

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



## Features:

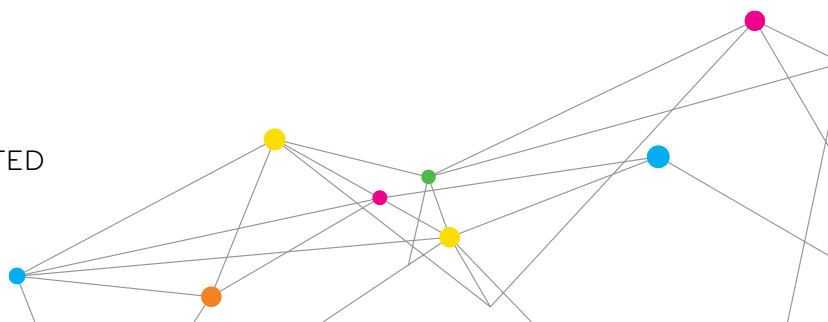
- The following features assume an SMPS spectrometer consisting of: 3082 Electrostatic Classifier, 3086 1nm DMA, 3757 Nano Enhancer, 3750 Condensation Particle Counter
- + High resolution particle size distributions;
    - + 64 channels per decade
    - + >109 channels between 1 and 50 nm
  - + Component 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  $\mu$ m with addition of 3081A Long DMA
  - + Optimized for minimal diffusion losses and system integration
  - + Unified system operation with Aerosol Instrument Manager (AIM) Software
  - + Discreet particle measurement: works well for multimodal samples

## 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



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# NANO ENHANCER MODEL 3757

The 1-nm Nano Enhancer 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 model 3750 it provides total number concentration. The new design focused on automation and integration to make measurements easier. The 1-nm SMPS model 3938E57 integrates the 3757 together with a 1-nm DMA model 3086 and enables size distribution measurements in the range of 1 nm to 50 nm.

## Operation:

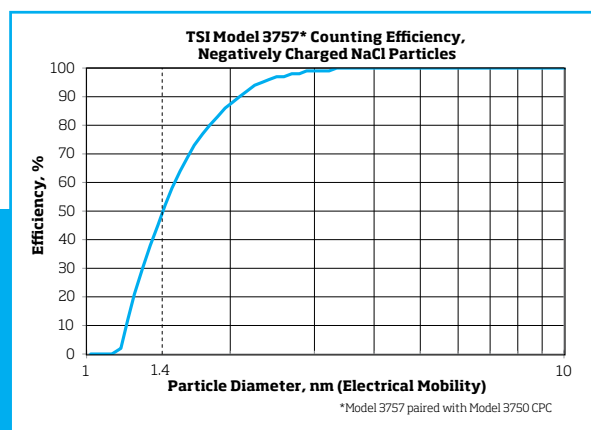
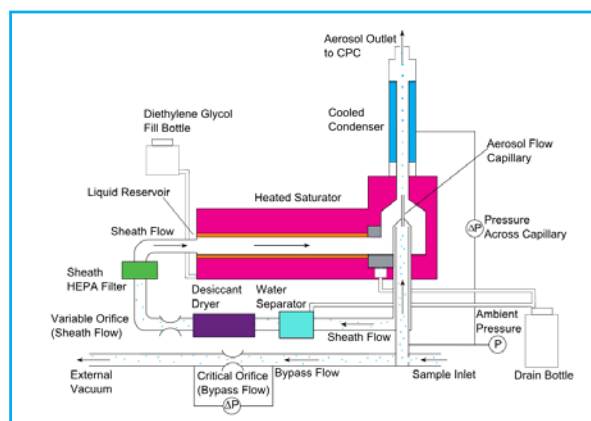
The physical properties of the working fluid in conventional CPCs (alcohol, or water) limit the lower detection limit ( $D_{50}$ ) of these CPCs to 2.5 nm. By using diethylene glycol (DEG) as a working fluid, the Nano Enhancer Model 3757 initiates condensation on particles as small as 1 nm (1.1 nm geometric 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 particle/cm<sup>3</sup>, 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 Model 3750 butanol-based CPC, 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 a TSI Model 3750 CPC 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/cm<sup>3</sup> with continuous, live-time coincidence correction (when used in combination with a Model 3750 CPC)



# SPECIFICATIONS

## MODEL 3757 NANO ENHANCER

### 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 3750 CPC.

### 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,  $\geq 99\%$ , 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 x 28.2 x 32.5 cm (11.8 x 11 x 12.6 in.),  
not including fill bottle and bracket  
Weight 9.1 kg (20 lbs)

## 1nm CPC SYSTEM (MODEL 3757 NANO ENHANCER AND MODEL 3750 CPC)

### 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  $3 \times 10^5$  particles/cm<sup>3</sup>, single particle counting with continuous,  
live-time coincidence correction

### Particle Concentration Accuracy

$\pm 10\%$  at  $< 1.65 \times 10^5$  particles/cm<sup>3</sup>  
 $\pm 15\%$  at  $3 \times 10^5$  particles/cm<sup>3</sup>

### False Background Counts

$< 0.01$  particle/cm<sup>3</sup>, based on 12-hr average

### Response time

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

### Catalog Items

Specify	Description
3757-50	1 nm 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	Environmental sampling system



# 1nm-DMA DIFFERENTIAL MOBILITY ANALYZER MODEL 3086



Designed to be used with TSI's Model 3082 Electrostatic Classifier, the Model 3086 1nm-DMA 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 Model 3082 Classifier 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 preliminary and subject to change without notice

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## KEY REFERENCES

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- + Jiang, J., Chen, M., Kuang, C., Attoui, M., and McMurry, P. H., 2011, "Electrical Mobility Spectrometer Using a Diethylene Glycol Condensation Particle Counter for Measurement of Aerosol Size Distributions Down to 1 nm," *Aerosol Science and Technology*, 45(4): 510-521
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