Compact & Lightweight Bathymetric Depth Finder for Surveying Tasks

RIEGL BDF-1

- *Laser rangefinder for bathymetric applications*
- *Surveying system with integrated IMU, GNSS, and data storage unit*
- *Optimized for UAV-borne operation*
- *Ideally suited for generating profiles of inland waterbodies*
- *Optionally equipped with up to two external cameras*
- *Active pitch compensation*
- *Essential performance improvements in adverse conditions by predetection averaging*
- *Highly accurate, reliable and informative bathymetric data resulting from RIEGL's proprietary hydrographic waveform processing*

The *RIEGL* BDF-1 is a laser range finder specifically designed for bathymetric surveying tasks. The compact and lightweight device is ideally suited for generating profiles of inland waterbodies when operated from a UAV. The topo-bathymetric depth finder comprises of a tilt compensator, an IMU/GNSS unit with antenna, a control unit, and up to two external digital cameras.

The BDF-1 laser depth finder sends out laser pulses at a rate of 4 kHz. The echo signal for each laser pulse is digitized and recorded for the entire range gate of 50 m. This means that predetection averaging of the waveforms can be performed in post processing, increasing the depth performance. The averaging rate can be chosen after the flight on basis of the measurement conditions. Subsequently the waveforms are processed by *RIEGL's* new and patented hydrographic full waveform processing algorithm based on exponential decomposition. Finally data sets with high accuracy, high range resolution, and hydrography-specific attributes are provided which support point classification.
The BDF-1 is designed to be operated from low altitudes at moderate flight speed, as in surveying missions carried out by UAV. With a measurement rate of 4 kHz the distance of the measurements on the ground is in the range between 1 cm and 10 cm, depending on the flight speed and averaging rate.
An innovative optical design allows the device to be classified as Class 2M Laser Product which can be considered safe for the unaided eye.

Typical applications include

- *Generation of River Profiles*
- *Repeated Survey of Water Reservoirs*
- *Canal Surveying*
- *Landscaping*
- *Surveys for Planning and Hydraulic Engineering Work*

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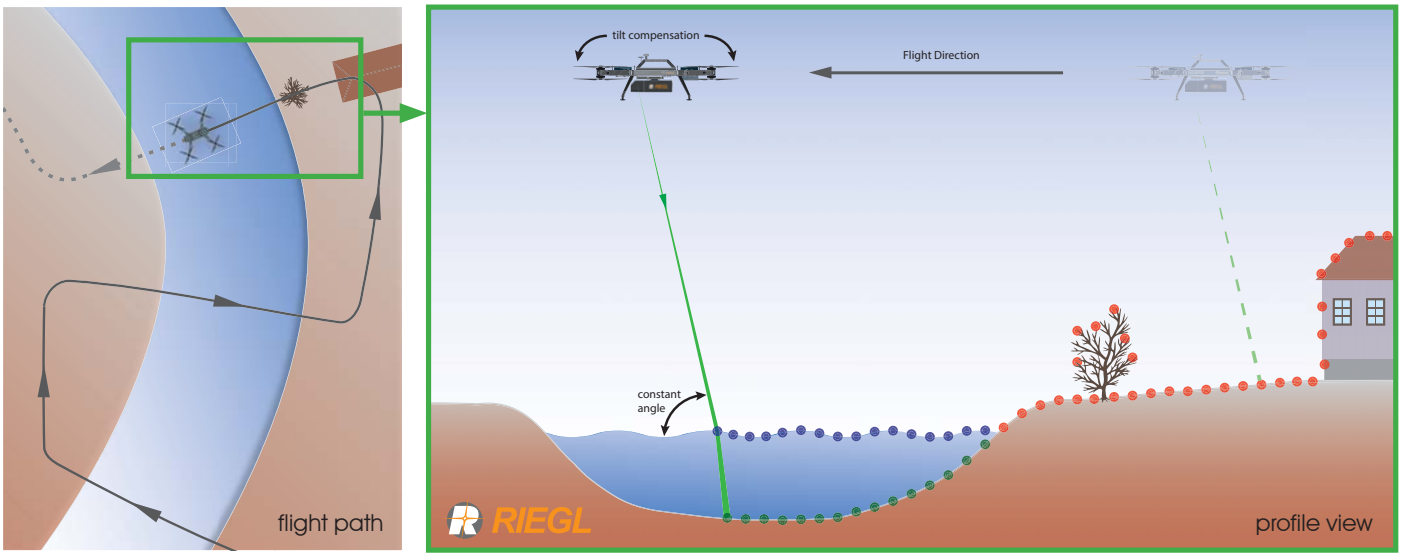
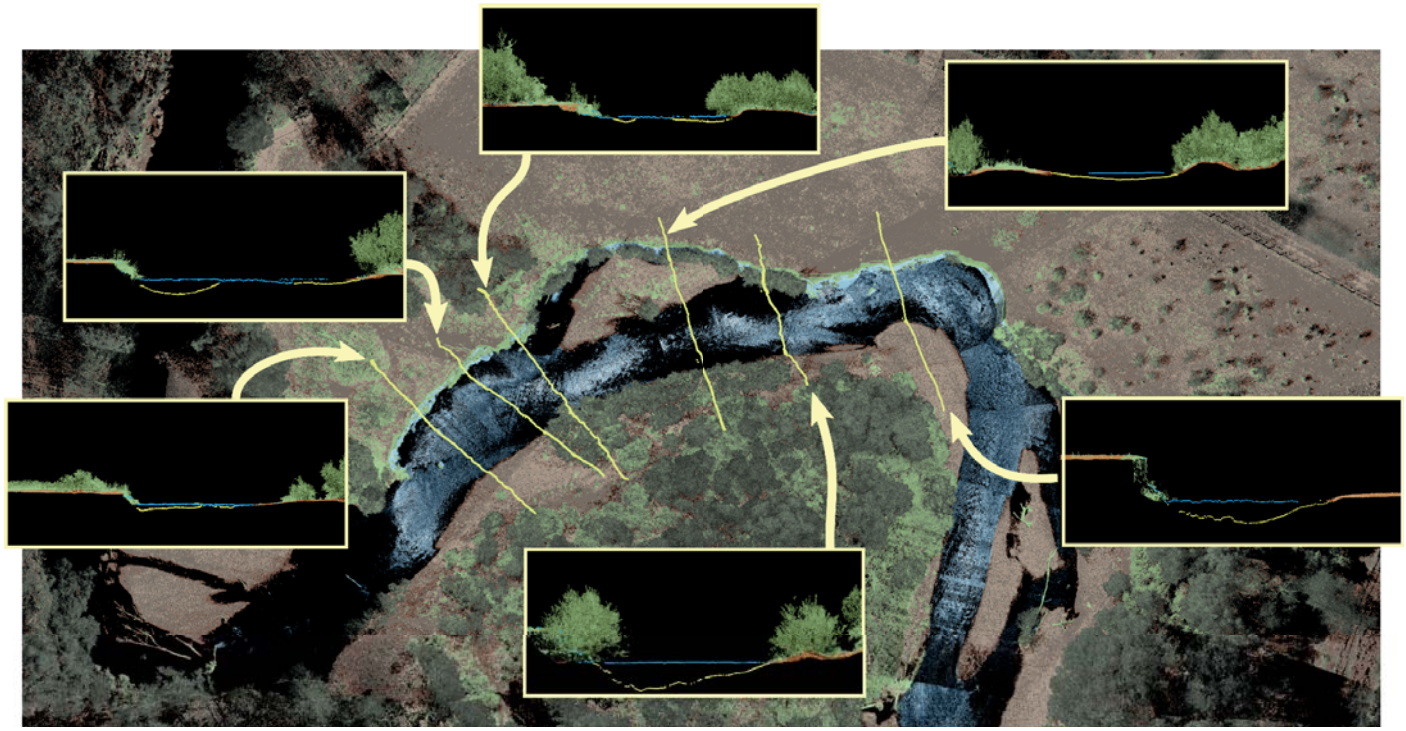
RIEGL®
LASER MEASUREMENT SYSTEMS

RIEGL BDF-1 Measuring Principle



The drawings above illustrate the measurement principle of the BDF-1 when operated from a UAV: The UAV performs a meander-like flight path over an inland water body (river, channel, or lake) while the BDF-1 is measuring downward. In case the optional tilt compensator is used, the measuring angle is user-defined and stabilized. Profiles of the water surface (blue dots), ground (green dots) as well as the surrounding landscape (red dots) are generated this way. The multi-target capability of the rangefinder is not only employed for separating the water surface from the ground but also for vegetation penetration.

RIEGL VUX-SYS Scan Data and *RIEGL* BDF-1 Profiles



Riverine zone surveying is a typical application of the *RIEGL* BDF-1:
The image above shows a colorized 3D point cloud acquired with a VUX-1UAV combined with profiles acquired by the BDF-1. Both devices were mounted on the RiCOPTER. The combined dataset provides comprehensive information about the topography of the river and its surroundings. The locations of the detailed river profiles are selected according to hydrographic viewpoints. They can be used to assess water transportation, roughness, and clarity.

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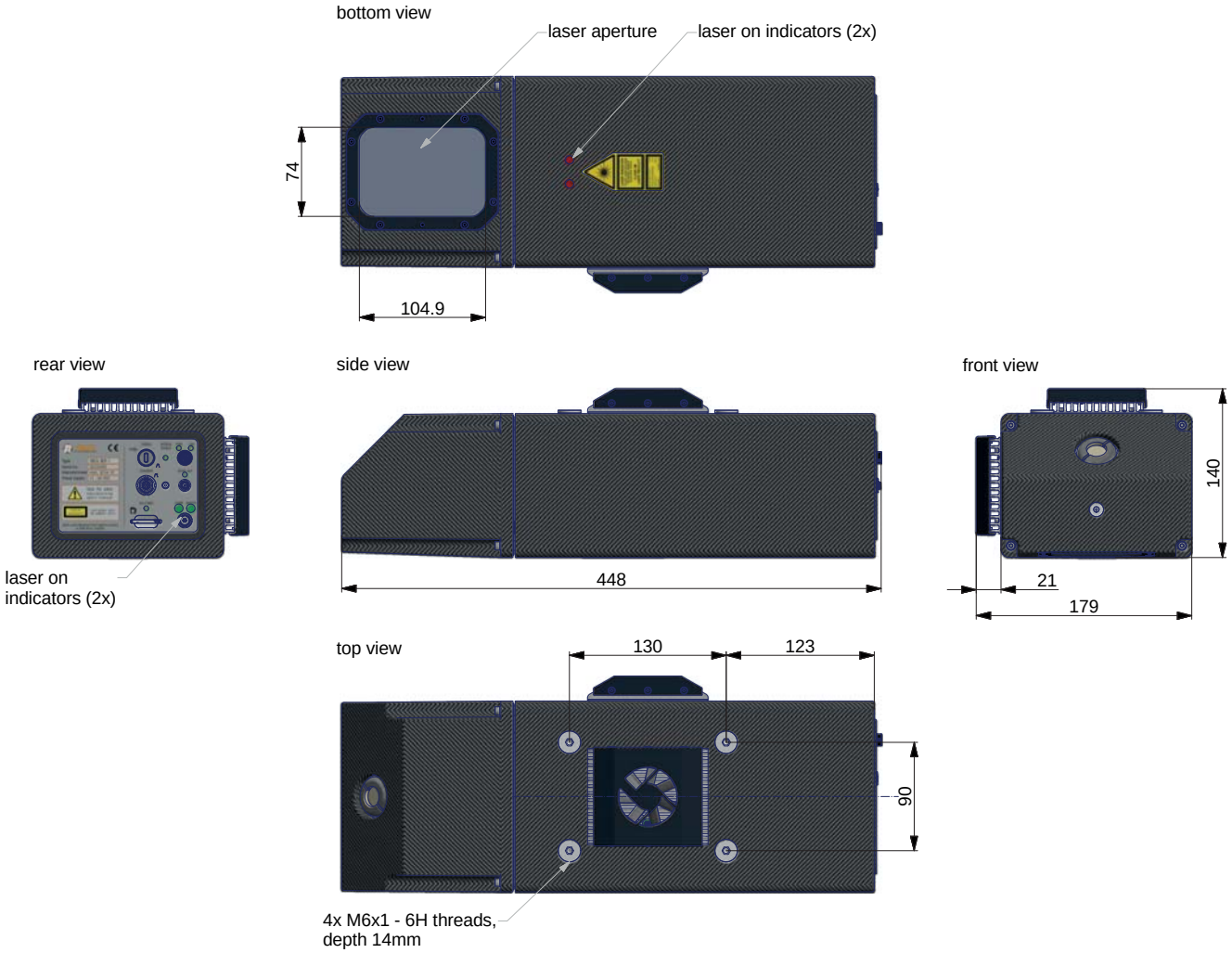
Dimensional Drawings *RIEGL* BDF-1

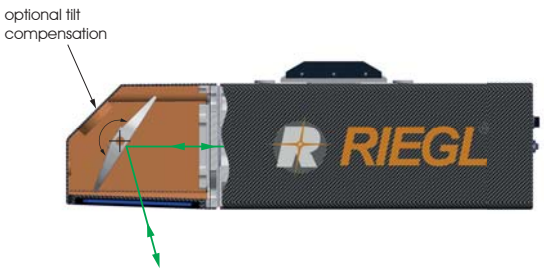


all dimensions in mm

Configurations *RIEGL* BDF-1

vertical setup
for static measurements

horizontal setup
with beam folding mirror including tilt compensation
for UAV-borne surveying



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Laser Product Classification	Class 2M Laser Product according to IEC 60825-1:2014

The following clause applies for instruments delivered into the United States: Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

Range Measurement Performance

Measuring Principle	time of flight measurement, echo signal digitization, online waveform processing, concurrent full waveform output for all measurements
Minimum Range	1 m
Maximum Range	50 m
Accuracy [1) 3)]	20 mm
Precision [2) 3)]	20 mm
Laser Pulse Repetition Rate	4 kHz
Achievable Secchi Depth vs. Measurement Rate[4)]	1.0 @ 4,000 meas./sec (single pulse) 1.2 @ 400 meas./sec (10 pulses averaged) 1.5 @ 40 meas./sec. (100 pulses averaged)
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	532 nm (green)
Laser Beam Footprint	approx. 70 mm @ 1 m approx. 20 mm @ 20 m

1) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.
2) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.
3) One sigma @ 15 m range under *RIEGL* test conditions.
4) Flight altitude 15 m above water surface.

Optional Tilt Compensator Performance[5)]

Single Axis Tilt Compensation Mechanism	swinging mirror
Compensation Range	up to 24°
Angle Measurement Resolution	0.0055°
Internal Sync Timer	for real-time synchronized time stamping of scan data

5) Tilt compensation is only available with Embedded GNSS-Inertial System

Data Interfaces

Configuration	LAN 10/100/1000 Mbit/sec
Scan Data Output	LAN 10/100/1000 Mbit/sec
GNSS Interface	Serial RS232 interface for data string with GNSS-time information, TTL input for 1PPS synchronization pulse
External Memory Interface	SDXC (SD 3.0) Slot (up to 2 TB)
External Camera	TTL input/output for up to two digital cameras
External GNSS Antenna	SMA connector

General Technical Data

Power Supply Input Voltage / Consumption	11 - 34 V DC / typ. 50 W
Main Dimensions (L x W x H)	140 x 179 x 448 mm
Weight	approx. 5.3 kg
Humidity	max. 80 % non condensing @ 31°C
Protection Class	IP64, dust and splash-proof
Max. Flight Altitude (operating / not operating)	16 500 ft (5 000 m) above MSL / 18 000 ft (5 500 m) above MSL
Temperature Range	0°C up to +40°C (operation) / -20°C up to +50°C (storage)

Optional Components (integrated)

Embedded GNSS-Inertial System	Applanix APX-15 UAV high performance multi-channel, multi-band GNSS receiver, solid-state MEMS IMU

Optional Components (external)

Digital Camera	RGB digital camera, 24.3 MPixel, APS-C, 24 mm focal length, FOV 83°

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