Microtrac S3500

Microtrac S3500 Series Particle Size Analyzer with Tri-laser Technology

SL-PS-01 Rev.C

Since the early 1970's Microtrac has a tradition of delivering innovative solutions in Particle Size Analysis through light scattering technology. The S3500 series is a continuation of that tradition. Utilizing the patented Tri-Laser Technology the S3500 provides accurate, reliable and repeatable particle size information for applications ranging from research and development to production, process and quality control. By increasing the number of light sources incident on the material being measured the S3500 Tri-Laser system makes more effective use of photo-detection devices while maintaining maximum stability and alignment of the optical system.

The Microtrac \$3500 complies with or exceeds ISO 13320-1 particle size analysis – light diffraction methods.

Main features of the S3500 Particle Size Analyzer are

- Resolution. The patented Tri–laser, multi-detector optical system delivers unsurpassed resolution over the entire measuring range of the instrument.
- Accuracy. Microtrac S3500 utilizes full Mie compensation for spherical particles. It also applies proprietary Modified Mie calculations for non-spherical materials – the majority of real life materials. This feature is unique to Microtrac!
- Stability. Optical bench design incorporating fixed detectors and lasers provides a rugged platform for consistently repeatable measurements. The enclosed optical path ensures protection of the optical components leading to little or no operator intervention.
- Alignment. Laser alignment is automatic. The overall optical bench stability ensures that auto-alignment is not routinely required.
- Range. Measurement capability is from 0.024 to 2800 microns covering most particle size analytical requirements.
- Detector Activity. Non-scanning, simultaneous parallel channel integration provides full constant signal accumulation to maximize signal acquisition.
- Wet and Dry Measurements. Using a selection of wet and dry sample delivery systems the S3500 can be converted from wet to dry mode in under 2 minutes.
- Flexibility. The modular design allows the user selectable configurations based on application requirements. The S3500 system is easily up-gradable to meet future requirements.
- Automation. Microtrac FLEX software allows programming, saving and recalling of Standard Operating Procedures (SOP's). This facilitates increased precision in sample preparation and operation through automated, multi sample accessories.
- Calibration. Internal uniform light source utilized for testing and calibrating detector segments.
- Validation. Full IQ/OQ support documentation available. The S3500 system meets or exceeds 21 CFR Part 11 security requirements.





Microtrac S3500

Tri-Laser Technology

The TRI-LASER System developed by MICROTRAC allows light scattering measurements to be made from the forward low-angle region to almost the entire angular spectrum (approximately zero to 160 degrees). It does so by a combination of three lasers and two detector arrays, all in fixed positions. The primary laser (on-axis) produces scatter from nearly on-axis to about 60 degrees, detected by a forward array and a high-angle array, both of which have logarithmic spacing of the detector segments. The second laser (off-axis) is positioned to produce scatter beyond the 60 degree level which is detected using the same detector arrays. The third laser (off-axis) is positioned to produce backscatter, again using the same detector arrays. This technique effectively multiplies the number of sensors that are available for detection of scattered light.



During a measurement cycle, Laser 1 is switched on while Lasers 2 and 3 remain inactivated. The sample to be measured scatters light in an angular pattern depending on the material size. The scattered light from Laser 1 is detected by the on-axis, forward detector and the off-axis, high angle detector. Laser 1 is then switched off and Laser 2 is activated. Laser 2 is directed at the sample at a different angle of incidence providing a different optical axis. Light scattered by the sample is detected by the same fixed detectors. Laser 2 is then switched off and Laser 3 is activated. Again the angle of incidence and optical axis is different. In this case the fixed detectors detect light that is back–scattered by the sample. The resultant scattered light information from all three lasers is combined to generate particle size distributions with unsurpassed resolution. Tri laser technology is proprietary and is patented by Microtrac.





The Software

The Microtrac S3500 Series is operated through the versatile Microtrac FLEX software package. The primary functions of making measurements, saving and retrieving data are easily achieved through intuitive menu driven software which combines flexibility and ease of use.



The main features of Microtrac FLEX software are

Measurement Criteria - Particle and carrier optical properties such as refractive index and shape are easily programmed for different materials. Other criteria like sample analysis time, sample ID and data presentation options are easily accessed through the SOP/SETUP icon.

Automatic Measurements - Automated measurement sequences can be programmed in combination with a selection of sample delivery systems. Levels of automation can be selected by the user.

Standard Operating Procedures (SOPs) - FLEX software facilitates the programming, saving and recall of measurement setups in accordance with standard operating procedures.

Database Management - Measurements are saved in Microsoft Access Encrypted Database Format. Analyses are easily recalled through a comprehensive search function for either review or comparison. Export functions - Data can be automatically or manually exported in either ASCII, excel or HTML formats. The user decides the export destination.

Data Tolerance (Pass/Fail function) - The operator can set upper and lower size limitations for material specifications. Useful in quality control applications.

Statistical Analysis Package - Live display of analyses as they are performed providing statistical analysis on an ongoing basis.

Trending - Ability to graphically plot individual size parameters over a specific time period or material type.

Report Generation - Microtrac FLEX software provides the user with the ability to design custom reports.

Security - FLEX software incorporates a comprehensive security administration facility allowing password access and electronic signature allocation.

21 CFR Part 11 - FLEX software is fully validatable with audit tracking in compliance with 21 CFR Part 11.

Microtrac S3500: Specifications

| Meauring Range | 0.02 to 2800 Microns | | |
|--|--|---|---|
| Basic Range | Wet: 0.7 to 1000 um | Dry | Ory: 0.7 to 1000 um |
| High Range | Wet: 2.75 to 2800 um | Dr | Dry: 2.75 to 2800 um |
| Standard Range | Wet: 0.24 to 1400 um | Dry | Dry: 0.24 to 1400 um |
| Special Range | Wet: 0.086 to 1400 u | n Dr | Dry: 0.24 to 1400 um |
| Extended Range | Wet: 0.021 to 2000 u | n Dr | Dry: 0.24 to 2000 um |
| Enhanced Range | Wet: 0.021 to 2800 u | n Dry | Dry: 0.24 to 2800 um |
| | | | |
| Precision | Spherical Glass Bead | ds D50 = | = 642 micron, Precision as $CV = 0.7\%$ |
| | Spherical Glass Beads | D50 = 5 | 56 micron, Precision as CV = 1.0% |
| | Spherical Latex Beads | D50 = 0 | 0.4 micron, Precision as $CV = 0.6\%$ |
| Lasers | Wavelength 78 | 0nm | |
| Power | 3mW nominal | | |
| | | | |
| Detection System | Two fixed photo-electr correct angles for opti detector segments. | ic detect mal scat | ctors with logarithmically spaced segments placed at attered light detection. 0.02 to 163 degrees using 151 |
| Data Handling | Volume, Number and A Data is stored in ODBC compatibility with ext ensured using FDA 21 protection, electronic | Area dist I format ernal sta CFR Part signature | stributions as well as percentile and other summary data. It in encrypted Microsoft Access Databases to ensure tatistical software applications. Data integrity may be art 11 compliant security features including password ures and assignable permissions. |
| Typical Analysis Time. | 10 to 30 seconds | | |
| Electrical. | AC input: 90 – 132 V/ 200 to 265 VAC, 47 – 6 | AC , 47 - 3 Hz, sin | - 63 Hz, single phase ingle phase |
| Power Consumption | 25 VA maximum | | |
| Environmental | Temperature: Humidity: Storage Temperature: Pollution | 1 9 -1 [| 10 to 35 Degrees C. (50 to95 Degrees F) 90% RH, non-condensing maximum 10 to 50 Degrees C (14 to 122 Degrees F)(Dry only) Degree 2 |
| Physical Specifications Finishes Dimensions Weight | Case Materia: Exterior Surfaces finis 14H x 22W x 18D in 60 lbs (27 kg) | Ste hed with (360H x | teel and impact resistant plastic ith corrosion resistant paint or plating x 560W x 460D mm) |
| Dry Operation | | | |
| Eductor Air Supply | 100 psi (689 kPa) maxin 5 CFM at 50 psi (345 k Free of dry contamina | num pre Pa) minii nts, mois | ressure himum flow rate bisture and oil. |
| Vacuum | No greater than 50 C | FM | |
| Contact Details For more information on the S350 other Microtrac products contact <i>I</i> (+1) 727 507 9770 or contact your Representative or log on to our we www.microtrac.com | 0 as well as Microtrac Inc at Iocal Microtrac ebsite at | Your I | r local Microtrac Representative is |



Sample Delivery Controller (SDC)

Sample Delivery for Microtrac Laser Diffraction PSA

The Microtrac Sample Delivery Controller (SDC) increases the accuracy and consistency of your particle sizing operation in a number of ways:

- The automated filling, de-aerating, pre-circulating and circulating operation means each sample is handled with a consistency that improves the repeatability of particle size distribution data.
- An in-line ultrasonic probe with variable power disperses agglomerated materials to ensure consistent sample dispersion during measurements.
- The Sample Delivery Controller is capable of delivering Wet dispersions or Dry Powder materials to the Microtrac range of Particle Size Analyzers.
- Versatility—Users can program, save and recall all operating commands such as routines for fill, disperse, measure, rinse and run commands.
- C onnectivity— The SDC's separate FILL pump allows the user to connect to any water or solvent source. The recirculator fills, de-aerates, auto-dilutes and pre-circulates automatically. The SDC communicates with the Microtrac FLEX operating software system through a USB connection via the Microtrac optical bench
- Durability— The rugged industrial design of the SDC features non-corrosive materials—stainless steel, Glass, Titanium and Teflon.
- Footprint— The SDC provides high functionality in one of the smallest packages available saving valuable laboratory bench space.
- Self-Cleaning— The washdown feature in the sample vessel ensures the walls of the vessel are thoroughly cleaned during the "rinse" cycle. This insures that there is no "carry-over" of material during repeated measurements.
- A uto-Dispersion— The SDC fluid dynamics feature built-in turbulance to ensure that all particles are moving constantly within the flow negating the need for an external stirrer.
- Solvent Compatibility— The SDC operates with all standard solvents that may be used in most applications.
- Auto-Sampling— The Microtrac FLEX software allows users to program fully automatic measurement routines.
- The SDC can also be used with the MAC26 autosampler to provide full autosampling for multiple samples.
- With a Microtrac Particle Size Analyzer, the SDC is fully compliant with 21CFR PartII protocols.





Sample Delivery Controller (SDC)

SDC Control Features

The SDC parameters are set by activating the Setup/SOP command in the Microtrac FLEX operating system and selecting the SDC/ASVR tab (below). Users can set the number of rinses, de-aration cycles and ultrasonic power and duration. For different materials these parameters can be stored under different names and recalled when required.

| Measurement Setup Options | - Measurement Setup Options |
|--|---|
| Timing Identifiers Analysis Perspective SDC/ASVR Dy Feeder | Timing Identifiers Analysis Perspective SDC/ASVR Dry Feeder |
| SDC/ASVR Options Auto Sequence Options | SDC/ASVR Options Auto Sequence Options |
| SDC/ASVR Information Control Default Number of Rinses: 3 × New Params Name Deaerate Cycles: 0 × Default Flow Rate: 55 × Ultrasonic Power: 25 × | Fill / Rinse Sample Loading Initial Rinse Ultrasonic Option Setzero Manual Perform Setzero I Auto Dilute I Continue until Valid Pause After |
| Save Delete Ultrasonic Time: 35 - | Auto Sequence I Auto Sequence Number of Cycles Run I Pre-Run Circulation Time OK Cancel |

The user also has the ability to program Auto-Sequence options: Parameters that can be set are

- Fill/R inse— By ticking this dialog, an initial rinse is programmed to occur before each sample measurement.
- Setzero— Setzero (blank measurement) is a background measurement performed on all Microtrac Particle Size A nalyzers. In most cases it is preferable to perform a setzero before each set of measurements. By ticking this box, a setzero is scheduled to be run for each auto-sequence cycle. The "Continue until V alid " feature forces the system to perform a rinse cycle and repeat the Setzero when a high background is detected.
- A uto Sequence— Determines the number of cycles or samples in each sequence.
- Sample L oading— After the setzero is deemed, valid the sample loading screen is displayed and the sample is added. T he user can select an Auto Dilute function where the SDC automatically drains 10% of the dispersion and adds the same amount of dispersing fluid. It will continue to do this until the sample concentration is correct. The user can also select a pause after loading but must then initiate a measurement manually before the sequence continues.

Built-In Ultrasonic - Can be programmed to run automatically or operated manually.

• R un— A pre-run circulation time can be programmed to allow the dispersion to stabilize before measurement.

The Auto Sequence is initiated by activating the





SDC Control Icons in Microtrac FLEX Software



Fills the vessel from reservoir or fluid supply source by activating the fill pump.



Activates Drain valve and pumps fluid to drain or reservoir.



Activates recirculation pump at speed selected in "SETUP" SOP.



Turns recirculation pump off.



Increases recirculation pump speed in increments of 5%.



Decreases the recirculation pump speed in increments of 5%.



Reduces concentration of dispersion in vessel by venting 10% of vessel volume and refilling from dispersion fluid reservoir or source.



Rinses vessel by draining the dispersion and then filling with clean fluid. Number of rinses is determined from the SOP/Setup dialog.



Activates ultrasonic probe at the power and duration programmed in the SOP/Setup dialog.

Turbotrac

Dry Powder Disperser

SL-PS-05 Rev. D

TURBOTRAC from Microtrac is a dry powder dispersion system for use with the Microtrac S3500 Series Particle Size Analyzer. Turbotrac's primary function is to deliver properly dispersed sample to the measuring cell in the Microtrac optical bench allowing for consistent and repeatable particle size analyses of dry powders.

Main features of the Turbotrac System are:

- Flexibility of compressed air and flow conditions settings allow the operator to achieve dispersion usually associated with fluid dispersal systems for highly agglomerated materials such as alumina. Dispersion conditions can be altered for the measurement of the most fragile crystals.
- Small Sample Volumes. Sample volumes can be as small as 0.1 cc. Ideal for applications where sample is expensive to produce or produced in small volumes.
- Rapid Measurements. Measurement time is typically 10 seconds with the Turbotrac Automatic Mode or even shorter using the Microtrac One-Shot accessory for very small sample volumes.
- Automatic Sampling. Microtrac FLEX software facilitates easy programming of measurement cycles. Simply place the sample in the sample tray, enter identifiers and press RUN. Data is saved on the system PC or can be exported to user networks or LIMS systems.
- Data Consistency. Data is comparable to fluid dispersions in most cases.
- Repeatability. Consistent control of aspiration settings deliver excellent sample to sample and bench to bench reproducibility.





Turbotrac

Turbotrac: How it works



A compressed air stream is used both as a carrier and a dispersing agent for the dry powder. The air stream is connected to the eductor block. The Turbotrac eductor nozzle incorporates a series of TURBOJETS set at multiple angles to the sample flow. This arrangement creates a number of mini-vortices within the sample flow which disperse the material. The eductor gap can be adjusted by raising or lowering the eductor nozzle resulting in increased or decreased sample dispersion. Air pressure settings and eductor gap settings are determined on the basis of the degree of dispersion required and the friability of the material being measured. The measured material is then collected by a vacuum system.

This combination provides unparalleled dispersion of dry powders for use in the pharmaceutical, biotech, food and beverage, ceramics, cement, metal powders and oxides, abrasives and general materials processing industries.

Turbotrac: Wet-Dry Data Comparison



Microtrac S3500 Wet-Dry Comparison Aluminum Oxide --5, 10, 18 and 65 Microns TURBOTRAC DRY versus SDC WET

The Turbotrac eductor system provides superb dispersion of dry powders through its unique Turbojet feature. Four different Aluminium Oxide samples were run in the Microtrac S3500 Particle Size Analyser. The samples were run wet in the Sample Delivery Controller (SDC) and dry in the Turbotrac Dry Powder Dispersion System. The samples had mean volume particle sizes of 5, 10, 18 and 65 microns respectively. As shown in the graphic, the dry Turbotrac data shows excellent agreement with the corresponding wet analyses.



Turbotrac: The software



Turbotrac operation is controlled from the Microtrac FLEX operating system. Feeder START, STOP, SEND HOME and CLEAN functions can be controlled by simply clicking on the relevant icon on the main FLEX screen. The Turbotrac Automatic Mode function allows the user to perform a full particle size analysis by simply clicking the AUTO icon to initialize the sequence. The sample to be measured is laid evenly on the sample tray. On starting the sequence the system invites the user to identify the sample by providing the relevant sample ID. Subsequently the vacuum system is activated followed by the activation of the pressurised airstream, both of which are controlled by internal valves.

A background check is then initiated to ensure the system is clean and to ensure validity of the analysis. The measurement cycle is started and the aspirator travels the length of the sample tray carrying the sample to the eductor. Microtrac performs the sample analysis and saves the data to the previously selected database. The pressurised airstream is turned off, followed by the vacuum system and the Turbotrac is then ready for the next measurement sequence.

Turbotrac: Specifications

| Particle Size | 0.25 to 2816 microns |
|----------------------------------|--|
| Physical | |
| Dimensions | 7.5″ H x 6.5″ W x 13.5″ D (191 H x 165 W x 343 D mm) |
| Weight | 10 lbs (4.5 kg) |
| Case Material | Door - Nalgene plastic; Covers - ABS plastic |
| Electrical | |
| Power | 12VDC and 24VDC provided by Microtrac Sample Delivery Controller (SDC) |
| Power Consumption | Included in maximum VA rating of SDC |
| Recirculator Interface | Standard 9 pin male-male straight through interface cable |
| Environmental | |
| Temperature (operating) | 10 to 35 Degrees C (50 to 95 Degrees F) |
| Temperature (storage) | -10 to 50 Degrees C (14 to 122 Degrees F) |
| Humidity | 90% RH, non condensing maximum |
| Pollution | Degree 2 |
| Connection Ports | |
| Vacuum Connection | Quick-disconnect fitting on S3500, 1.25 in tube (Standard Vacuum hose.) If supplied by user, vacuum source must exceed 50 CFM, 50 "H2O |
| Eductor Sample Connection | 3/8" tube fitting |
| Eductor Air Connections | 1/4" push-to-connect fittings |
| Eductor Air Supply | 100 psi (689kPa) maximum supply pressure 5 CFM at 50 psi (345 kPa) minimum flow rate Free of dry contaminants, moisture and oil |
| Materials in Contact with Sample | |
| Dry operation | Stainless steel, anodized aluminium (black chrome plated, stainless steel optional), PVC, HDPE |
| | Vacuum (subject to change by manufacturer), paper, cotton, glass fibre, aluminium, EVA |

Contact Details

For more information on Turbotrac as well as other Microtrac products contact Microtrac Inc at (+1) 727 507 9770 or contact your local Microtrac Representative or log on to our website at www.microtrac.com

Your local Microtrac Representative is



SDC Specifications

Dimensions and Weight

| Height: | 30.5 cms (12 in.) |
|---------|-------------------|
| Width: | 6.5cms (6.5in.) |
| Depth: | 42.4cms (16.7in.) |
| Weight: | 19Kg (42lbs.) |

Electrical

| V oltage: | 90 to 250 V A C |
|--------------------|--|
| Frequency: | 47 to 63 HZ |
| Power Consumption: | 200V A Max Wet only, 1000V A Max Wet and Dry model |

Environmental

| Temperature: | 5 to 40 Degrees C (operating) (41 to 104 Degrees F) |
|--------------|---|
| Humidity: | up to 90% non condensing |

Fluid

| V iscosity: | 5 cp maximum |
|-----------------|----------------------------|
| V olume: | 200mls nominal |
| Flow Rate: | 0 to 65 mls/sec with water |
| Inlet Pressure: | 50 psig maximum |

Ultrasonics

| Frequency: | 40K Hz nominal, self tuning to maintain consistent output |
|--------------|---|
| Power Level: | V ariable, 20 to 40 W atts, |
| Time: | 1 to 999 seconds programmable. |

Contact Details

For more information on Zetatrac as well as other Microtrac products, contact Microtrac Inc. at (+1) 727 507 9770 or contact your local Microtrac Representative or logon to our website at www.microtrac.com

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<u>USVR</u>

Ultra Small Volume Recirculator

SL-PS-08 Rev. D

The Ultra Small V olume Recirculator is a convenient solution for those users who either manufacture materials in small, high value amounts or for those who disperse their materials in expensive fluids. The USVR is used in combination with the Microtrac S3500/B luewave Series of Laser Diffraction Particle Size Analyzers. Along with the Sample Delivery Controller (SDC) and the Turbotrac Dry Powder Disperser, the USVR provides Microtrac users with a complete toolkit for the characterization of any material or dispersion.



The Ultra Small V olume Recirculator (USVR) used in combination with the Microtrac S3500/ Bluewave Series provides users with the best value/performance ratio with the smallest footprint of any Particle Size A nalysis system.

- Ultra-Small Recirculator Volume : 35 to 50mls
- Variable Speed Centrifugal Pump.
- Stainless Steel Vessel
- Compatible with most inorganic and organic solvents
- Manual Fill and Drain Valve
- Sample stirring using pump drive shaft to ensure consistent dispersion
- Simple, fast interchange with other Microtrac Sampling Systems





Technical Details

Electrical AC input: 90 to 250 VAC, 47 to 63 Hz single phase DC output: 24VD C Environmental Temperature: 5 to 40 Degrees Celsius (44 to 104 Degrees F) Humidity: 90% RH, non-condensing maximum Storage temperature: -10 to 50 Degrees Celsius (14 to 122 Degrees F) Pollution: Degree 2 Liquid V iscosity: 5cP Maximum Volume: 25ml nominal Flow Rate: 25ml/sec maximum. 0 to 100% variable motor speed. **Circulation Ports** Fittings: 3/8" 316 Stainless Steel Fluid return from Analyzer—Teflon 6mm OD Tubina: Fluid flow to Analyzer—Teflon 8mm OD 3 Way Valve: Material Perflouro Resin Drain: 8mm Teflon tubing Mixing Tank Material: 304 Stainless Steel Particle Size Particle Size : 700microns maximum (sample dependent) Density: 15g/ml maximum **Physical Specifications** Case Material: Stainless Steel Dimensions: 260H X 100W X 170D mm (10.2H X 3.9W X 6.7D inches) Weight: 4kg (8.8 lbs)

Contact Details:

For more information on USVR as well as other Microtrac products, contact Microtrac Inc. at (+1) 727 507 9770 or contact your local Microtrac Representative or logon to our website at www.microtrac.com

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