Model 3022A
Condensation Particle Counter

The Model 3022A is a general-purpose Condensation Particle Counter (CPC) that detects airborne particles greater than or equal to 7 nanometers in diameter. Its unique advantage is that it detects these small particles over a wide range of concentrations. Using both single-count and photometric detection modes, the Model 3022A provides highly accurate measurements, even in concentrations up to $10^7$ particles per cubic centimeter. That’s several orders of magnitude higher than other continuous-flow particle counters!

The Model 3022A offers many features that contribute to its overall versatility:

- A laser-diode light source and ruggedized optics ensure reliability, even in the field.
- An automatic fluid-filling system minimizes required maintenance, allowing you to monitor submicrometer particles continuously for weeks unattended.
- A selectable aerosol-inlet position provides great flexibility when determining experimental setups.
- A built-in microprocessor handles all data-processing tasks and monitors and controls temperatures, flow rates, and photodetector output for you.
- An RS-232 output port allows the CPC to interface directly with your computer.

The successor to TSI’s widely used Model 3020,* the Model 3022A benefits from over 20 years of development experience. Building upon this heritage, the Model 3022A provides added features that make it the standard against which all sensors of this type should be compared.

TSI is the world’s leading manufacturer of high-performance CPCs. We offer additional models to accommodate specific needs. A comparison chart describing our complete line of CPCs appears on the back of this document. Contact your TSI representative for more information.

*TSI Model 3020 is no longer available.
APPLICATIONS

- Basic aerosol research
- Outdoor and indoor air-quality research
- Filter and air-cleaner testing
- Particle shedding and component tests
- Particle formation and growth studies
- Atmospheric and climate studies
- Particle counter calibration (when used as the reference standard)
- Combustion and engine-exhaust studies
- Inhalation or exposure-chamber studies

The Model 3022A is available in either a standard or a scanning configuration. The scanning version, Model 3022A-S, is required for use in TSI Scanning Mobility Particle Sizer (SMPS) systems. Collectively, SMPS systems configured with a 3022A-S provide size-distribution measurements from 0.007 to 1.0 micrometer. Specific size ranges vary depending on the Differential Mobility Analyzer used.

OPERATION

CPCs take advantage of the principle that supersaturated vapor condenses on small particles. An internal pump draws the aerosol sample into the Model 3022A. The inlet can be configured for high-flow operation (1.5 liters per minute) to speed response time and minimize transport loss, or low-flow operation (0.3 liters per minute) to provide flexibility when used as part of an SMPS system. A linear-element flowmeter controls the flow volumetrically.

Upon entering the instrument, the sample passes through a heated saturator, where butanol evaporates into the air stream and saturates the flow. The aerosol sample then passes into a cooled condenser tube, where vapor supersaturates and condenses onto the airborne particles. This produces larger, easily detectable aerosol droplets. These droplets pass through an optical detector immediately after leaving the condenser.

For concentrations below $10^4$ particles per cubic centimeter, the detector counts individual pulses produced as each particle (droplet) passes through the sensing zone (single-count mode). Higher concentrations up to $10^7$ particles per cubic centimeter are measured by detecting light scattered by all particles in the sensing zone at any one time and comparing the intensity of the scattered light with calibration levels (photometric mode).
SPECIFICATIONS

Particle size range
Minimum detectable particle: 50% of 7-nm particles
Maximum detectable particle: >3 μm

Particle concentration range: 0 to 9.99 × 10^6 particles/cm^3; counts single particles in concentrations from 0 to 10^4 particles/cm^3; photometric calibration from 10^4 to 10^7 particles/cm^3; provides running-average over 1, 2, 20, and 200 seconds depending on concentration range; display updated every second

Concentration accuracy: ±10% up to 5 × 10^3 particles/cm^3, ±20% from 5 × 10^3 to 10^7 particles/cm^3; coincidence less than 2% at 10^4 particles/cm^3; live-time particle counting from 10^3 to 10^4 particles/cm^3 provides automatic correction for coincidence

False background counts: <0.01 particle/cm^3

Response time: <13 sec for 95% response to concentration step change when sampling in high-flow mode; <20 sec for low-flow mode

Aerosol medium: Recommended for use with air; safe for use with inert gases such as nitrogen, argon, and helium (Performance specifications are for air.)

Signal-to-noise ratio: 25:1 nominal

Light source: Stable, 5-mW, 780-nm laser diode

Flow
Aerosol flow rate: 300 ± 15 cm^3/min
High-flow inlet: 1500 ± 150 cm^3/min
Low-flow inlet: 300 ± 15 cm^3/min

Flow control: Automatic volumetric flow control calibrated using pressure drop across capillary to control an internal carbon-vane pump

Condensing liquid
Working fluid: Reagent-grade n-butyl alcohol (not included)

Filling system: Electronic liquid-level sensor initiates automatic filling as needed, requires connection to fill bottle (provided with instrument)

Operating temperatures
Saturator: 35 ± 0.3 °C
Condenser: 10 ± 0.3 °C
Optics: 36 ± 2.0 °C

Communications
Protocol: Command set based on ASCII characters
Interface: RS-232, 9-pin, “D” subminiature connector, pinouts compatible with standard IBM-style serial cables and interfaces

Outputs
Digital display: Concentration, total counts, status (temperatures, aerosol flow, photodetector voltage)

Analog: BNC connection, 0 to 10 volts, user-selectable function output (linearized concentration, log concentration, aerosol flow, pump control, photodetector voltage) (For use in TSI SMPS systems, a Host mode allows output to 11 volts.)
Pulse: BNC connection, 13V square pulse, typically 3.3 μsec wide

Software: Supplied with CPCount™ Software

Calibration: Recommended annually; calibrated with 50-nm monodisperse NaCl using primary differential mobility analyzer method

Power requirements: 100/120/230/240 VAC, 50/60 Hz, 200 W maximum

Physical features
Front panel: 12-digit LED-pixel display, aerosol sample inlet, indicator lights (particle, laser, flow, temperature, liquid status), operating buttons
Rear panel: Power connector, fuse, 9-pin serial connector, three BNC connectors, fan, liquid-fill and drain connectors, makeup-air port, pump-exhaust port, fill bottle with bracket

Dimensions (LWH): 24 cm × 38 cm × 20 cm (9.5 in. × 15 in. × 8 in.), not including fill bottle and bracket

Weight: 12.5 kg (27 lb)

Environmental operating conditions
Ambient temperature range: 10 to 35 °C
Ambient humidity range: 0 to 90% RH, noncondensing

Specifications are subject to change without notice.
Specify Description
3022A Condensation Particle Counter with CPCount™ Software
3022A-S Condensation Particle Counter with Fast-scanning EPROM and CPCount™ Software
EP3022-S Fast-scanning EPROM only (for upgrading Model 3022)
EP3022A-S Fast-scanning EPROM only (for upgrading Model 3022A)

The Model 3022A-S is a standard component in selected Scanning Mobility Particle Sizer (SMPS) systems. Ask your TSI representative for additional information on SMPS systems.

Accessories
Specify Description
376060 Particle Size Selector
376061 Additional screens for Particle Size Selector (set of 12)

Accessories must be ordered separately. TSI, the TSI logo, and CPCount are trademarks of TSI Incorporated. IBM is a trademark of IBM Corporation.

**COMPARISON CHART**

<table>
<thead>
<tr>
<th>TSI Condensation Particle Counters</th>
<th>3010</th>
<th>3022A</th>
<th>3025A</th>
<th>3760A</th>
<th>3762</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum particle size (50% efficiency, nm)</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Aerosol flow rate (cm³/min)</td>
<td>1000</td>
<td>300</td>
<td>30</td>
<td>1500</td>
<td>3000</td>
</tr>
<tr>
<td>Upper concentration limit (particles/cm³)</td>
<td>10⁴</td>
<td>10⁷</td>
<td>10⁴</td>
<td>10⁴</td>
<td>5 × 10³</td>
</tr>
<tr>
<td>Lower concentration sensitivity (particles/cm³)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>False background counts (particles/cm³)</td>
<td>&lt; 0.00001</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>&lt; 0.00005</td>
<td>&lt; 0.00005</td>
</tr>
<tr>
<td>Response time (sec for 95% response)</td>
<td>&lt; 5</td>
<td>&lt; 13</td>
<td>1</td>
<td>&lt; 3</td>
<td>&lt; 1.5</td>
</tr>
<tr>
<td>Vacuum source</td>
<td>External</td>
<td>Internal pump</td>
<td>Internal pump</td>
<td>External</td>
<td>External</td>
</tr>
<tr>
<td>SMPS compatibility</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

TSI offers the most complete set of scientific CPCs available anywhere. (Model 3762 is not pictured. It has the same appearance and dimensions as Model 3760A.) The comparison chart, above, lists the major differences between our CPCs. Contact your TSI representative for more information.

**BIBLIOGRAPHY**


For the most current information available on this instrument, go to www.tsi.com and select “Particle Instruments.”