

# GENERAL PURPOSE WATER-BASED CONDENSATION PARTICLE COUNTER (GP-WCPC) MODEL 3787

A FAST, SMPS™ SPECTROMETER  
COMPATIBLE WCPC THAT DETECTS  
DOWN TO 5 NANOMETERS

TSI's Model 3787 can detect airborne particles down to 5 nm in diameter utilizing state-of-the-art water-based condensation particle counting technology. With a high sample flow rate of 0.6 LPM, the versatile Model 3787 is a good choice for low concentration measurements; yet it is also capable of measuring up to 250,000 particles/cm<sup>3</sup> using exclusively single particle counting. The carefully designed flow path, high flow rate and sophisticated electronics used in the Model 3787 result in a rise time response of <math>\frac{1}{3}</math> second. This utilitarian instrument can be employed as a standalone counter or it can be used as a component of a TSI SMPS™ Spectrometer, a submicron sizing system.



## Applications

The GP-WCPC Model 3787 is suitable for many particle counting applications due to its comprehensive set of specifications, but the convenience of using water for the measurement of submicron particles make it well suited for:

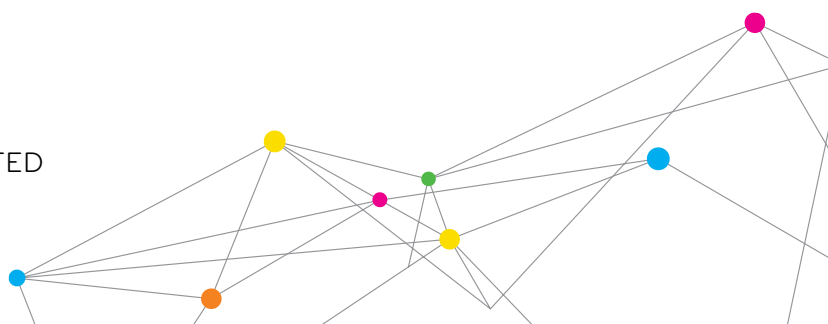
- + Indoor research applications
- + Ambient air research
- + Inhalation or exposure chamber studies
- + Health effects studies

## Features and Benefits

- + 5 nanometer detection
- + < 300 millisecond rise time response
- + High aerosol flow rate for enhanced counting statistics
- + Convenient, VOC-free water as working fluid
- +  $\frac{1}{10}$ <sup>th</sup> second data reporting
- + Built-in SMPS™ spectrometer compatibility
- + 6" color touch screen with graphical interface
- + USB flash drive data storage option
- + Built-in Ethernet capability
- + Advanced instrument diagnostics



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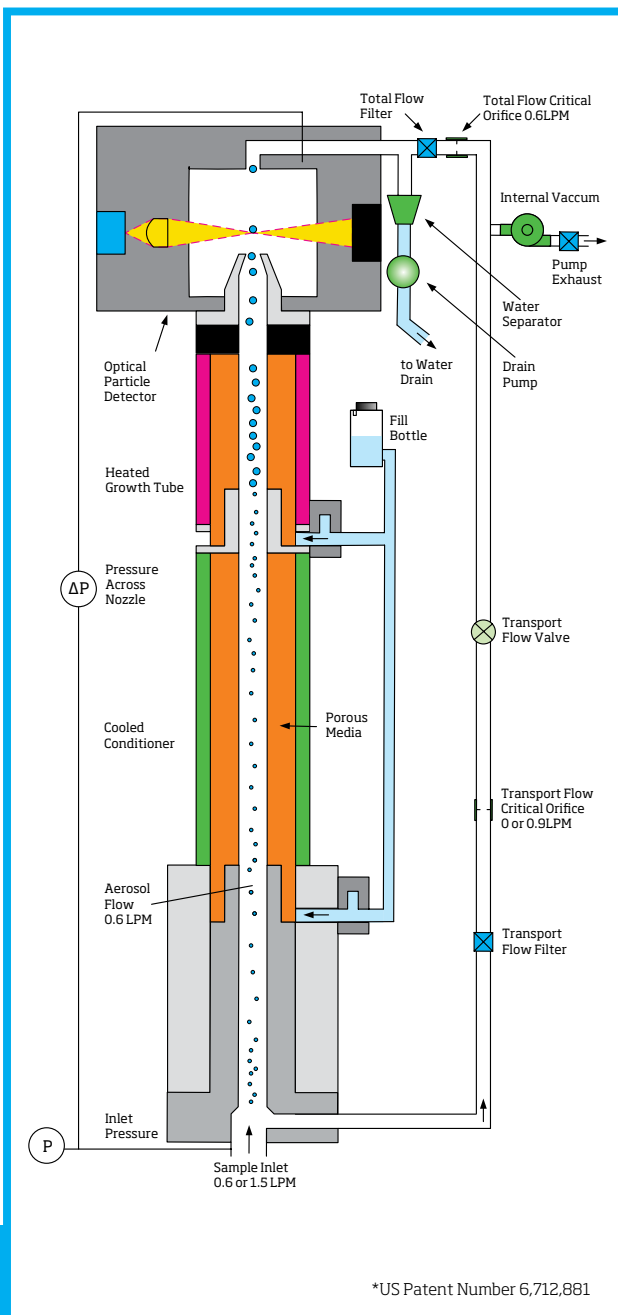
## Second Generation WCPC Technology

Building from the successful introductory line of WCPCs, the Model 3787 takes WCPC design to the next level by combining precision measurements with robust field performance. This instrument delivers a research quality measurement, but it's modern, intuitive user interface and flexible data acquisition options make the GP-WCPC suitable for a variety of industrial applications as well. Newly engineered from the ground up, the Model 3787 features an air flow scheme utilizing protected critical orifices, a new water handling system with optimized wicking and active water removal, and improved optical and detection design for superior signal detection. A host of on-board instrument diagnostics including a laser reference detector, nozzle pressure transducer and inlet pressure transducer allow remote, real-time monitoring of instrument status. Other unique features include a removable wick cartridge for easy wick replacement and a field swappable optics module. Manufactured at TSI's ISO 9001 certified facility and checked out and calibrated using NIST traceable analytical tools, each Model 3787 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.

## Operation

The GP-WCPC utilizes a patented\* laminar-flow, water-based condensational growth technique. Laminar flow CPCs have less particle loss and more precise temperature control (resulting in more predictable particle growth) than mixing type CPCs. In CPCs, particles that are too small to scatter enough light to be detected by conventional optics are grown to a larger size by condensation. In this instrument, an air sample is continuously drawn through the inlet via an internal pump.

- + **Condition:** The aerosol sample is pulled through a cool region saturated with water vapor where its temperature is equilibrated.
- + **Grow:** The sample then passes to a growth section where wetted walls are heated to produce an elevated vapor pressure resulting in a thermodynamic 'supersaturation' condition. The small cool particles in the flow stream act as nuclei for condensation and grow into micron sized droplets.
- + **Detect:** The droplets are passed by a laser and create a large light pulse. Particle pulses are detected and counted. The GP-WCPC counts single particles with continuous, livetime coincidence correction to provide accurate concentration measurements up to 250,000 particles/cm<sup>3</sup>.



\*US Patent Number 6,712,881

### Software and SMPS™ Spectrometer Compatibility

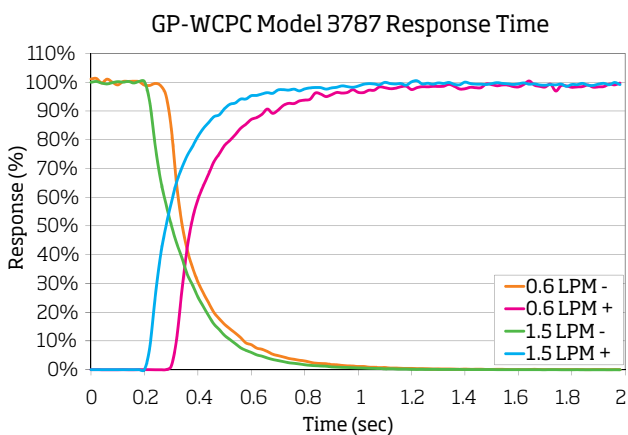
The GP-WCPC comes with built-in compatibility for use in TSI SMPS™ spectrometers, which when operated together, are capable of providing size distributions from 0.005 to 1 μm. The Model 3787 is supplied with Aerosol Instrument Manager® software for CPCs which features comprehensive statistical analysis, advanced instrument diagnostics, real-time data display, advanced file management, easy data export options, and auto recovery from power failure.

### Pulse Height Analyzer

The GP-WCPC utilizes a pulse height analyzer to monitor instrument health and supersaturation state as a safeguard for measurement accuracy. In well functioning CPCs the particles all grow to a similar size and the analog pulses all have a similar height. The Model 3787 monitors and displays the amplitude of the analog pulse height on the status screen of the instrument. A warning will trigger if the pulse height amplitude falls below a threshold value.

### GP-WCPC Response Time

The response of the GP-WCPC to a step change in concentration was measured and is plotted below. The ~750 millisecond time to a 95% response in concentration in high flow mode includes a flow rate based pipe delay. Under normal operation with constant flow, the traditional rise time (10-90%) is < 300 milliseconds. The time constant (τ) of the Model 3787 is ~130 milliseconds.

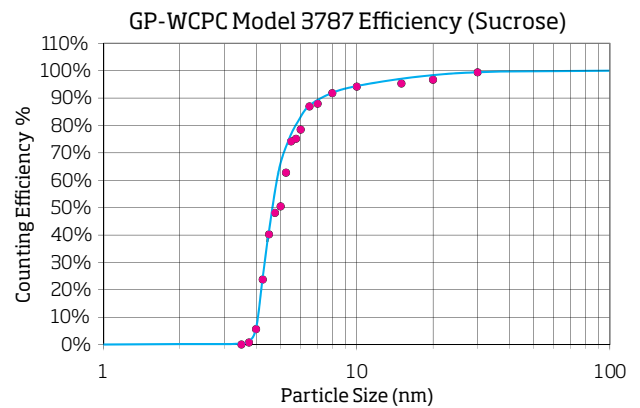
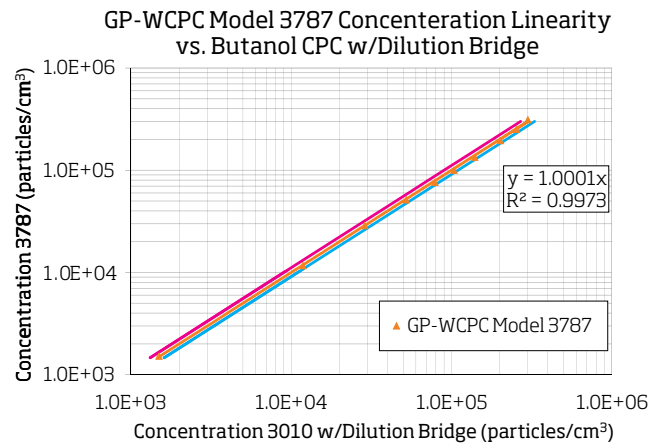


### Extended Single Particle Counting

The Model 3787 employs optimized optics design, more controlled particle growth and advanced electronics processing to extend the single particle counting range of condensation particle counters. Single particle counting gives greater data consistency and is in principle, a more fundamental measurement than other techniques used to increase concentration ranges in CPCs.

### Efficiency and Concentration Linearity

The minimum size particle detection efficiency was determined using sucrose aerosol generated by a Electro spray Model 3480 and size classified using the Electrostatic Classifier Model 3080. GP-WCPC concentration comparisons were made versus both a butanol CPC with a dilution bridge and an electrometer using classified salt aerosol showing excellent agreement.



# SPECIFICATIONS

## GENERAL PURPOSE WATER-BASED CONDENSATION PARTICLE COUNTER (GP-WCPC) MODEL 3787

### Particle Size Range

Min. Detectable Particle ( $D_{50}$ ) 5 nm, verified with DMA-classified sucrose  
Max. Detectable Particle > 3  $\mu\text{m}$

### Particle Concentration Range

Single Particle Counting 0 to 250,000 particles/cm<sup>3</sup>, with continuous live-time coincidence correction

### Particle Concentration Accuracy

$\pm 10\%$  at 250,000 particles/cm<sup>3</sup>

### Flow

High Flow Rate 1.5  $\pm 0.15$  L/min  
Low Inlet Flow Rate 0.6  $\pm 0.06$  L/min  
Aerosol Flow Rate 0.6  $\pm 0.06$  L/min

### Response Time (95% Response to Concentration Step Change)

High Flow (1.5 LPM)  $\sim 3/4$  second  
Low Flow (0.6 LPM)  $\sim 1$  second  
Rise Time (10-90%) < 300 milliseconds  
Time Constant ( $\tau$ )  $\sim 130$  milliseconds

### False Background Counts

< 0.01 particles/cm<sup>3</sup> 12-hour average Dew point < 30 C (i.e. < 35°C @ 75% RH)

### Aerosol Medium

Air only

### Environmental Operating Conditions

Ambient Temperature Range 10 to 35°C (50 to 95°F)  
Dew point < 30°C (i.e. < 35°C @ 75% RH)  
Ambient Humidity Range 0 to 90% RH, non condensing

### Inlet Pressure Operation (Absolute)

75 to 110 kPa (0.75 to 1.1 atm)

### Inlet Pressure (Gauge)

0 to -5 kPa (-20" H<sub>2</sub>O)

### Condensing Liquid

Water (distilled (< 6 ppm) or HPLC water; tap water must not be used)

### Water System

External 1L bottle used in recycle mode for up to 30 days of continuous operation

### Water Consumption

< 33 ml/day

### Vacuum

Internal vacuum pump

### Outputs

Interfaces RS-232, USB, Ethernet, or USB Flash Drive  
Digital Display 6" color touch screen interface  
Analog Output BNC connector, 0 to 10V proportional to concentration (log scaling)  
Protocol Command set based on ASCII characters

### Power Requirements

100 to 240 VAC, 50/60 Hz, 200 W maximum

### Physical Features

Dimensions (H x W x D) 30.5 x 16 x 36 cm (12 x 6.25 x 14.25 in.)  
not including water supply bracket  
Weight 8.2 kg (18 lbs)

### Software

TSI Aerosol Instrument Manager® software included for CPC. TSI SMPS™ spectrometer software compatible

### Calibration

Recommended annually

## TO ORDER

### General Purpose Water-based Condensation Particle Counter

Specify	Description
3787	General Purpose Water-based Condensation Particle Counter with TSI Aerosol Instrument Manager® Software for CPC

### Optional Accessories

Specify	Description
3031200	Environmental Sampling System (includes a standard PM10 inlet, a PM1 cyclone, a flow splitter and a Nafion® dryer)
1187001	Model 3787 maintenance kit
376060	Particle Size Selector with 11 screens: adjusts 3787 lower end efficiency cut-point between $\sim 0.014$ and $\sim 0.2 \mu\text{m}$
376061	Additional screens for Particle Size Selector, set of 12. Adjusts 3787 cut-point up to $\sim 0.45 \mu\text{m}$

Specifications reflect typical performance and are subject to change without notice. The technique of using a Condensation Particle Counter with diffusion screens to select specific size ranges is covered in U.S. Patent Number 5,072,626.

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