Knowledge Beyond Measure.

1nm Scanning Mobility Particle Sizer™ (SMPS™) Spectrometer

Model 3938E57

TSI's SMPS™ spectrometer is widely used as the standard for measuring size distributions of aerosols below 1 micrometer.

With the addition of the Nano Enhancer 3757 and Differential Mobility Analyzer 3086 (1nm-DMA), the SMPS™ spectrometer's size range has been expanded down to 1 nm.

Applications

- Particle nucleation and growth studies
- Gas-to-particle conversion experiments
- Atmospheric and climate research
- Engineered nanomaterials science studies
- Combustion and engine exhaust research
- Filter and air cleaner testing
- Health effects studies

Features and Benefits

The following features assume an SMPS™ spectrometer consisting of: Electrostatic Classifier 3082, 1nm DMA 3086, Nano Enhancer 3757, Condensation Particle Counter 3750

- High resolution particle size distributions;
  - 128 channels/decade
  - 217 channels between 1 and 50 nm
- Component design for maximum flexibility
- Broad size range from 1 nm to 50 nm
  - Ability to measure over three decades of size from 1 nm to 1 µm with addition of 3081A Long DMA
- Optimized for minimal diffusion losses and system integration
- Unified system operation with Aerosol Instrument Manager Software
- Discreet particle measurement: works well for multimodal samples

Nano Enhancer

Model 3757

The Nano Enhancer 3757 enables researchers to measure the number concentration and size of aerosols with high resolution and speed starting from 1 nm. Combined with a Condensation Particle Counter (CPC) 3750 it provides total number concentration. The new design focused on automation and integration to make measurements easier. The 1nm SMPS™ 3938E57 integrates the 3757 together with a 1nm DMA 3086 and enables size distribution measurements in the range of 1 nm to 50 nm.

Operation

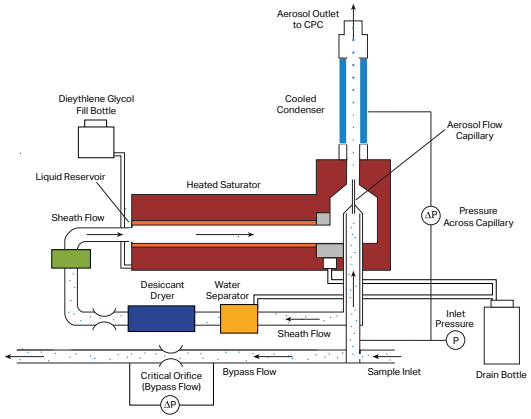
The physical properties of the working fluid in conventional CPCs (alcohol, or water) limit the lower detection limit (D50) of these CPCs to 2.5 nm. By using diethylene glycol (DEG) as a working fluid, the Nano Enhancer 3757 initiates condensation on particles as small as 1 nm (1.1 nm geometric diameter, 1.4 nm electrical mobility diameter). The model 3757 continuously draws an aerosol sample through a heated saturator in which DEG is vaporized and diffuses into the sample stream. The aerosol and DEG vapor pass through a cooled condenser where the DEG vapor becomes supersaturated, forcing the DEG vapor to condense on the particles in the sample stream. As the DEG vapor condenses on the particles, they grow. The Nano Enhancer is optimized to prevent homogeneous nucleation of the working fluid, keeping the false count rate below 0.01 particles/cm³, based on a 12-hr average.

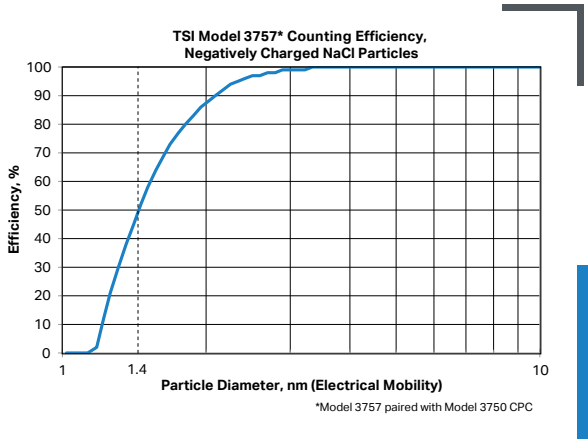
While the use of DEG as a working fluid enables the 3757 to initiate the growth of particles down to 1 nm, DEG also limits the maximum size to which these particles can be grown. As the particles pass through the Nano Enhancer, they grow to a size which is still too small to be optically detected, but large enough to be measured by a conventional CPC. The DEG-enhanced particles are drawn out of the Nano Enhancer into a butanol-based CPC (model 3750), which uses another saturation and condensation stage to further grow the particles until they are large enough to be optically detected and counted by a laser-based optical system.

The Nano Enhancer is optimized to be paired with the TSI® Condensation Particle Counter 3750 creating a 1nm CPC system.

Features and Benefits

- Sensitivity down to 1 nm
- Diethylene glycol (DEG) working fluid
- Optimized for use with TSI's existing SMPS™ spectrometer systems
- High inlet flow rate to minimize diffusion losses
- 300,000 particles/cm³ with continuous, live-time coincidence correction (when used in combination with the CPC 3750)





Specifications

Nano Enhancer 3757

Particle Size Range

Min. Detectable Particle (D_{50})	1.4 nm (electrical mobility diameter, 1.1 nm geometric diameter), verified with NaCl particles

Flow

Aerosol Flow Rate	2.5 L/min
Aerosol Outlet Flow Rate	1.0 L/min
Transport Flow Rate	1.5 L/min
Flow Source	External vacuum
Flow Control	Volumetric flow control of transport flow internal critical orifices. Aerosol flow rate controlled by CPC 3750.

Aerosol Medium

Recommended for use with air; safe for use with inert gases such as nitrogen, argon, and helium (performance specifications are for air)

Liquid System

Diethylene Glycol (DEG, ≥99%, not included) used as working fluid. Sheath air is dried using a water separator and refillable desiccant dryer. Use of internal water removal pump to remove condensate is recommended.

Communications

Embedded touch display, USB type C to connect Nano Enhancer directly to CPC 3750.

Accessories Required

Electrical	100 to 240 VAC, 50/60 Hz, 240W maximum, auto-recovery have power failure built-in
Vacuum	60 kPa (18 inch Hg) minimum gauge (below atmosphere pressure)
Included	Fill and drain bottles, dryer

Physical Features

Dimensions (H x W x D)	30 × 28.2 × 32.5 cm (11.8 × 11 × 12.6 in.), not including fill bottle and bracket
Weight	9.1 kg (20 lbs)

1nm CPC System (Nano Enhancer 3757 and CPC 3750)

Particle Size Range

Min. Detectable Particle (D_{50})	1.4 nm (electrical mobility diameter, 1.1 nm geometric diameter), verified with NaCl particles

Particle Concentration Range

0 to $3x10^5$ particles/cm^3, single particle counting with continuous, live-time coincidence correction

Particle Concentration Accuracy

±10% at <$1.65x10^5$ particles/cm^3

±15% at $3x10^5$ particles/cm^3

False Background Counts

<0.01 particle/cm^3, based on 12-hr average

Response Time

<4s to 95% in response to concentration step change

Catalog Items

Specify	Description
3757-50	1nm Condensation Particle Counter
3032	Vacuum pump 110V
3032-1	Vacuum pump 230 V/50 Hz
3750-MKIT	Maintenance Kit for CPC
3750-WKIT	Wick replacement kit for CPC
3772200	Sampling System for Atmospheric Aerosol

Differential Mobility Analyzer (1nm DMA)

Model 3086

Designed to be used with TSI's Electrostatic Classifier 3082, the 1nm DMA 3086 features an optimized flow path that reduces diffusion losses and improves size resolution over the particle size range of 1 to 50 nm.

Specifications

Size Range

1 to 50 nm

Resolution

R=4.7 at 1.47 nm

Flow Rate Range

(flows provided by Electrostatic Classifier 3082 and/or external source)

Aerosol Flow Rate	0.1 to 2.5 L/min
Sheath Flow Rate	2 to 25 L/min
Bypass Flow Rate	0 to 12 L/min

Specifications are subject to change without notice.

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Key References

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