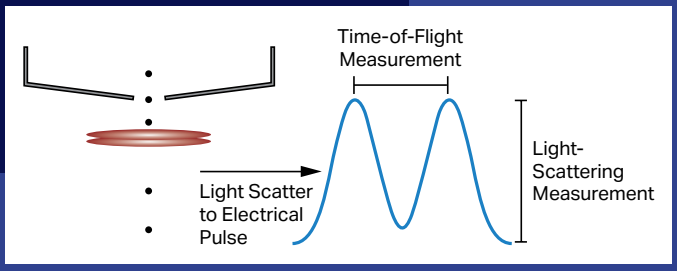
Aerodynamic measurements account for differences in particle size, shape, and density. This is crucial when determining if a particle will penetrate a filter, be removed by a collecting device, or be deposited in the lung. The Aerodynamic Particle Sizer™ (APS™) spectrometer is the only one of its kind and has been used successfully for over 30 years in laboratory and field applications to provide high-resolution, real-time aerodynamic measurements in the range from 0.5 to 20 µm. It also measures side light-scattering intensity in the equivalent optical size range of 0.37 to 20 µm. By providing paired data for each particle, the APS™ opens up exciting new possibilities for aerosol scientists interested in studying the shape and other characteristics of an aerosol.

The model 3321 APS™ spectrometer uses a patented, double-crest optical system for unmatched sizing accuracy. It also includes an optimized nozzle configuration and fast signal processing. The result is greater small-particle sizing efficiency, improved accuracy of mass-weighted distributions, and near elimination of false background counts. The Aerosol Instrument Manager® software provides advanced data-handling capabilities.

The 3321 has a large screen and indicator lights as well as an easy-to-use navigation wheel for simple user operation.

Applications

- Atmospheric Monitoring for Supermicron Particles
- Air Cleaner Performance Testing
- Biological Aerosol Research
- Inhalation Toxicology



3321 APS time-of-flight measurement

APS Accessories (available separately)

Specify	Description
3302A	Aerosol Diluter
3306	Impactor Inlet

APS Accessories

Aerosol Diluter

Model 3302A
Dilutes high-concentration aerosols for use with the Aerodynamic Particle Sizer™ (APS™) spectrometer.

This diluter reduces particle concentrations of high-concentration aerosols, providing a representative sample that meets the flow input requirements of the APS™ spectrometer. The 3302A achieves dilution ratios of 100:1 or 20:1 using easy-to-change capillary tubes. Two diluters in a tandem configuration provide dilution ratios as high as 10,000:1.

Engineered to provide very low particle loss in the 0.5 to 10 µm size range, the Aerosol Diluter is totally self-contained and requires no outside power or compressed gas. Durable construction and simple maintenance procedures translate into years of trouble-free operation. Aerosol Instruments Manager software can correct for diluter losses via provided user-selectable efficiency files.

The model 3302A installs easily on top of the 3321 APS™ instrument for a compact footprint.

Impactor Inlet

Model 3306
Collects a size-segregated sample for mass or chemical analysis while making APS™ measurements.

As an accessory for the APS, the 3306 combines a single-stage impactor with a filter. It takes a size-segregated sample and directs a diluted (80:1), representative portion of the initial test aerosol into the particle sizer for measurement. The inlet aerosol passes through a single-stage impactor (2.5 or 4.7 µm, 50% cut size) and is collected with an after-filter for later mass or chemical analysis. The model 3306 includes two inlet throats: one for standard applications, and the other a USP throat for pharmaceutical research.

The Impactor Inlet 3306 is designed to sit atop the Aerodynamic Particle Sizer™ spectrometer model 3321.

Accessory (available separately)

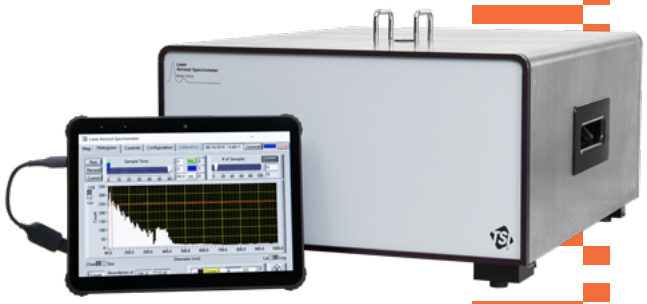
Specify	Description
3033	Vacuum Pump

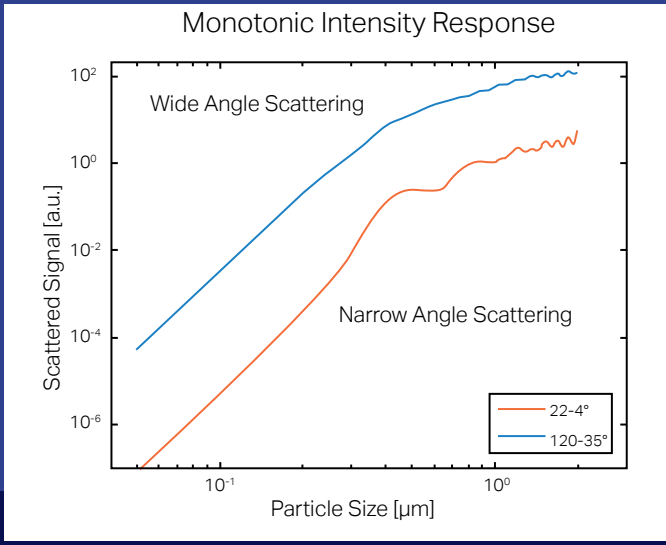
Laser Aerosol Spectrometer

Model 3340A
High-resolution optical particle sizing down to 90 nm.

TSI's Laser Aerosol Spectrometer (LAS) 3340A is a high-sensitivity, high-resolution optical particle sizer. This "turn on and measure" instrument allows users to easily measure particle size distributions from 0.09 (90 nm) to 7.5 µm in 100 user-configurable size channels in seconds. The patented intracavity laser and advanced optics overcome the limitations of conventional optical particle counters, and enhance the resolution and sensitivity of detection.

The 3340A is an essential tool to have for monitoring your filters or your processes, measuring in a lab, or sampling on field campaigns. The Laser Aerosol Spectrometer has become a de facto standard in air cleaner testing for Clean Air Delivery Rate (CADR).

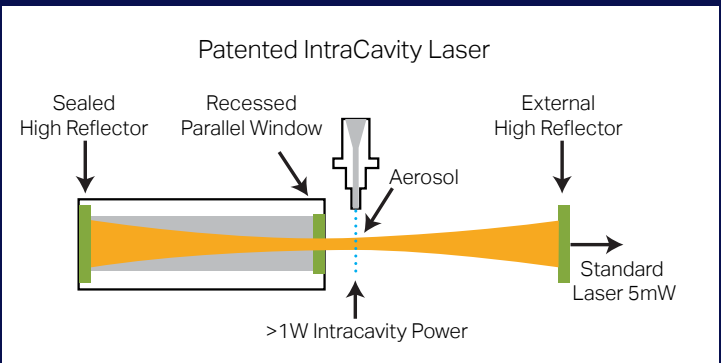




The 3340A uses a wide angle light collection to get a monotonic response over a wide range of particle sizes.

Accessory (available separately)

Specify	Description
1140001	Isokinetic Coupler (Used with 3302A Diluter for AHAM AC-1 Testing)



The Laser Aerosol Spectrometer uses a He-Ne laser with a novel intracavity laser design to achieve higher light scattering sensitivity at a lower laser power.

Fast Mobility Particle Sizer™ Spectrometer

Model 3091
Measures size distribution and number concentration of rapidly changing, submicrometer aerosol particles in real time.

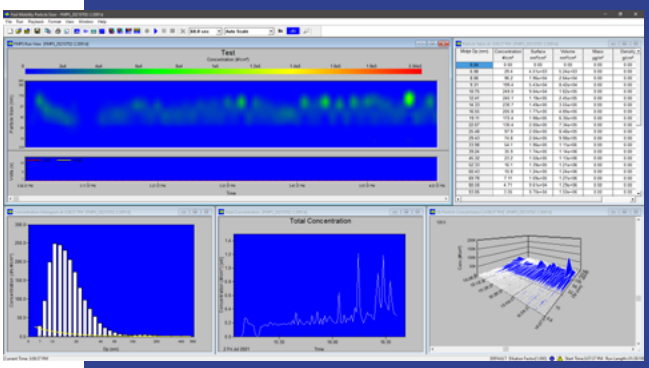
The Fast Mobility Particle Sizer™ (FMPS™) spectrometer measures particles in the range from 5.6 to 560 nm, offering a total of 32 channels of resolution (16 channels per decade of size). This submicrometer particle sizer uses an electrical mobility measurement technique similar to that used in the SMPS™ spectrometers. However, instead of a CPC, the model 3091 FMPS™ spectrometer uses multiple, low-noise electrometers for particle detection. This produces particle-size-distribution measurements with 1-second resolution, providing the ability to visualize particle events and changes in particle size distribution in real time.

The model 3091 operates at a high flow rate (10 L/min) to minimize diffusion losses of ultrafine and nanoparticles. It operates at ambient pressure to prevent evaporation of volatile and semivolatile particles. It requires no consumable working fluids. Plus, it uses an efficient pair of unipolar chargers to eliminate the need for a radioactive neutralizer.

The FMPS™ spectrometer is easy to transport, set up, and operate. It can be configured to measure single or multiple runs continuously for up to 12 hours. Its large, color-LCD display and built-in control knob provide easy access to instrument functions, and data displays. The FMPS™ software highlights include a variety of graphing options, including 3-D playback of size distribution and concentration versus time, data export capabilities, and the ability to input individual effective densities per channel to calculate a continuous output of total particulate mass.

All of these features make the FMPS spectrometer appropriate for a variety of applications, especially particle formation and growth studies, indoor air quality measurements, environmental research, inhalation toxicology studies, urban canyon studies, and transient emission studies from stacks, boilers, and wood burners.

Developed by TSI Incorporated under license from Airel, Ltd. of Tartu, Estonia.



FMPS™ software offers advanced options for data display, such as Run View, concentration histogram, and 3D particle concentration graphs.

Accessory (available separately)

Specify	Description
1137021	Flow Adjustment Accessory (for Sample Flows Less than 10 L/min)

Particle Counters and Detectors

In environmental research and monitoring, researchers face high concentrations in city centers, near freeways or harbors, or alternatively very low concentrations in remote locations which are used as reference sampling points.

In the laboratory, particle counters are often combined with other components in order to measure particle size distributions. Users in workplaces, hospitals, schools, homes and other sensitive environments may prefer water-based Condensation Particle Counters to ensure the occupants' safety and health. Combustion aerosols provide their own unique challenges, such as in sampling of the high temperature, humidity, and concentration aerosol without changing it, or complying with strict regulatory directives for engine exhaust emissions.

Condensation Particle Counters

TSI® introduced its first Condensation Particle Counter (CPC) in 1978. Since then, we have continuously developed the technology further, working together with the research community along the way. Today we have the most modern, reliable and successful selection of CPCs, operating with water, butanol, isopropanol or diethylene glycol.

The applications for CPCs are very numerous. They are used around the world to count particles in air accurately – in laboratory setups, in sensitive environments (schools, workplaces), in vehicle emissions, or outdoors to monitor air quality. Our CPCs detect particles as small as 1 nm, count particles at up to 50 Hz and can handle concentrations up to 10^7 particles/cm^3.

TSI® has a great depth of experience in designing and manufacturing CPCs and in supporting users in their CPC applications. With so many choices, let us help you to find the solution for your measurement challenge.

Models 3001 & 3002
For aerosol researchers, environmental, and health professionals, OmniCount™ Portable Water-based Condensation Particle Counters deliver accurate, portable, and cost-effective ultrafine particle (UFP) measurements.

Built for real-world use, the OmniCount™ PWCPCs maintain measurement accuracy during jostling and tilting and operate for more than four hours on battery power, making them suitable for both mobile and stationary applications where power may be limited. Bluetooth connectivity enables seamless, wireless data monitoring for efficient field and lab workflows.

Using distilled water simplifies operation, lowers consumable costs, and enhances safety and sustainability—making them ideal for routine monitoring, teaching labs, and expanding research teams.

The dual-channel OmniCount™ 3002 enables simultaneous UFP measurements in two environments, perfect for Personal Protective Equipment (PPE) fit assessment, indoor/outdoor air quality evaluation, and other comparative studies.

Applications

- Personal and mobile UFP monitoring
- Outdoor and indoor air quality monitoring
- Field and remote measurement campaigns
- Occupational health and safety
- Academic research and teaching
- Real-time PPE & filter assessment

CPC Comparison Chart

Please see the specification sheets for individual instruments for further details..

Specifications	3001 & 3002	3007	3750	3750-10 & 3750-CEN10*	3752		3756		3757-50**	3790A/ 3790A-10	3783		3789	
D50 Min. Size (nm)	< 10	10	7	10	4		2.5		1****	23/10	7		2.2, 7, custom	
Max. Concentration (particles/cm³)	200,000†	100,000	100,000	100,000	100,000; up to 10^7 ***		300,000		300,000	10,000/50,000	1,000,000		200,000	
Concentration Accuracy (%)	+/- 20%	± 20	± 5	± 5	± 5; ± 20***		± 10		± 10; ± 15***	± 10	± 20		± 5	
Sample Flow (L/min)	0.1	0.1	1.0	1.0	0.3		0.05		1.0	1.0	0.12		0.3	
Total Inlet Flow Mode (L/min)	0.1 L/min	0.7	1.0	1.0	0.3	1.5	0.3	1.5	2.5	1.0	0.6	3.0	0.6	1.5
Response – T95 (s)	< ~5s	< ~3	~2	~2	< 4	< 3	< 3	< 1	< 4	< 5	< 5	< 3	< 1	
Response – T10-T90 (s)	< 2	< 1.1	< 1	< 1	< 2	< 1.5	< 2	< 0.2	1.5	< 1.6	< 0.7		0.6	
Flow Source	Internal	Internal	External	External	Internal				External	External	External		Internal	
Working Fluid	Water	Isopropyl	Butanol						Butanol and DEG	Butanol	Water			
Weight	3001/3002: 0.85/1.0 kg (1.87/2.2 lbs.)	1.7 kg (3.7 lbs.)	6.6 kg (~14.6 lbs.)	6.6 kg (~14.6 lbs.)	9.1 kg (~20 lbs.)				<20 kg (<44 lbs.)	5.5 kg (12 lbs.)	~10 kg (~22 lbs)		8.2 kg (18 lbs.)	
Display	Digital LCD	Digital LCD	Embedded touch display							LCD	Embedded touch display			
Data Logging/ Storage	Internal memory	Internal memory	Internal memory							SD/MMC flash card	Flash Drive		Internal Memory	
TSI SMPS Compatibility	No	No	Yes (3082 classifier)							No	No		Yes (3082)	
Pulse Height Monitor	Yes	No	Yes							Yes	Yes			
Sample Speed (Hz)	10	1	50							10	1		50	
Additional Features	Battery-powered operation; single/ dual channel. OmniCount Software	Battery-powered operation	Onboard flash data storage for standalone operation. Remote control via USB or Ethernet possible with AIM 11 CPC software or JSON command set, RS232 for serial command set							PMP/ ISO 27891 compliant for 23 nm/10 nm	Water use ~ 250 mL/ wk.		(same as 3750x-series)	

T95 indicates the time to get from 0 - 95% of the concentration; T0-T95.

*3750-CEN10 is available by applying a CEN calibration to an otherwise-standard 3750-10

**Model 3757 Nano Enhancer also available for purchase separately

***3752: Above 100,000 particles/cm³ the 3752 uses photometric mode which has concentration accuracy of ±20%
3757-50: is concentration-dependent ± 10% below 1.65 x 10^5 particles/cm³; ± 15% at 3 x 10^5 particles/cm³

****1.4 nm electrical mobility diameter, 1.1 nm geometric diameter. Verified with NaCl particles

†At 25°C, with fully saturated wicks. Absolute accuracy decreases with two or more of the following occurring simultaneously: partially saturated wicks, elevated temperatures, and elevated concentrations.

Aerosol Electrometer

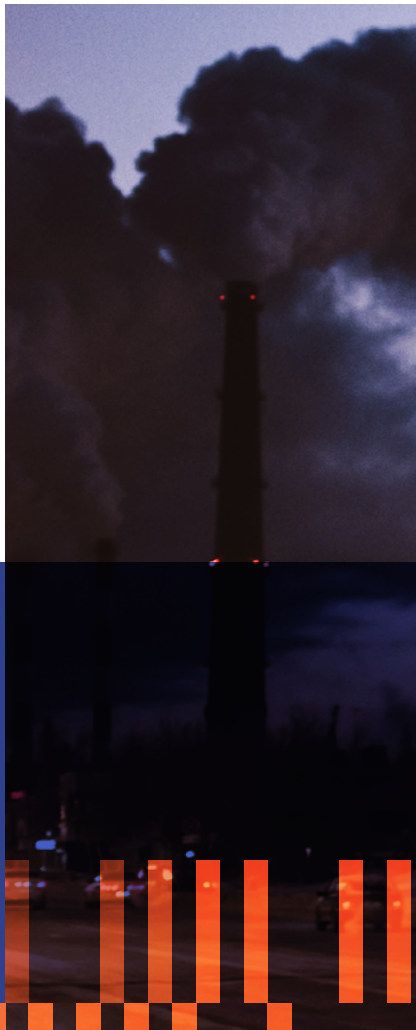
Model 3068B
A reference standard for measuring the total amount of charge on aerosol particles.

This reference instrument provides accurate measurements of total net charge on aerosol particles from 0.002 to 5 µm. In combination with a monodisperse aerosol generator, it serves as a particle number concentration reference standard.

- High sensitivity of ±1 fA
- Wide dynamic range with no range settings (±12,500 fA)
- Temperature stabilized to significantly reduce drift
- Automatic flow control (0.3 to 10 L/min) with accuracy down to ±3 %
- Low internal particle losses
- Fundamental particle concentration measurement when used along with a TSI® Electrostatic Classifier. Cannot be used as a detector in a Scanning Mobility Particle Sizer™ spectrometer
- Wide particle size range (0.002 to 5.0 µm)
- Compatible with TSI® AIM software

Accessory (available separately)

Specify	Description
3033	Vacuum Pump



Laser Photometer

Model 8587A
A compact, reliable photometer for a variety of applications, including customized filter testing.

This photometer features a reliable laser diode that produces constant laser power, so aerosol concentration measurements remain stable over a long period of time. An advanced sheath-air design keeps the optics clean for low background levels and minimal maintenance requirements. The electronics allow for exceptionally high dynamic range and low noise.
The 8587A uses an internal switching valve to measure two aerosol streams, for example, both the upstream and downstream aerosol concentration in fit test chamber or filter testing applications. A special high-speed "purge" mode shortens the purge time when switching between upstream and downstream measurements. A simple serial command set can be incorporated into a custom computer program to give you complete flexibility in control and data management.

Accessory (available separately)

Specify	Description
3032	Vacuum Pump

Air Filter & Respirator Testers

Our automated air filter and respirator testers are known for easy, efficient, and reliable operation. Aside from automated testers, other components relevant to filter testing - for example, the Optical Particle Sizer 3330 - are also available individually.

Model	8130A[a]	8150	3160
Measurement Application	Loading and Quality Control Tests	Rapid Production Line Quality Control Tests	MPPS , Fractional-Efficiency Testing, Single-Size Quality Control Testing
Maximum Efficiency[b]	99.9995% (oil aerosol)		99.999999+%
Aerosol Type[c]	DOP, PAO, DEHS, Paraffin, and other Oils or NaCl	DOP, PAO, DEHS, Paraffin, and other Oils	DOP, PAO, other Oils, or NaCl, PSL
Aerosol Generation	Atomizer		Atomizer with Classifier
Count Median Diameter[d]	0.185 µm (NIOSH Oil) or 0.075 µm (NIOSH NaCl)	0.185 µm (NIOSH Oil)	Monodisperse, selectable from 0.01 to 1 micron
Geometric Standard Deviation[d]	≤1.6 (Oil) or ≤1.86 (NaCl)	≤1.6 (Oil)	≤1.1
Flow Rate	10 to 110 L/min	10 to 120 L/min	5 to 100 L/min
Resistance	0 to 255 mm H_2O (0 to 2500 Pa)		0-150 mm H_2O (0-1470 Pa)
Particle Detection	Forward Light Scattering Photometers		Condensation Particle Counters
Typical Test Length	10 sec to > 2 hours	3 to 10 sec[e]	30 sec to hours
Data Reporting	Touch Screen, Modbus TCP, and RS-232	RS-232, Modbus TCP, Relay logic	PC with Integrated Software
Operation	Stand-alone Reference Tester	Automated Production Lines	Stand-alone Tester
Application Examples[f]	US 42 CFR part 84, EN 13274-7, JMOL, ISO 23328-1	US 42 CFR part 84, EN 13274-7	EN 1822 part 3, NFPA 1971, ASTM F2299, ISO 29463 part 3, ISO 21083-1

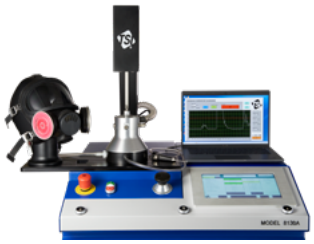
a) EN versions (for equivalent results to EN 143 standard) available (8130A-EN)
b) Efficiencies higher than 99.9999% require longer than typical testing times
c) Aerosol abbreviations: DOP (dioctyl phthalate), PAO (polyalpha olefin), DEHS (di-ethylhexyl sebacate)
d) EN version CMD and GSD are different. See spec sheet for more info.
e) Testing speed depends on the operational settings and optimization of integration into the production line
f) Not an exhaustive list. Contact TSI for other applications

Automated Filter Testers

Models 8130A & 8130A-EN
Filter testers for commercial respirator, flat sheet media, military mask testing and more.

The Automated Filter Tester 8130A continues to be the best solution for testing particulate respirator filters, disposable filtering facepieces, and a wide assortment of filter media. The tester provides measurements of filter penetration and filter pressure drop for the media (or finished filter) under initial or loading test conditions. It has a high degree of automation and self-diagnostics that greatly simplify operation, increase throughput, and improve overall measurement performance. The built-in capability to test with salt and oil means that just one unit is needed to test your product to: US 42 CFR 84, GB2626, JMOL, EN 13274-7, ISO 23328-1 and more.

Optional Accessory: Respirator Leak Tester 8119A
The 8119A enables you to verify the integrity of respirators with ease, giving you the confidence that your equipment is up to the task. For example, after maintenance or repairs, you need to be certain that your respirators are still providing the protection they were designed for. The 8119A allows you to conduct crucial tests to verify that your equipment is in top condition.



Accessories (available separately)

Specify	Description
8118A	Salt Generator
8119A	Respirator Leak Tester
8233	Oil Aerosol Generator
8107	External Adapter
8118A-EN	Salt Generator for EN Standards;
1081414R-EN	Oil Generator for EN standards;
8130A-P1197	Pump Relocation Kit;
8130A-NOISE	External Pump Noise Isolation Box

Model 8150
Taking high performance from the lab to the production line.

The Automated Filter Tester 8150 is designed for 100% quality assurance testing of P100, FFP3 and P3 and similar respiratory filters and cartridges directly in the production line. Applications include detecting defects from the manufacturing process such as cracks in filter media pleats, gaps in the adhesive or assembly defects, or media that does not meet performance specifications. While optimized for high-volume throughput and around-the-clock remote operation, the 8150 also provides penetration measurement results matching those provided by the well-established 8130A used in the quality control lab. The 8150 is a highly compact and configurable automated filter tester that can easily be retrofitted into any existing production line.

As an oil (DOP, Emery, DEHS, Paraffin, etc.) only tester, the 8150 complies with standards such as NIOSH 42 CFR 84 and EN 13274-7.

The Production Line Simulator 8150-PLS enables the Automated Filter Tester 8150 to be operated outside of the production line environment for maintenance, troubleshooting, or determination of optimal settings during process characterization.

8150 Accessory (available separately)

Specify	Description
8150-PLS	Production Line Simulator (PLS)

Model 3160
Determines penetration vs. particle size of filters and filter media.

The Automated Filter Tester 3160 is the most advanced tester available for challenging filters and filter media with submicrometer aerosols. It can be used to test both low- and high-efficiency filters and filter media, up to 99.999999+% efficient, or penetrations down to 0.000001% or lower.

The 3160 uses a bank of atomizers - three for oil (alcohol-based) solutions and three for salt (water-based, including PSL) solutions - and the TSI® 3082 Electrostatic Classifier to challenge a filter or filter media with monodisperse particles. Two 3750 Condensation Particle Counters (CPCs) simultaneously count the number of particles upstream and downstream and software calculates the penetration value at each size. Filters can be sequentially challenged with up to 11 different monodisperse particle sizes from 10 nm to 1000 nm. At the end of a test, the 3160 generates a curve of penetration vs. particle size and produces a summary of test results, including the most penetrating particle size (MPPS). The quick test mode allows rapid testing of multiple samples at a single particle size, while minimizing operator exposure to aerosol. Test results can be automatically saved in a Microsoft® Access® data base and downloaded into Microsoft® Excel®.

The 3160 is often used for EN 1822-3, ISO 21083-1, and ISO 29463-5, and provides the most complete information on filter penetration available from any filter tester. You'll find it invaluable for product development and quality control.

Engine Emissions & Non-Exhaust Emission Instruments

Engine Exhaust Particle Sizer™ Spectrometer

Model 3090
The best tool for measuring transient particle emissions and characterizing exhaust after-treatment devices in real time.

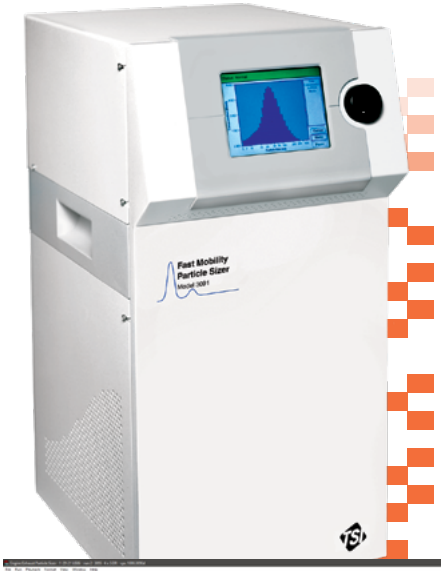
The Engine Exhaust Particle Sizer™ (EEPS™) spectrometer measures the size distribution of engine particle emissions in the range from 5.6 to 560 nm at 10 Hz. Users can visualize and study the dynamic behavior of emissions that occur during transient test cycles, such as changes in engine speed, or load. They may also measure emissions that occur during the first few seconds of a cold start or during regeneration of a particle trap or diesel particulate filter (DPF).

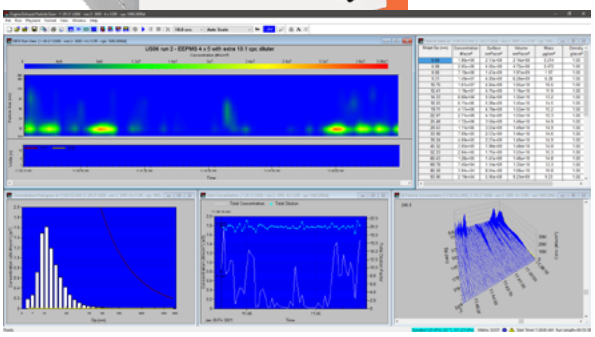
Measurements are displayed with high size resolution (32 total channels, 16 channels per decade of size). The EEPS™ spectrometer operates over a wide particle concentration range, which makes it well-suited for measuring upstream and downstream of a particle trap or DPF to determine soot loading and removal efficiency. The EEPS™ spectrometer operates at ambient pressure to prevent evaporation of volatile and semivolatile particles, requires no consumable working fluids, and uses a pair of efficient, unipolar chargers to eliminate the need for a radioactive neutralizer. Users can select from multiple inversion matrices tailored to specific aerosols for more accurate measurements.

Like its sister instrument the Fast Mobility Particle Sizer (FMPS), the EEPS is a very easy-to-use device. All components, including the vacuum source, are housed in a single cabinet that weighs just 32 kg (~70 lbs). Just turn on the power and allow the instrument to warm up. An onboard Digital Signal Processor (DSP) inverts the raw data in real time to reduce data processing delays for faster results. The EEPS also features an external "start" input trigger for remote operation, two analog inputs to log and correlate other engine parameters, and four user-configurable analog outputs to integrate emission measurements with the test cell host computer.

The EEPS software allows users to display measurements in a variety of graphical and tabular formats, including 3-D viewing of size distribution and concentration versus time. These can be replayed for a unique "movie" view of the entire engine cycle, or you can zoom in on a period of interest. The software includes a data export capability and allows users to input individual effective densities per particle size channel to calculate a continuous output of total particulate mass.

The EEPS spectrometer was developed by TSI Incorporated under license from Airel, Ltd. of Tartu, Estonia. Additional assistance was provided by the University of Minnesota Center for Diesel Research.





Applications

- Gasoline Direct Injection Engine Emissions
- Diesel Exhaust
- Brake and Tire Emissions
- Cold Start Emissions
- Engine and After Treatment Development
- Tobacco and E-Cigarette Emissions

Porous Tube Thermodiluter

Model 3098
The 3098 Porous Tube Thermodiluter (PTT) is the next generation sample conditioning system specifically designed for the 3090 Engine Exhaust Particle Sizer™ (EEPS™) spectrometer to characterize advanced combustion designs and solid particle emissions from modern engines.

The PTT employs two low-loss solid-state porous tube diluters with a catalytic stripper (CS) to remove volatile species along with advanced mass flow controllers to provide real-time dilution ratio measurement and control from 10:1 up to 500:1. Three different heated sample line length choices are available, and the system has been fully characterized for losses. Operation is intuitive with the familiar EEPS software or via AK commands provided by the test cell controller.

When the 3098 PTT is combined with the 3090 EEPS, the Model 3095 Engine Exhaust Particle Measurement System (EEPMS) is created.

Model 3095S

Models

Specify	Description
3098S	PTT with 2.5 m heated sample line
3098M	PTT with 4.0 m heated sample line
3098L	PTT with 6.0 m heated sample line
3095S	EEPMS (PTT and EEPS) w/2.5 m HSL
3095M	EEPMS (PTT and EEPS) w/4.0 m HSL
3095L	EEPMS (PTT and EEPS) w/6.0 m HSL

PTT Accessories (available separately)

Specify	Description
3074B	Filtered Air Supply
3098-MFC	Spare Mass Flow Controller Module
3098-PR	Pressure Reducing Device (for pre-GPF/DPF measurements)
3098-EX	Exhaust Venting Kit (send instrument exhaust to a duct)

Applications

- Diesel, Gasoline, Hydrogen, and Compressed Natural Gas Engine Exhaust Measurements
- Cold Start Engine Emissions
- Sub-23nm Solid Particle Emissions
- Non-Road Machinery Emissions
- Exhaust After-Treatment (DPF or GPF) Characterization
- Aircraft Engine Emissions
- Brake and Tire Wear Particle Emissions
- EV Battery Fires

Engine Exhaust Condensation Particle Counters

Models 3790A and 3790A-10
The particle number (PN) concentration benchmark for UNECE Regulations 83 and 49.

The Engine Exhaust Condensation Particle Counters (EECPCs) accurately measure PN concentration of exhaust emissions. In fact, the GRPE Particle Measurement Programme (PMP) concluded that PN measurements using a CPC plus evaporation tube are 20 times more sensitive and much less variable than the traditional mass (PM) method (i.e., gravimetric filter analysis*). As a result, the measurement of solid PN emissions is part of Regulation 83 (Euro 6) for certification of new passenger vehicles, and Regulation 49 (EURO 6) for heavy-duty engines. Upcoming EURO 7/VII regulations are expected to reduce the cutpoint of the PN emissions down to 10 nm, for which the model 3790A-10 is now available.

The models 3790A and 3790A-10 EECPCs are fully compliant with PMP requirements incorporated in current and upcoming EURO regulations for light duty vehicles and heavy duty engine certification. The models 3790A/3790A-10 EECPCs incorporate a wide assortment of features such as an anti-spill design, condensate removal, removable saturator for ease of maintenance, built-in microprocessor with USB and RS-232 communication interfaces, touch-panel membrane keys and a display that enables instrument set-up, viewing particle concentration and count data, interrogating instrument status, and data storage capabilities. The EECPC includes our Aerosol Instrument Manager® software. An external vacuum pump is required to operate these CPCs.

3790A shown

Models

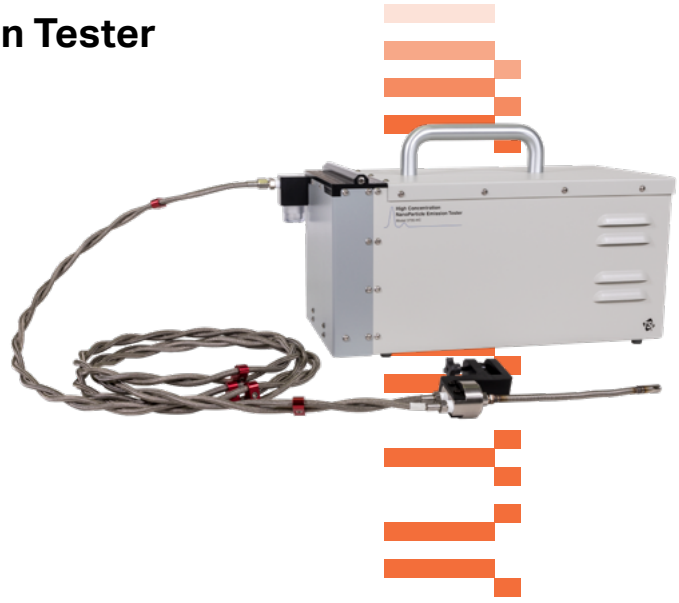
Specify	Description
3790A	23 nm EECPC (up to Euro 6/VI)
3790A-10	10 nm EECPC (upcoming Euro 7/VII)

EECPC Accessory (available separately)

Specify	Description
3032	Vacuum Pump

*Particle Measurement Programme (PMP) Heavy-duty Inter-laboratory Correlation Exercise (ILCE_HD) Final Report

Engine Exhaust Nanoparticle Emission Tester



Model 3795-HC
Solid Particle Measurements
Sampling from combustion sources is often challenging due to the presence of volatile material in the exhaust gas. Volatile components are extremely sensitive to sampling conditions and can grow existing particles and form new particles by nucleation. By oxidizing away volatile components and particles, the Nanoparticle Emissions Tester (HC-NPET) 3795-HC measures only the remaining solid particles, using the same core technology as our research grade CPCs.

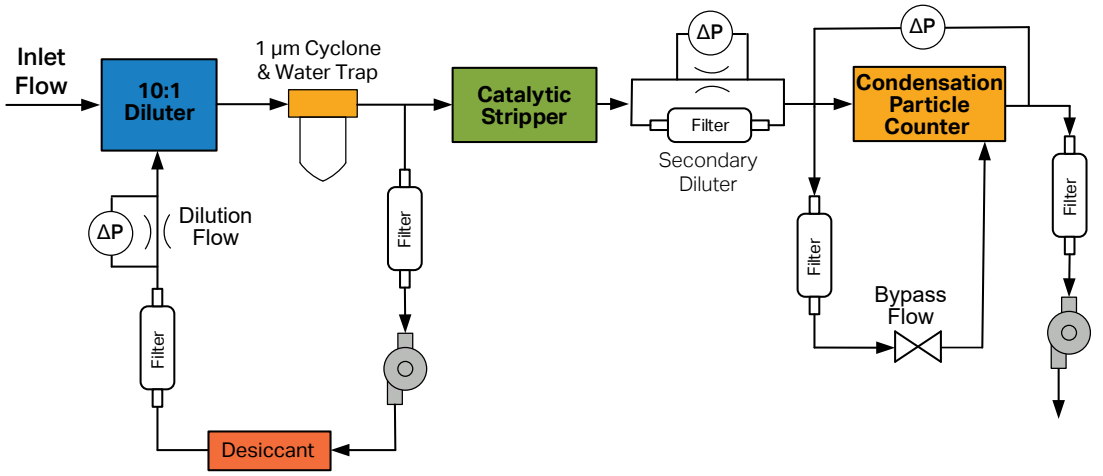
Portable and Accurate
The 3795-HC helps you bring laboratory-grade particle counting to your worksite.

The HC-NPET features a sampling probe compatible with tailpipes, 200:1 dilution permitting measurements up to 100,000,000 particles/cm^3, and a catalytic stripper to remove volatile particles.

General Emissions Testing
The High-Concentration NPET 3795-HC was developed to assist DPF manufacturers, engine developers and fleet managers to assess nanoparticle emissions and the efficiency of after-treatment systems. It can also be used to characterize various emission sources, such as wood stoves, biomass burning, or waste conversion power plants.

Accessory (available separately)

Specify	Description
3795-TAB	Tablet PC



Schematic of NPET 3795-HC

Environmental Air Monitors

Ultrafine Particle Monitors

Model 3750-CEN10
As a first step in harmonizing the measurement of ultrafine particles (UFPs) in the atmosphere, the European Committee for Standardization (CEN) created the European Norm EN 16976 (formerly known as CEN/TS 16976) which defines a set of requirements for the Condensation Particle Counter (CPC) and the sampling system.

The model 3750-CEN10 CPC is fully compliant with EN 16976. Your order includes the verification and calibration by the World Calibration Centre for Aerosol Physics, Leibniz Institute for Tropospheric Research (TROPOS).

Environmental Particle Counter

Model 3783
Ultrafine particles are omnipresent in our atmosphere, and their number concentration can be very strongly influenced by weather and local particle sources, such as traffic. The Environmental Particle Counter 3783 was developed especially for near-freeway monitoring, i.e. continuous and routine monitoring of particle number concentration in high-concentration environments.
The design of this instrument considered everything from the variable configuration of the sampling inlet to mounting the instrument into the standard racks of monitoring containers.

Ultrafine Particle Monitoring

Complete Monitoring Solutions from a Single Source
Monitoring the quality of the air we breathe is crucial to maintaining public health. Ultrafine particles (UFPs) are one of the most important air pollutants, as they can negatively impact human health.

TSI provides a robust remedy with the Scanning Mobility Particle Sizer™ (SMPS™) spectrometers, CPCs, sampling systems, and accessories which help you reliably monitor ultrafine particles in the atmosphere. These systems offer:

- Continuous unattended operation - critical for air quality monitoring
- Durability - no need to be onsite unscheduled
- Remote access data - monitoring from your office
- Ease of maintenance - documentation and video available to enable DIY maintenance
- Reference solution - established global install base, acceptance by air quality monitoring researchers the world over

We Have a Solution that Meets your Individual UFP Monitoring Needs

Sampling
The Sampling System for Atmospheric Particles 3750200 conditions the aerosol according to EN 16976 such as requiring less than 30% particle loss for 7 nm particles and an aerosol dryer. It can be combined with the 3750-CEN10 CPC but also with other nanoparticle instrument from TSI® such as the SMPS™ spectrometer or Model 3783 EPC.

Sizing
See page 6, "Particle Sizers," for offerings.

Counting
See page 14, "Particle Counters and Detectors" and page 26, "Environmental Air Monitors," for offerings.

Accessories
See page 38, " Instruments & Accessories," for offerings.

Don't see what you need? Contact TSI for expert guidance.

Cascade Impactors

Airborne particulate matter affects each of us in numerous ways. Characterizing that particulate matter, in terms of its mass and/or chemical content, gives us insight into ambient air quality, atmospheric composition, vehicle emissions, industrial particle emissions, and many more applications.

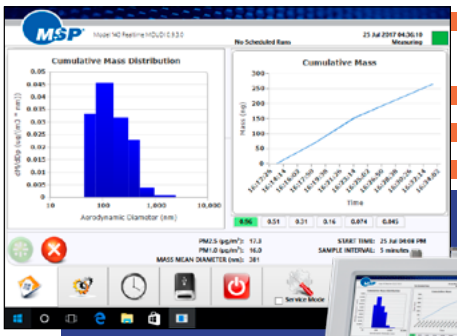
For over 30 years, Micro-orifice Uniform Deposit Impactors (MOUDI™) impactors manufactured by MSP® have been widely used for collecting airborne particles in a size-segregated fashion, allowing researchers to learn more about the morphology and chemical composition of the sampled particles. Each MOUDI™ stage has thousands of precision drilled holes to reduce pressure drop and increase uniformity of particle deposition.

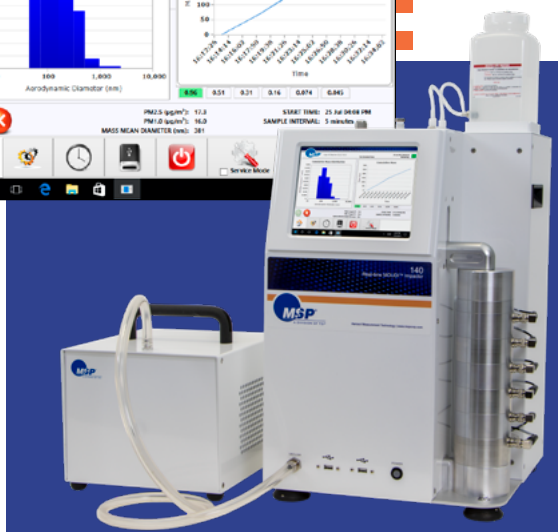
TSI's suite of cascade impactors can collect particles with aerodynamic diameters (cutpoints) from 10 nm to 10 µm, in 3 to 13 different size fractions, and at flow rates of 2, 10, 30 or 100 L/min.

Real-Time Quartz Crystal Microbalance (QCM) MOUDI™ Impactor

Model 140

The QCM MOUDI™ has a 2.5-µm inlet and six stages with sharp collection efficiency curves and calibrated cutpoints of 960, 510, 305, 156, 74 and 45 nm at 10 L/min inlet flow rate. The QCM MOUDI™ provides excellent mass measurement accuracy thanks to the integrated humidity conditioning system that ensures reliable coupling of aerosol particles to the quartz crystal sensors, and eliminates undesirable solid particle bounce. With the QCM MOUDI, setup and measurement time has gone from hours to minutes allowing the user to collect size fractionated aerosol masses, in real time (1 Hz data collection, down to 10 s sample averages), from tens of nanograms up to a few hundred micrograms per stage.





Accessories (available separately)

Specify	Description
140-HFSS	High Flow Sampling System
3334-10	Diluter, 10:1 @10 L/min
3334-100	Diluter, 100:1 @ 10 L/min

Non-Rotating MOUDI™ Impactors

Models 100S4 and 110NR MOUDI™ Impactors
Non-rotating MOUDI™ impactors are classic, research cascade impactors with sharp cut-sizes and low internal losses. These impactors are used for collecting size-fractionated particle samples in the 0.056 to 10 µm aerodynamic diameter range with a 30 L/min sampling flow rate.

Particle deposits are collected on standard 47 mm substrates which can be analyzed for mass, chemical composition or by microscopy.

Model	Stages	Nominal Cut Points (µm)	Flow Rate (L/min)	Pressure Drop (kPa)
100S4	3	10, 2.5 and 1.0	30	1
110NR	10	10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32, 0.18, 0.10, and 0.056	30	40

100NR shown

Accessories (Available Separately)

Specify	Description
3033	Vacuum pump for 100S4 (use with 100S4-FTG-KIT)
0100-01-1052	Vacuum Pump, 100/110, 220V, UK
100S4-FTG-KIT	Fitting kit, for using 3033 with 100S4
0100-47-AF	Al Foil Substrates, 47 mm, Pkg. 300
0001-01-9953	Glass Fiber Filters, 47 mm, Pkg. 100
0001-01-5024	Quartz Fiber Filters, 47 mm, Pkg. 100

Model 135 Mini MOUDI™ Impactors
Mini MOUDI™ 135 impactors are high-accuracy impactors with a low sampling flow rate and a small physical size. They are available with 6, 8, and 10 impaction stages to provide size-fractionated particle samples.

The Mini MOUDI™ impactors 135 are used for personal exposure sampling and for unique applications such as characterizing e-cigarette smoke. Particle deposits are collected on 37 mm semicircular substrates. All models come standard with a cone (3/8 in. tube) inlet , and are available with an optional accessory cowl inlet.

135-6B with cone inlet shown

Model	Stages	Nominal Cut Points (µm)	Flow Rate (L/min)	Pressure Drop (kPa)
135-6B	6	10, 5.6, 3.2, 1.8, 1.0, and 0.56	2	1
135-8B	8	10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32, and 0.18	2	10
135-10B	10	10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32, 0.18, 0.10, and 0.056	2	40

Accessories (available separately)

Specify	Description
0135-01-0014-AF	Al Foil Substrates, Pkg 300
0135-01-5203	Glass Fiber Filters, 37-mm, Pkg 100
0135-75-5007	Vacuum Pump, 135-6,135-8, 110V charger
0135-75-5008	Vacuum Pump, 135-6,135-8, 220V charger
0135-78-0060	Semicircular Substrate Punch
0135-78-0021	Cowl Inlet (replaces cone)

Rotating MOUDI™ Impactors

Models 120R and 125R

MOUDI™ II and Nano MOUDI™ II impactors are second generation impactors. These impactors are noted for their superior aerodynamic design, sharp cut-size, and low particle loss characteristics. Thousands of precision micro-orifice nozzles are used to reduce pressure drop, jet velocity, particle bounce, and re-entrainment.

MOUDI II impactors allow users to sample uniformly for days thanks to the reliable internal impaction plate rotation. Sampling flow rates are 30 L/min for the model 120, and 10 L/min for the model 125. The nominal cut-size aerodynamic diameter range is 10 nm to 10 µm. MOUDI II can be operated remotely through a web browser using an Ethernet connection to the onboard PLC.

Model	Stages	Nominal Cut Points (µm)	Flow Rate (L/min)	Pressure Drop (kPa)
120R*	10	10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32, 0.18, 0.10, and 0.056	30	40
125R	13	10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32, 0.18, 0.10, 0.056, 0.032, 0.018 and 0.010	10	90

* Has an inlet with an 18 µm cutpoint

120R MOUDI™ impactor shown

Accessories (available separately)

Specify	Description
0100-47-AF	Al Foil Substrates, 47 mm, Pkg. 300
0001-01-9953	Glass Fiber Filters, 47 mm, Pkg. 100
0001-01-5024	Quartz Fiber Filters,47 mm, Pkg. 100
0120-98-1051	Vacuum Pump, 120R, 110V
0120-98-1050	Vacuum Pump, 120R, 220V
0125-98-0100	Vacuum Pump, 125R, 110V
0125-98-0101	Vacuum Pump, 125R, 220V

High Flow Impactor

Model 131B

The High Flow Impactor (HFI) is ideal for sampling particles at low concentrations, for obtaining samples in short sampling intervals, or for collecting more mass per stage as compared to more conventional medium flow rate impactors. The HFI is available with 6 stages in the 0.25 to 10 µm aerodynamic size range. HFIs sample at a high flow rate with a low flow resistance. Particle deposits are collected on 75-mm substrates which can be analyzed for mass, or via chemical analysis or microscopy.

Model	Stages	Nominal Cut Points (µm)	Flow Rate (L/min)	Pressure Drop (kPa)
131B	6	10, 2.5, 1.4, 1.0, 0.44 and 0.25	100	6

131B impactor shown

Accessories (available separately)

Specify	Description
0130-01-1051	Vacuum Pump,131B, 110V
0130-01-1050	Vacuum Pump,131B, 220V, EU
0130-01-1050	Vacuum Pump,131B, 220V, UK
0130-75-AF	Al Foil Substrates, 75 mm, Pkg. 300
0130-01-5010	Glass Fiber Filters, 90 mm, Pkg. 100

Aerosol Generators and Dispersers

Collectively, our generators and dispersers produce particles in the range of 0.001 to > 100 µm from liquids, suspensions or powders.
Visit: www.tsi.com/aerosol-generators-and-dispersers/ for the full overview.

Monodisperse Generators

This type of generators is useful anywhere a precise, monodisperse aerosol is needed. Specific applications include calibrating particle counters, testing various filters, and studying size-dependent particle properties.

Model	3480	3482	3940A	3475	1520
Particle Size Range (µm)	<0.002 to >0.15		0.01 to 1.0	0.1 to 8.0	0.8 to 12 (dry particles) / 15 to 90 (droplets)
Particle Concentration (particles/cm³)	~10^7	Up to 10^7	<10^5	>10^6	~10^3 (at 1 µm) to ~10^2 (at 10 µm)
Nominal Flow Rate (L/min)	0.2 to 2.5		0.2 to 3.5	3.5 to 4	5 to 25

Electrospray Aerosol Generator

Models 3480, 3482
Produces monodisperse particles as small as 2 nm.

The Electrospray Aerosol Generator (EAG) uses a patented technique to produce high concentrations of monodisperse, submicrometer particles in the range from <2 to >150 nm in diameter. The EAG produces such small, uniform particles by pushing a charged liquid solution or suspension through a capillary tube and exerting an electrical field on the liquid at the capillary tip. The electrical field pulls the liquid from the capillary, forming individual droplets. Air and CO_2 mixed with the droplets evaporate the liquid, and the remaining particles are neutralized by an ionizer. The result is a neutralized, monodisperse aerosol. Applications for the EAG include instrument calibration, analysis of nanomaterial suspensions, macromolecular analysis, and nano-aerosol studies.

The classic model 3480 uses a pressure capsule fluid delivery system and radioactive Po-210 neutralizer.

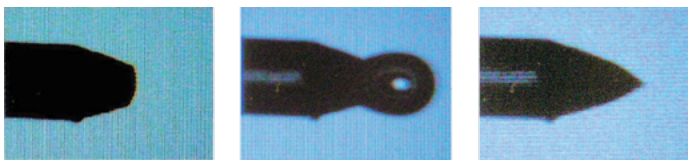
The next generation model 3482 features a built-in touch screen, soft x-ray neutralizer, and is compatible with a syringe or HPLC pump liquid delivery system.

The optional pressure capsule accessory 3482-PCAP adapts the liquid delivery system of the 3480 for use by the 3482 and provides a smooth delivery of the sample into the 3482 capillary, ensuring stability of the aerosol generation.

3482 with 3482-PCAP and 3480

Accessories (available separately)

Specify	Description
3482-PCAP	Pressure Capsule Kit
3482-SPUMP	Syringe Pump
3482-SPUMP-ACC KIT	Syringe Pump and Accessory Kit
348002	Replacement Po-210 Aerosol Neutralizer for Model 3480



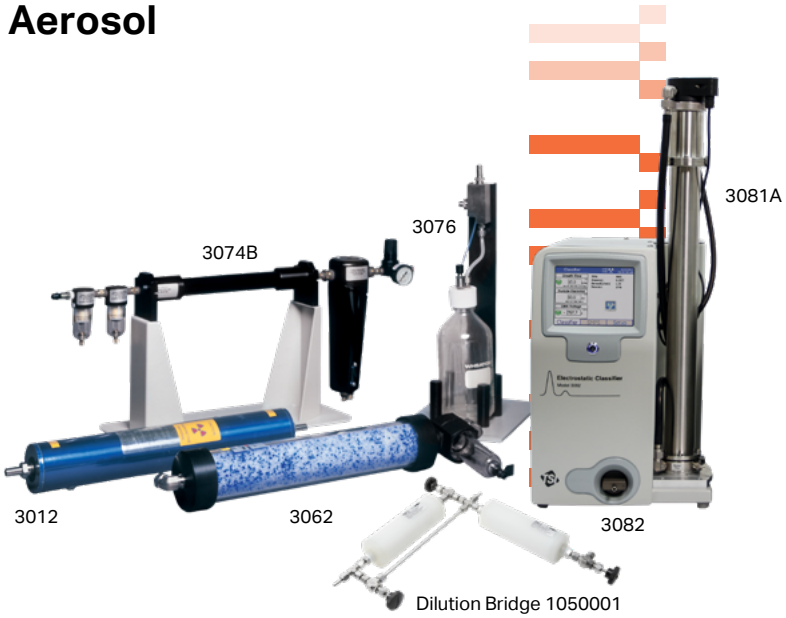
The 3482 produces particles down to at least 2 nm. The camera (3482) or viewing window (3480) allows you to easily see the capillary tip during operation: (1) no liquid flow; (2) with liquid flow but no electric field; (3) with liquid flow and electric field (showing the formation of the Taylor cone).

Submicrometer Monodisperse Aerosol Generation System

Model 3940A
A complete system for generating monodisperse, submicrometer particles.

The Submicrometer Monodisperse Aerosol Generation System gives you the ability to produce monodisperse particles from 0.01 to 1.0 µm in diameter. The system includes:

- Electrostatic Classifier 3082
- Long DMA 3081A
- Aerosol Neutralizer 3077A
- Aerosol Neutralizer 3012
- Filtered Air Supply 3074B
- Constant Output Atomizer 3076
- Diffusion Dryer 3062
- Dilution Bridge 1050001 and accessories



Electrostatic Classifiers

Model 3082
Primary-standard instruments that produce highly monodisperse, submicrometer aerosols.

The 3082 Electrostatic Classifiers are primary standard aerosol instruments that give you highly monodisperse, submicrometer aerosol from a polydisperse source. Our classifiers are first-principles instruments (i.e., they are not calibrated against other particle instruments), and have been used in a variety of aerosol generation and particle sizing applications with highly repeatable results.

The Electrostatic Classifier uses a Differential Mobility Analyzer (DMA) to classify and select out a narrow, predictable size band. TSI® provides a choice of four DMA columns. You can purchase any column and interchange them on the same platform, giving you unprecedented versatility. The platform is available separately for use with your own DMA, just connect the tubing and enter the DMA dimensions on the touch screen.

Particles classified with our Electrostatic Classifiers range in size from 0.001 to 1.0 µm. For monodisperse aerosol generation, simply set the touch screen for the desired particle size.

Electrostatic Classifiers are included in our SMPS™ systems. Models 3082 and 3081A are part of the 3940A Submicrometer Monodisperse Aerosol Generation System. DMA columns are interchangeable. For restrictions, consult local authorities on the use of Aerosol Neutralizers. The Nano DMA was developed in cooperation with the University of Minnesota Particle Technology Laboratory and Gerhard Mercator University. Refer to United States Patent Number 6,230,572. Wide-Range Differential Mobility Analyzer 3083 is based on TROPOS Vienna-type DMA.

Electrostatic Classifiers and DMAs

Specify	Description
3082	Electrostatic Classifier
3081A	Long DMA (10 nm to 1 µm)
3085A	Nano DMA (2 to 150 nm)
3083	Wide-Range Vienna DMA (10 to 800 nm in a single scan, 1 micron maximum)
3086	1 nm DMA (1 to 50 nm)

Accessories (available separately):

Specify	Description
3077	Aerosol Neutralizer
3077A	Aerosol Neutralizer (for High Concentrations/Charges)
3088	Advanced Aerosol Neutralizer (Soft X-Ray)
6005931	Lead Shielding Column

Condensation Monodisperse Aerosol Generator

Model 3475
Generates high-concentration, monodisperse aerosols quickly and accurately.

The Condensation Monodisperse Aerosol Generator (CMAG) is a Sinclair-LaMer-type instrument that produces high-concentration, monodisperse aerosol particles. It is well-suited for challenging HEPA and ULPA filters, seeding wind tunnels, conducting inhalation studies, or other applications requiring monodisperse supermicron particles in high concentrations.

The CMAG generates liquid or solid particles from a variety of oils, waxes, and other materials. It generally produces concentrations greater than 10^6 particles/cm^3, and operates at a flow rate of 3.5 - 4 L/min. Particles can be fluorescently or radioactively labeled. Monodisperse particles can be generated by condensing volatilized oil or wax onto solid seed particles; in this case, the final monodisperse size is within the range of 0.1 - 8 um, and is user-adjustable. The CMAG can also generate particles via homogenous nucleation, resulting in a polydisperse aerosol. The CMAG can operate for long periods without interruption. Aerosol may be monitored for concentration using the optional 3375 Process Aerosol Monitor.

CMAG Accessory (available separately):

Specify	Description
3375	Process Aerosol Monitor

Flow Focusing Monodisperse Aerosol Generator

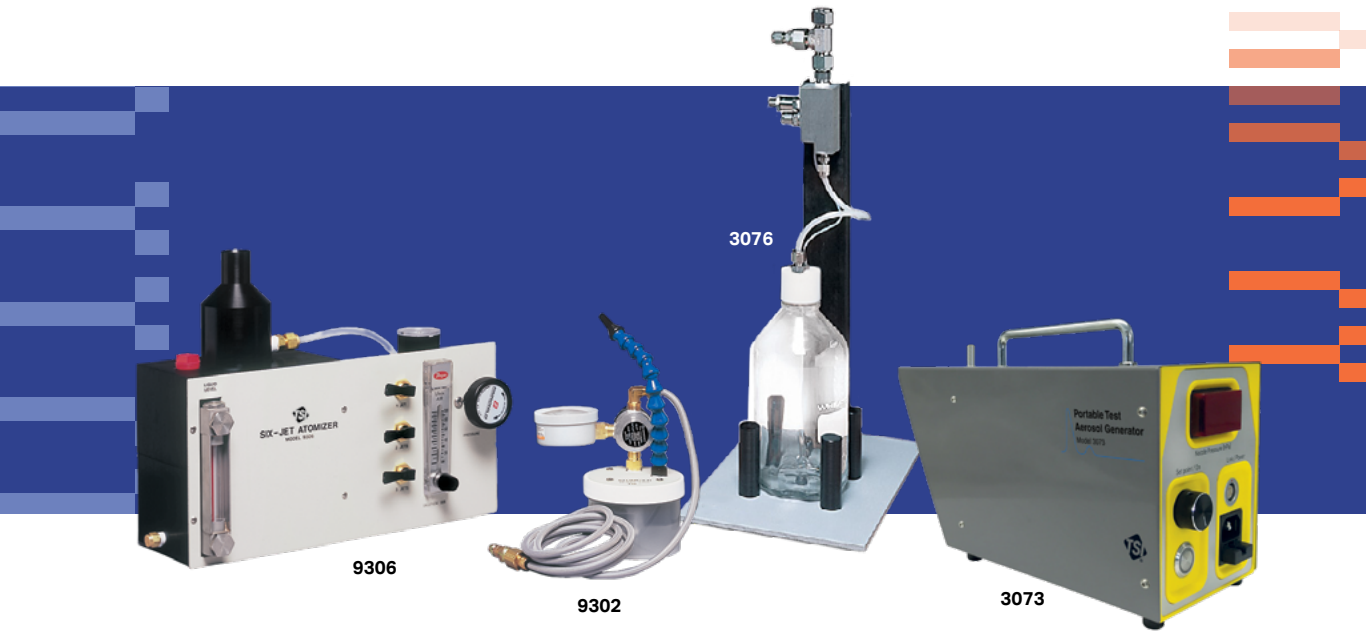
Model 1520
Produces monodisperse droplets and solid particles.

The Flow Focusing Monodisperse Aerosol Generator (FMAG) 1520 uses the aerodynamic flow-focusing effect to accurately control the diameter of a liquid jet for generating monodisperse droplets from 15 to 90 µm in diameter, which can then be dried to produce particles from 0.8 to 12 µm in diameter. In normal operation, a built-in syringe pump pushes liquid out of a 100-µm-diameter nozzle and is stretched to a much thinner stream by the focusing gas flow. The resulting thin liquid jet then breaks up into uniform-sized droplets after passing through a vibrating piezoelectric aerosol generation head. A coaxial flow of clean air is introduced to dry the droplets into solid particles. The aerosol then exits the top of the FMAG after passing by a built-in electrical alternating current corona ionizer and inspection light for easy viewing. The large 100-µm-diameter nozzle in the FMAG enables aerosol generation over extended periods of time without experiencing nozzle clogging problems, and at a very low liquid pressure. This low shear stress generally enables biological cells to remain viable, even after dispersion as uniform particles. An optional extension cable accessory (1530-98-1006) allows for remotely mounting the aerosol generation head upside down for generating large liquid droplets for applications such as flow seeding in laser diagnostics imaging applications.

Polydisperse Generators

This type of generator is typically capable of producing aqueous solutions (e.g. salt), suspensions (PSL, gold or glass nanoparticles), or oil or similar substances. They serve a variety of applications from laboratory research, field tests of detectors, and filter testing.

Model	3073	3076	9302/9306	8108	9307-6
Particle Size Range (µm)	0.01 to 2.0 (nominal 0.3 count mean diameter)			0.3 to 10	0.01 to 2.0
Particle Concentration (particles/cm³) in Output	10^2 to 10^7	$>10^7$	$>10^7$	$<10^3$ at 1 µm	$>10^7$
Nominal Flow Rate (L/min)	0.3 to 4.5	3.0	6.5 to 39	140	30 to 10^3
Note	Portable, battery operation possible	Laboratory grade	Collison atomizers	Designed for ISO 16890-2 and ASHRAE 52.2 filter testing	Laskin nozzle atomizer



Portable Test Aerosol Generator

Model 3073
A portable test aerosol generator for low and high concentration polydisperse aerosols. It generates submicron aerosols from oils, and from salt or PSL suspension or other solutions. The modular atomizer design permits operation in Collison or Laskin nozzle modes. The innovative new flow control reduces power consumption and achieves highly stable particle production rates, ideal for calibration of particle sizing instruments. Its compact and lightweight design coupled with battery operation (user-supplied) make it a perfect fit for use in field test applications.

Constant Output Atomizer

Model 3076
The 3076 can generate aerosols of stable concentrations over 10^7 particles/cm^3 (nominal). Its nominal aerosol flow rate is 3.0 to 3.5 L/min. Stainless steel components make this Collison-type atomizer suitable for biological and medical research, material synthesis, filter testing, instrument calibration, and basic research.

Single-Jet Atomizer

Model 9302
Our simplest atomizer is highly compact and includes a built-in pressure regulator for controlling compressed air from an external source. It can produce particles in concentrations over 10^7 particles/cm^3 at a nominal flow rate of 6.5 L/min.

Six-Jet Collison Atomizer

Model 9306
Features a high flow rate and a built-in dilution system. Users may individually select up to six jets, each capable of producing particle concentrations greater than 10^7 particles/cm^3 at 6.5 L/min (nominal at 25 psig pressure). Built-in dilution air controlled by a rotameter allows you to vary the output particle concentration.

All six atomizers produce a mean droplet diameter of 0.3 µm with a geometric standard deviation of less than 2.0 when generating salt solution. They are suitable for work with a wide range of solutions and suspensions, including polystyrene latex (PSL) spheres, dioctyl phthalate (DOP), silicone oil, salt or sugar solutions, and methylene blue.

Large Particle Aerosol Generator

Model 8108
Generates aerosols up to 10 µm in diameter.

The Large Particle Aerosol Generator produces aerosol over a wide particle size range, from 0.3 to 10 µm. Designed for easy cleaning, this generator produces potassium chloride (KCl) and other aerosols. A peristaltic pump pushes the KCl solution into a nozzle at the top of the generator, where a compressed air stream forces it out into a spray. As the droplets fall down the column, a counterflow of heated, ionized drying and dilution air moves upwards to neutralize the aerosol and remove excess water. The very broad size distribution exits the bottom of the generator, ready to to be introduced into the test duct. The model 8108 meets the requirements of ASHRAE 52.2 and can also be used for ISO 16890-2 filter efficiency testing. It's an ideal aerosol generator for fractional efficiency testing of general ventilation filters and automotive cabin-air filters.

Six-Jet Laskin Nozzle Generator

Model 9307-6
The 9307-6 Laskin Nozzle Generator is a high-output, general-purpose aerosol generator designed to produce large quantities of particles for demanding applications, including seeding high-speed flows. Using six Laskin nozzles, it generates oil aerosols as well as aerosols from other fluids such as DEHS or salt solutions for producing solid salt particles.

Under normal operating conditions, the generator delivers an aerosol flow rate of approximately 1000 L/min, producing particle concentrations of up to 10^8 particles/cm^3. The generated particles have a nominal mean size between 500 nm and 1 µm, making the system well suited for a wide range of laboratory and industrial aerosol applications.

An internal baffle is incorporated to remove the largest droplets and particles, ensuring a more uniform aerosol output. A built-in pressure regulator allows easy control of inlet air pressure, providing flexibility to increase particle output volume when required. Anywhere from one to six jets can be activated, allowing control of total aerosol output.

Powder and Dust Dispersers

This type of generators disperse dry dust and powders for applications that need continuous and basic stable dosing with high accuracy. These aerosols are commonly used in basic aerosol science, filter testing, industrial processes, and quality assurance tasks.

Model	3410U	3410L	3400A
Particle Size Range (µm)	0.2 to >100	0.2 to >100	0.5 to 40
Particle Mass Concentration	50 to 20,000 mg/m³	0.5 to 160 g/m³	10 to 100 mg/m³
Nominal Flow Rate (L/min)	8 to 35	25 to 67	5 to 15
Note	Refillable during operation. Cover included to keep dust dry. Modular.		Fluidized bed

Fluidized Bed Aerosol Generator

Model 3400A
Disperses powders with stable concentrations for dust experiments or particle seeding.

The Fluidized Bed Aerosol Generator (FBAG) is a general-purpose powder disperser. It prepares any dry, free-flowing powder for dispersion in a gas. It disperses powders that range from 0.5 to 40 µm, with concentrations from 10 to 100 mg/m³. Unsurpassed constant output and concentration make the FBAG useful for inhalation toxicology studies, laser-velocimeter seeding, and filter testing.

Accessories (available separately):

Specify	Description
3012A	Aerosol Neutralizer
3074B	Filtered Air Supply
1502574	Replacement bronze beads

Dust Aerosol Generator

Model 3410U/L
The Dust Aerosol Generator 3410U/L comes in two versions that differ in the way the powder is fed to the disperser.

The Dust Aerosol Generator 3410U/L disperses dry dust and powders for applications that need continuous and stable dosing with high accuracy. The interchangeable dispersing units make it possible to disperse different materials (e.g. soot, TiO_2 , cellulose, or ISO 12103 test dust) at different output concentrations. A purged cover keeps the material dry even in locations with higher ambient humidity.

Both versions disperse the powder via an ejector nozzle with ceramic inlay to make it more resistant against abrasive material. Shear forces in the ejector nozzle disperse and de-agglomerate particles. In both models the reservoir can be refilled while in operation to accommodate any required operation interval.

The model 3410U is for poorly flowing powders at low dosing rates (50 mg/m³ to 20 g/m³). Here the powder is continually poured onto a metal ring where excess material falls off the side and back into the reservoir.

The model 3410L meters powder using a moving toothed belt. The well-defined spaces between the teeth ensure a constant and reproducible supply of powder and achieves mass concentrations of 0.5 to 160 g/m³.

Dust Aerosol Generator

Specify	Description
3413L	Fully-enclosed version (includes 3410L disperser)
3413U	Fully-enclosed version (includes 3410U disperser)

Accessories (available separately):

Specify	Description
3074B	Filtered Air Supply
3410-DISL	Model L Dispersion Unit for 3410U
3410-DISU	Model U Dispersion Unit for 3410L
3411	Remote Control Pendant (for 3410U, 3410L, 3413U, and 3413L)

Instruments & Accessories

Flow Calibrators

Models 4148 & 4048
TSI® Flow Calibrators are small, simple and portable flow measuring devices. A low pressure drop minimizes the impact on your experiments.

These easy-to-read, handheld units can be powered through the included battery pack (6 AA batteries) or via the included universal power supply allowing for portable benchtop use. The standard or volumetric flow rate (selectable by software) is continuously displayed allowing for fast and easy confirmation of the inlet flow displayed on the unit. The flow calibrators are temperature-compensated and pressure-corrected allowing calculated volumetric flow readings to have an accuracy of ±2% of reading. An in-line HEPA filter is included to protect the flowmeter from particles in the aerosol sample and help maintain calibration.

The model 4148 operates from 0 to 20 L/min and has tube stub fittings for 1/4" tubing.

The model 4048 operates from 0 to 200 L/min and has tube stub fittings for 3/8" tubing.

Both models are calibrated for air.

4048

4148

Aerosol Humidity and Temperature Sensor

Model RHT3000

Humidity and temperature affect aerosol processes and properties. This sensor was designed to measure both parameters in an aerosol flow and to record them along with your aerosol measurements.

It features plug-and-play operation with 375X and 3789 series CPCs or 3938 SMPS™ systems containing these CPCs. It is powered by USB-C and has a simple serial command set for standalone use.

Sheath Flow Dryer

Model 3082-SHEATHDRYER

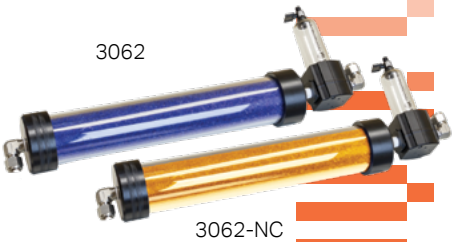
The Sheath Flow Dryer is a desiccant dryer designed to reduce the sheath air relative humidity (RH) in the TSI® Electrostatic Classifier model 3082 or the Scanning Mobility Particle Sizer™ (SMPS™) spectrometer model 3938.

Whether your application involves moderate to high relative humidity (RH) levels in the sampled aerosol or not, the addition of a sheath dryer can prove to be immensely valuable when utilizing an SMPS™ spectrometer for continuous ambient air monitoring. It has a maximum flow rate of 5 L/min, and satisfies the requirements of CEN/TS 17434.

Diffusion Dryers

Models 3062 & 3062-NC
Removes water or solvent vapors from sample aerosols.

Our Diffusion Dryers include a coalescing preseparator for collecting large droplets. Desiccant surrounding the aerosol flow path removes excess moisture by diffusional capture. Because aerosol never comes in contact with the desiccant, there is minimal particle loss. Regenerate the desiccant simply by removing it from the Diffusion Dryer and baking it at 120°C. Maximum flow rate is 4 L/min. The -NC version has identical specifications, but no cobalt in the orange desiccant. When filled with activated charcoal instead, it can remove solvent vapors from oil-in-alcohol solutions.



Compact Catalytic Vapor Filter

Model CCVF100

The Compact Catalytic Vapor Filter CCVF100 is a plug-and-play device that is compatible with all common TSI® butanol and isopropyl alcohol Condensation Particle Counters (CPCs) models. This device oxidizes alcohol vapors into carbon dioxide and water vapor, protecting the environment from disagreeable odors and preventing interference with VOC sensors. Unlike activated charcoal, it is continuously regenerating and is designed for constant use.

Radioactive Aerosol Neutralizers*

Models 3012 and 3077
Minimize particle losses and coagulation by electrostatic charges, or charge particles properly for size analysis or air-filter measurements.

Aerosol particles dispersed by nebulization, combustion, or powder dispersion are usually electrostatically charged and are subject to high losses during transport. To reduce transport losses and ensure that instruments operating on the electrostatic principle work properly, particles must be neutralized. These Aerosol Neutralizers use a radioactive source (^{85}Kr) to perform this function. The radioactive source ionizes the surrounding gas creating positive and negative ions. Particles carrying a high charge can discharge by interacting with ions of opposite polarity. After a short time, the particles reach charge equilibrium. TSI® recommends models 3012A or 3077A for aerosols with higher charge levels or when operating at higher flow rates or high concentration.

3012

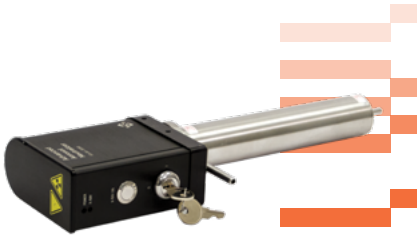
3077

Radioactive Aerosol Neutralizers

Specify	Description
3012	For general-purpose applications with high flow rates (up to 50 L/min). 2 mCi, 74 MBq
3012A	Same as above, but with five times the activity (10 mCi, 370 MBq)
3077	For general-purpose applications with low flow rates (up to 5 L/min); standard with 3938 Scanning Mobility Particle Sizer™ spectrometers. 2 mCi, 74 MBq
3077A	Same as above, but with five times the activity (10 mCi, 370 MBq)

Non-Radioactive Aerosol Neutralizers

Model 3088
The TSI® Advanced Aerosol Neutralizer 3088 offers an alternative to traditional radioactive neutralizers frequently required for aerosol measurement applications. Due to increasingly stringent local, state and national regulations, obtaining licensing to acquire and use radioactive sources is often difficult and in some cases prohibited. Fully compliant with US FDA, CDRH* standards, the patented model 3088 provides an attractive alternative, with sizing performance virtually identical to TSI's Aerosol Neutralizer 3077A.



The 3088 is compatible with TSI's SMPS spectrometers models 3938, and Electrostatic Classifier 3082. Like a radioactive neutralizer, it uses bipolar ions to neutralize particles up to 10^7 particles/cm^3, and does not generate particles. Its maximum design flow rate is 5 L/min.

*Provide end-user name and address when ordering Aerosol Neutralizers. TSI has been issued license number 1154-200-62 by the Minnesota Department of Health to sell and distribute these Aerosol Neutralizers. Users in the United States need not apply for additional U.S. Government licenses to handle these products. However, some state and local governments may require special licenses, and some organizations may have special handling procedures. Check all local requirements.

Filtered Air Supply

Model 3074B
Cleans, dries, and regulates compressed air for aerosol generation and other applications.

The Filtered Air Supply removes oil or other liquid droplets from the incoming air using two prefilters. It also removes any remaining moisture in the air stream by passing the air through an advanced regenerating membrane dryer. Plus, it removes fine particles and vapors using a high-efficiency filter at the outlet. This full-featured compressed-air conditioner allows you to make pressure adjustments using an included gas-regulator valve. It provides a maximum flow rate of 60 L/min at a dewpoint as low as 2°C. Maximum inlet pressure is 1,000 kPa (150 psig).

Flow Splitter

Model 3708
Routes sample from one source to several instruments.

The Flow Splitter directs an aerosol sample to as many as four destinations at once. This accessory is especially useful when performing instrument comparison or calibration experiments. Smooth flow transitions provide equal flow distribution. Stainless-steel construction and an electropolished interior prevent the aerosol from being contaminated or lost to the walls. The Flow Splitter has a ⅜-inch straight-tube inlet and four ¼-inch outlets (outside diameters). Maximum total flow rate is 30 L/min.

Conductive Tubing

TSI offers flexible, conductive tubing in different sizes to accommodate most experimental setups.

TSI Part Number	For Fitting Sizes	Dimensions (OD x ID, in.)	Length (ft)
6017729	1/16-1/8 in. or 2 mm	0.25 x 0.0625	50
6013242	1/8-3/16 in. or 4 mm	0.25 x 0.125	250
3001788	1/4 in. or 6 mm	0.375 x 0.1875	50
6017730	5/16 in. or 8 mm	0.5 x 0.25	50
3001789	3/8 in. or 10 mm	0.5 x 0.3125	50
3001835	1/2 in. or 13 mm	0.75 x 0.4375	25
3001901	3/4 in. or 19 mm	1.125 x 0.6875	25

Particle Size Selector

Model 376060
Allows selection of different cutoff sizes for CPCs.

The Particle Size Selector (PSS) allows you to control the lower size cutoff of a TSI® Condensation Particle Counter (CPC). The PSS is a separating device that selectively removes small particles from an aerosol by diffusion. Simply add or remove diffusion screens to change the lower cutoff size. The cutoff shifts toward larger sizes as more screens are added.

The PSS includes 11 screens and, therefore, can be configured for 11 cutoff sizes. An extra set of 12 screens may be ordered to expand the cutoff range further. Specific cutoff sizes vary based on CPC operating flow rate.

The technique of using a Condensation Particle Counter with diffusion screens to select specific particle size ranges is covered in United States Patent Number 5,072,626.

PSS Accessory (available separately):

Specify	Description
376061	Set of 12 additional diffusion screens

Vacuum Pumps

Models 3032 & 3033
Use these top-quality pumps when you need a portable vacuum source.

The model 3032 is a quiet diaphragm pump with up to 5 L/min vacuum flow. Permanently lubricated bearings ensure long life and maintenance-free operation. Compatible with 3790A/-10, 3783, and 3750 CPCs, as well as 3938 SMPS with a 3750 CPC. The 3032-EC is a higher-capacity carbon-vane version (230V / 50 Hz only).

The model 3033 is a rotary-vane pump with up to 60 L/min vacuum flow. Self-adjusting carbon vanes maintain top efficiency, and lubricated ball bearings ensure low maintenance. Recommended for the 3068B Aerosol Electrometer, multiple CPCs needing an external vacuum, or the TSI 3306 Impactor Inlet with APS.

Model 3036
This model is a powerful, oil-free diaphragm pump designed for continuous, contamination-free evacuation and gas pumping. Its robust construction and maintenance-free drive ensure a long operational life, making it ideal for demanding lab and industrial applications.

Vacuum Pumps

Specify	Description
3032	Diaphragm pump, for flow rates up to 5 L/min, 115 V
3032-1	Diaphragm pump, for flow rates up to 5 L/min, 230 V
3033	Rotary-vane pump, for flow rates up to 60 L/min, 115 V (Available in voltages of 100-240VAC and 50-60 Hz)
3032-EC	Rotary-vane pump, for flow rates up to 30 L/min, 230V/50 Hz only
3036	High-Output Double-Diaphragm Pump, 230V, 50-60 Hz only

TSI® recommends these pumps only for use with specific TSI® particle instruments. Please specify voltage requirements at time of order.

High Flow MOUDI™ Sampling System

Model 140-HFSS
The High Flow Sampling System (HFSS) 140-HFSS is an accessory designed to be used with MOUDI™ impactors with 10 L/min flow rate such as the 140 QCM MOUDI™ and 125R MOUDI™ II impactors when sampling ambient air at varying temperature and humidity conditions.

A Nafion® dryer can reduce the relative humidity of the sample air from as varying as ~100% at 40°C to below 80% at normal room temperature (i.e. 25°C), avoiding water condensation in the sampling line upstream of the MOUDI™ impactor.

TSI® Incorporated serves a global market by investigating, identifying, and solving measurement problems. As an industry leader in the design and production of precision instruments, TSI® partners with research institutions and customers around the world to set the standard for measurements relating to aerosol science, air flow, health and safety, indoor air quality, and biohazard detection. With headquarters based in the U.S. and field offices throughout Europe and Asia, TSI® has established a worldwide presence in the markets we serve. Every day, our dedicated employees turn research into reality.

Ordering
To order, contact your nearest representative or sales office. If you don't know which office handles your territory, then contact our corporate headquarters. Our staff will answer any questions you may have or they will put you in contact with the appropriate sales office. Contact information can also be found on the TSI website. When ordering, specify the model number, instrument name, accessory models and names, and voltage requirements and final country of delivery.

Customer Service
TSI Customer Service Specialists are available to answer your questions about installation or operation:

US & Canada: +1 800 874 2811
UK: +44 1494 459200
Germany: +49 241 52303 0
or visit: www.tsi.com

General Information
TSI Incorporated manufactures innovative instruments for use in industry and research. The particle instruments described in this catalog represent only one of our product families. TSI offers a broad array of sensors and instrumentation systems used in a variety of measurement applications around the globe.

Headquartered in Shoreview, Minnesota, TSI has sales and representative offices all over the world. For more information on TSI particle instruments, use the contact information shown below or visit tsi.com/contact-us. For information on TSI instruments not discussed in this catalog, go to the main TSI web page at www.tsi.com.

Knowledge Beyond Measure.

TSI Incorporated - Visit our website **www.tsi.com** for more information.

USA	Tel: +1 800 874 2811	**India**	Tel: +91 80 67877200
UK	Tel: +44 149 4 459200	**China**	Tel: +86 10 8219 7688
France	Tel: +33 1 41 19 21 99	**Singapore**	Tel: +65 6595 6388
Germany	Tel: +49 241 523030		

P/N 1931001 Rev U

Printed in U.S.A.

MAR-2003