

# Ultrasonic Doppler Velocimeter **DOP4000**



UDOP

The DOP 4000 is a very compact and  
light instrument

It has been especially designed for fast  
and versatile acquisition in any  
situations where strong stationary  
echoes are present

It can also acquire simultaneously  
profiles from any of its 4 channels  
and realize 2D/3D measurements in  
real time.



# Overview

## A pulsed ultrasonic velocimeter

Like all other ultrasonic Doppler velocimeters manufactured by Signal Processing SA, the DOP4000 uses pulsed ultrasonic echo technique to measure velocity profiles. This instrument has been designed in order to fit almost all user's requests in terms of specifications and ease of use, especially when high level stationary echoes are present.

Like the DOP3010, the DOP4000 can measure instantaneously different types of profiles, such as the Doppler energy profiles, the echo profiles, the spectral density (FFT) and many other data profiles in flowing liquids. It computes and displays in real time these data profiles based on the analysis of a user's specified number of gates placed along the ultrasonic beam.

## The assisted mode

All the ultrasonic parameters (starting depth, number of gates, resolution...) and the processing conditions (PRF, TGC, number of emissions by profile ...) can be defined automatically or set by the user.

Based on very simple indications given by the user, such as the measurement depth along the ultrasonic beam and the maximum velocity to be measured, all the operating parameters are defined automatically. Tedious manual setting can therefore be avoided. Of course, advanced users can still fine-tune all these parameters or bypass this automatic mode.

The DOP4000 series also lets the user to set a quality factor of the measure, which defines an optimal trade-off between signal to noise ratio and sampling rate.

## High resolution

The DOP4000 can emit any ultrasonic burst having a period in the range from 100 ns to 2'220 ns. The time between two adjacent measuring points can be as slow as 170 ns and can be extended to 20 ms. Moreover a profile can contain up to 1000 gates.

The definition of the thickness of the sampling volumes are not only defined by the length of the ultrasonic burst, as it is some times mentioned, but also by the bandwidth of the instrument. To achieve an optimal resolution and a very good SNR ratio, the bandwidth of the DOP4000 has been fixed to 250 kHz.

## A sensitive instrument

The sensitivity is a very important parameter because it influences the range of possible application of the instrument. A high sensitive instrument allows measurements in liquids containing few particles and/or in liquids having high a attenuation coefficient. The sensitivity is defined as the minimum instantaneous power of the Doppler echoes from which Doppler information can be extracted.

Signal Processing made a lot of effort to offer very high sensitive instruments. This is why when many other instruments failed our ultrasonic velocimeters still deliver quality information.

## A plug and play device

Like the DOP3000 series an external PC or a laptop controls the instrument through its built-in USB interface.



# The key features

## Dynamic extender circuitry

The DOP4000 includes a special electronic circuitry, the dynamic extender, which extends the dynamic of the incoming Doppler signals that can be analyzed. This electronic circuitry is especially efficient in case of strong level of stationary echoes coming, for instance, from walls or reflections inside the high temperature sensor system. This circuitry improves the dynamic range by a factor of around 16 dB. The dynamic extender circuitry, can be switched on or off, depending the situation.

## Simultaneous acquisition on 4 channels

The DOP4000 can acquire simultaneously or sequentially profiles from any of its 4 channels. For all the channels, the parameters can be set independently, with the following restrictions in case of simultaneous acquisition: same PRF, same number of emissions by profile and same emitting power.

## Many instruments can be synchronized

The DOP4000 contains two connectors that can be defined by software as input and/or output. These 2 connectors allow a precise synchronisation of many DOP4000 instruments, extending the capability to acquire simultaneous profiles from different probes. The following signals can be also available on these connectors: PRF, acquisition region, profile pulse

## UDV 2D/3D capability (in option)

UDV 2D or 3D Ultrasonic Doppler Velocimetry measuring technique is a method that enables the measurement of two velocity components ( $V_x$  and  $V_z$ ) or three velocity components ( $V_x$ ,  $V_y$  and  $V_z$ ) simultaneously along a line. UDV 2D/3D has all the advantages of classical ultrasonic Doppler velocimetry, such as the capacity to realize measurements in non translucent liquids. One of the most interesting property of this technique compared to other techniques is that it can measure simultaneously more than one velocity component in real time. Only few tens of milliseconds are necessary to compute and display a complete 2D or 3D velocity field. This is not possible by means of use of the standard channels multiplexer.

The DOP4000 contains a special internal controller that manages the way the emitted burst is sent and the way the echoes are received from the 2 or 3 receivers.

Note that in order to be able to use this hardware an additional software package must be purchased and installed.

## Very small size and small weight

The aluminum case of the DOP4000 is only 264 x 155 x 69 mm

Its weight... only 1.5 Kg



# DOP4000

## Specifications

Ultrasonic emission	
Period of emitted pulse	from 100 ns (10 MHz) to 2220 ns (450 kHz) step of 20 ns
Emitting power	3 levels, approximated instantaneous maximum level_ Low = 10Vpp, Medium = 30 Vpp, High = 60 Vpp
Number of emitted cycles	from 2 to 32, step of 2 cycles
Pulse repetition frequency	from 0.1 Hz to 15'625 kHz (100'000 ms to 64 ms step 1 ms)

Reception	
Number of gates	from 4 to 1000 gates, step of 1 gate
Position of first gate	movable by step of 1 gate, but not earlier than the end of the emitted burst
Amplification (TGC)	Uniform: -40 dB to +40dB, step 1 dB Slope mode: linear in dB custom mode: number of cells from 1 to 1024
Sensitivity	> -100 dBm

Sampling volume	
Lateral size	defined by the acoustical properties of the transducer
Longitudinal size	defined by the burst length internal filter bandwidth : 240 kHz (around 0.8mm for C=1500 m/s, defined at 50% of the received signal level)
Display resolution	distance between the center of each sampling volume selectable from 0.170 to 20 ms, step of 0.170 ms,

Environment	
US interface	4 BNC, US probe In/Out (1 for each channel) 1 BNC emitted burst, output 2 BNC, TTL In/out, user defined, used as Trigger input and/or for synchronisation
Host PC Operating system	Windows (starting from XP version)
Power supply	110 - 220 VAC, 50 - 60 Hz
Communication	USB 2, Connector type B
Temperature	5 - 35 degrees
Sizes	264 x 155 x 69 mm
Weight	1.5 Kg

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Ultrasonic processor	
Doppler frequency	computation based on a correlation algorithm. 5 levels of the received Doppler energy may disable the computation Output value: signed byte format
Wall filter	IR high-pass filter 2nd order
Dynamic extender	Increase the dynamic of the Doppler signals by a factor of 16dB. User's selectable ON or OFF
Emissions per profile	from 8 to 512, any values minimum acquisition time per profile: about 2-3 ms
Filters on profiles	moving average: from 2 to 1000 profiles zero values included or rejected median: from 3 to 32 profiles
Velocity resolution	1 LSB, Value given in a signed byte format. Depends on velocity scale and emitting frequency
Velocity	variable positive and negative velocity range, movable origin. automatic computation of the projected velocity component along the flow axis
Compute and display	velocity profile, with or without histogram Doppler energy, with or without histogram echo profile, with or without histogram velocity profile with echo profile or Doppler energy velocity profile with v(t) of a selected gate power spectrum of one selected gated velocity profile and time-space velocity profile and flow rate
Cursor	4 available cursors in tracking mode (follow the displayed curve). Statistical values available (mean, standard deviation, minimum, maximum)
Additional tools	auto correction of the aliasing measurement of the ultrasonic field raw data acquisition (15'000 demodulated IQ values)

Acquisition	
External Trigger	manual or external signal (logic state) automatic record capability trigger delay: up to 32s, step of 1 ms
Data format	binary ASCII (only statistical values if desired)
Replay mode	replays a binary recorded measure
Acquisition mode	save the past (sizeable circular memory) record the future
Internal memory size	from 1 to 65'536 blocks each block containing from 1 to 64'000 profiles
Configuration parameters	9 saved configurations with description

Multiplexer	
Number of channels	4
Switching time	2 ms
Acquisition mode	sequential (channels measured one after the other) simultaneous (delay between channels of 1 PRF)

Options	2D /3D software package
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