SOLUTION SHEET

FlexPDA system

Particle size and velocity measurement solutions



PDA system for particle dynamics measurement applications

PDA (Particle Dynamics Analyzer) – also known as PDPA (Phase Doppler Particle Analyzer) and PDI (Phase Doppler Interferometer) – is a well-established technique for the simultaneous measurement of particle size and velocity. PDA works as an extension to Laser Doppler Anemometry (LDA). Both are optical techniques ideal for non-intrusive point measurement in a wide range of fluid dynamics applications.

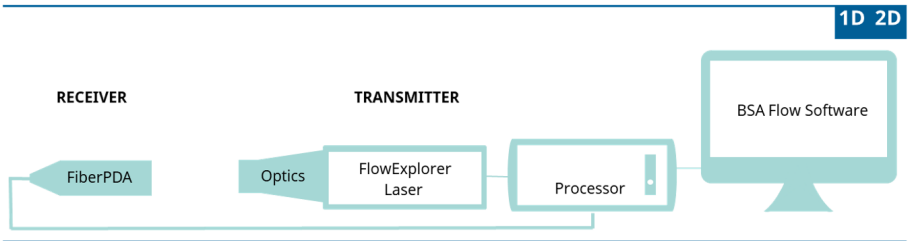
The FlexPDA solution inherits the best of PDA and LDA technology, resulting in a compact best-value system for simultaneous particle size and velocity measurement applications.

Key benefits

- Factory aligned transmitter optics
- Receiving probe with optical fibers for maximum flexibility
- Wide particle size measurement range, from 1 - 500 µm
- State-of-art signal processor to handle the most demanding applications
- Advanced, flexible, and feature rich software platform with a user-friendly interface
- Automatic phase calibration for accurate size measurements
- Attachment rail and mounting mechanisms for alignment in any PDA application
- Possibility to work completely as a standalone LDA system in backscattering mode
- Upgradable to other solutions

The FlexPDA solution

This solution is designed to deliver a complete entry-level PDA/LDA platform for particle size and velocity measurement. The system can be configured for 1D or 2D velocity measurements, and integrated with a 1D, 2D, or 3D traversing unit for spatial mapping.
The solution is based on four core components: transmitting optics, receiving optics, signal processor and software.
The transmitter optics convey two or more laser beams to the measurement volume, generating an interference fringe pattern where the “point” measurement is made. When a particle passes through these fringes, it scatters light modulated in intensity. The receiver optics collects the scattered light and sends it to the signal processor using optical fibers. Inside the processor, the light signal is converted into an electrical one via photomultipliers, where the digitized version of this signal in time is identified as a Doppler burst. Signal processing techniques extract the frequency and phase of these bursts, which contain information about the velocity and size of the particle that can be analyzed in software.



FlexPDA system – basic setup for 1D and 2D solutions.

Various options are available for advanced synchronization, analog inputs, velocity/particle size monitoring, independent processor control, and more allowing additional flexibility to customize the solution to meet unique measurement requirements.

Transmitting optics

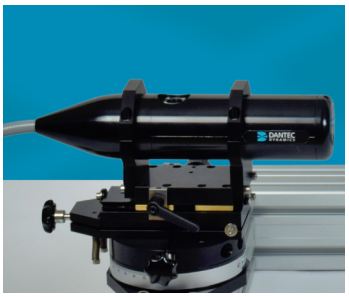
FlowExplorer – turnkey, compact and calibrated laser transmitter
The FlowExplorer is a compact, turnkey LDA/PDA transmitter which uses diode lasers of 70 or 90 mW for each component.
Since the optics are factory aligned and calibrated, the system is the ideal solution for applications requiring documentation of the measurement uncertainty.
The velocity calibration uncertainty is 0.11% (coverage factor 2). The velocity resolution is better than 0.002% of the chosen velocity range. The FlowExplorer can also be used as transmitter/receiver for pure LDA applications, giving the FlexPDA solution maximum flexibility.



FlowExplorer laser transmitter unit with rotation support for alignment with PDA receiver.

Receiving optics

Fiber PDA receiver
The FiberPDA receiving probe is designed to make PDA measurements across a wide range of applications. The FiberPDA employs a three-aperture mask and detector configuration integrated into a single compact fiber-optic probe. A fiber cable guiding three receiving fibers connects the receiving probe to the signal processor, which contains the photomultipliers.
A compact, lowight-weight design makes the FiberPDA probe easy to handle. It is factory aligned and requires no maintenance. A rugged fiber optics design with sealed optical fibers prevents dust contamination for an extended lifetime.
An achromatic composite lens is used to focus the detected scattered light from each individual aperture onto a separate receiving fiber. This solution ensures excellent transmission efficiency and signal quality.



FiberPDA receiver probe with rotation, tilt and translation support for alignment with LDA transmitter.

Measurement distances up to 400 mm are possible with standard front lenses. Through an eyepiece, the user can see the spatial filter and the laser probe volume, allowing precise and easy alignment of the PDA optics. The probe is mounted on a support allowing quick coarse positioning as well as fine adjustment of rotation, tilt, and translation for perfect overlapping.

Processor

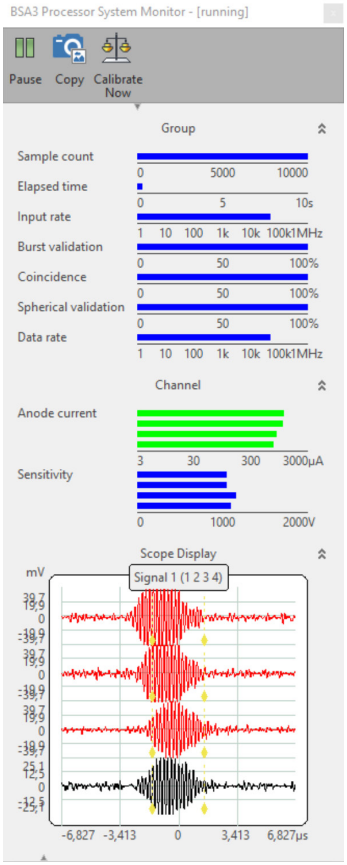
Burst Spectrum Analyzer (BSA) – fast and powerful all-in-one processor

The BSA F100 processor is a fast and powerful all-in-one processor. With Ethernet, Wi-Fi and USB interfaces included, the processor can be connected to a PC via a local area network, or a wireless or cabled connection. In large facilities or in situations where remote access is required, these features make it easy to have the processor near the experiment while keeping the PC at a greater distance away for safety and/or convenience. System setup is very easy and user friendly: the setup is done directly in velocity units, based on a center velocity and a velocity span value.

The BSA P100 processor has a maximum bandwidth of 5 MHz, making it the right choice for a wide range of applications in sprays and particle measurement. Depending on the optical configuration, the processor covers a velocity range up to more than 68 m/s. The BSA can handle date rates up to 100 kHz continuously and peak rates of 1 MHz.

Since the signals are analyzed by hardware/firmware inside the processor, the FlexPDA solution can provide real-time measurements. The user can monitor Doppler bursts, spectra, size and velocity data, data rate, validation rate and other information on-line and in real time.

PDA systems require an accurate measurement of the phase differences of light signals detected from different perspectives, which are then used to provide the particle size measurements. Therefore, calibration of the electronics is required to find and store the phase delays before data acquisition. This process is handled automatically by the BSA processor whenever required. The BSA processor includes an automatic overload protection feature for the photomultipliers (PM's). This protection quickly reduces the high voltage to the PM's when too much light is detected to prevent damage and extend the lifetime of these sensitive components. Please refer to the separate data sheet for further details on the BSA processor.

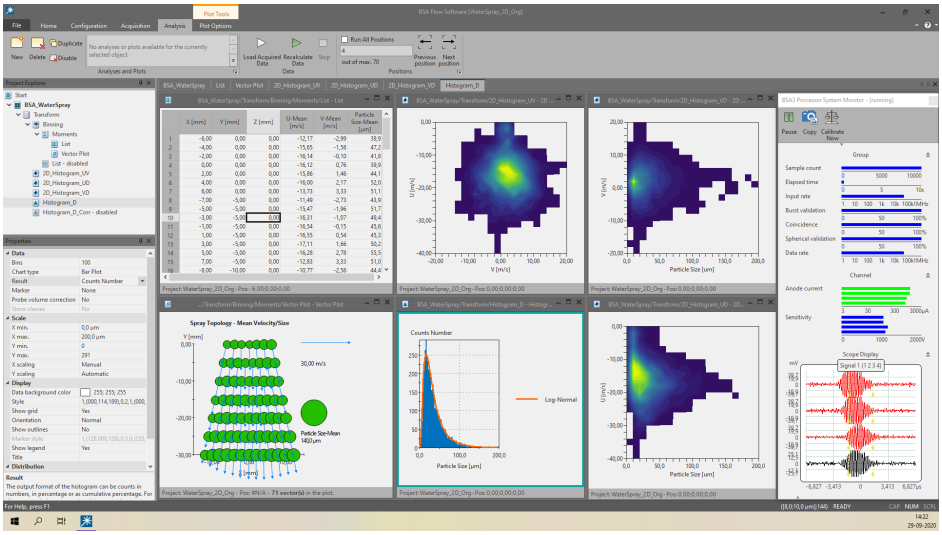


Real time display of signals, data rate, valiation rate etc. with the System Monitor.

Data analysis

BSA Flow Software – The most flexible and comprehensive software for PDA measurements

The FlexPDA solution includes the latest and most modern acquisition and analysis software for LDA/PDA applications, BSA Flow Software.
BSA Flow Software acquires, post processes, and presents data with extensive graphical features. Measurement results can be displayed on-line during acquisition in several formats such as Histograms, 2D/3D plots, Lists (individual result statistics), and a software signal monitor to verify the measurement quality.
The BSA Flow Software is intuitive and easy to use, thanks to its workflow-based user interface. Starting from the system setup, optical configuration and processor settings are controlled via software. Tools are provided which enable user-defined data analysis and display, updated during PDA measurements. Data analysis can be customized with a built-in Calculation module, with Python or via a MatLab link for ultimate flexibility. Graphical output includes vector plots, 2D line and scatter plots, and 3D plots. Both plots and numerical resultscan be transferred to a measurement report in PDF or HTML format. Numerical output includes binary, ASCII, MS Excel, and TecPlot formats. For further details on the software performance, please see the data sheet on "BSA Flow Software" available at our website.



The Dantec Dynamics BSA Flow Software is the most flexible and comprehensive software for PDA measurements.

Configurations

Item no.	Item name	Description
9061N0051	FlexPDA 1D	FlowExplorer 1D 90 mW BSA P100 1D 660 nm FiberPDA Receiving Probe 60 mm Diam., 5 m cable Probe Support, Rotation for FlowExplorer transmitter Probe Support, Rotation/Translation/Tilt for FiberPDA receiver L-Shaped Mounting Bench 1200 mm x 800 mm BSA Flow Software Advanced Graphics Add-on Particle Sizing Add-on Laser Alignment Eyewear Laser Protective Eyewear Front Lens for FlowExplorer (300 mm or 500 mm) Front Lens for FiberPDA (160 mm or 400 mm)
9061N0061	FlexPDA 2D	FlowExplorer 2D 90/70 mW BSA P100 2D 660/785 nm FiberPDA Receiving Probe 60mm Diam., 5m cable Probe Support, Rotation for FlowExplorer transmitter Probe Support, Rotation/Translation/Tilt for FiberPDA receiver L-Shaped Mounting Bench 1200 mm x 800 mm BSA Flow Software Advanced Graphics Add-on Particle Sizing Add-on Laser Alignment Eyewear* Laser Protective Eyewear Front Lens for FlowExplorer (300 mm or 500 mm) Front Lens for FiberPDA (160 mm or 400 mm)

** For 660nm, protects against 785nm*

Options

The FlexLDA system offers several options to meet the requirements of the application. The options include:

Processor upgrade: The BSA P100 processor can be upgraded to BSA P600 with 120 MHz max. frequency, or to BSA P800 with 200 MHz max. frequency, allowing for measurements of higher velocities.

Software add-ons: Spectrum/Correlation Add-on, Cyclic Phenomena Add-on, Scripting and MATLAB link Add-on, LIF and Parametric Analysis Add-on. Please see the separate data sheet on our website.

Traverse: A software controlled automatic traversing mechanism with 1D, 2D or 3D capability for flow mapping can be added to the system. Several standard traverse controllers are supported in the software. Please see the separate data sheet on our website.

Technical specifications

Transmitter Optics	FlowExplorer
Laser	Diode
Laser power	90/70 mW (1D/2D)
Laser wavelength	660/785 nm (1D/2D)
Focal length	300 or 500 mm
Measurement volume dimensions	0.09 x 0.09 x 0.92 mm^3 (300 mm focal length) 0.15 x 0.15 x 2.55 mm^3 (500 mm focal length)
Optics weight (excl. laser controller)	5 kg

Receiver Optics	FiberPDA
	FiberPDA 60 mm receiver probe Aperture masks for easy selection of size range Maintenance free optical fibres
Focal length	160 or 400 mm
Optics weight (excl. fiber)	0.8 kg

Processor	BSA P100	BSA P600	BSA P800
Max. Velocity	>40 m/s (300 mm focal length) >68 m/s (500 mm focal length)	>130 m/s (300 mm focal length) >220 m/s (500 mm focal length)	>390 m/s (300 mm focal length) >660 m/s (500 mm focal length)
Data rate	>100,000 bursts/sec		
Resolution	>16 bits		
Particle size range	from 0.5 µm >1 mm*		

**Depends on the optical setup, scattering angle and fluid properties.*

Software	Features
BSA Flow	Workflow-based user interface Real-time oscilloscope display of signals On-line display of data validation, data rate, coincidence rate, photomultiplier anode current Real-time end results thanks to multi-threading and decimation of displayed data Set up of BSA processor Acquisition of data from BSA Control of traversing system Statistics of results (mean, RMS, Skewness and Flatness) Listing of results Export of data
Advanced Graphics Add-on	Includes profile plots with confidence interval, vector plots, contour plots, 2D plots, and more
Particle Sizing Add-on	Enables PDA measurement, data analysis and result presentation

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