

Compact Fully Integrated Topo-Bathymetric Airborne LiDAR System with Online Waveform Processing and Full Waveform Recording

RIEGL VQ[®]-840-GE

IMPROVED PERFORMANCE

- **up to 200 kHz measurement rate**
- **integrated 24 MPixel digital camera**
- **integrated inertial navigation system**
- **designed for combined topographic and bathymetric UAV-based survey**
- **high accuracy ranging based on echo digitization and online waveform processing with multiple-target capability**
- **concurrent comprehensive full waveform storage of all measurements for subsequent waveform averaging**
- **high spatial resolution due to a measurement rate of up to 200 kHz and a high scanning speed of up to 100 scans/sec**
- **straightforward integration with UAVs and crewed aircraft**
- **compliant with stabilized platforms**

The **RIEGL VQ-840-GE** is a fully integrated compact airborne LiDAR system for combined topographic and bathymetric surveying. Its compact and very lightweight design facilitates integration into UAVs. The all-in system package comes with an integrated and factory-calibrated IMU/GNSS system and an integrated 24 MPixel digital camera.

The scanner carries out laser range measurements for surveying of underwater topography with a narrow, visible green laser beam, emitted from a pulsed laser source. Subject to clarity, at this particular wavelength the laser beam penetrates water enabling measurement of submerged targets.

The distance measurement is based on the time-of-flight measurement with very short laser pulses and subsequent echo digitization and online waveform processing. The laser beam is deflected in an elliptic scan pattern and hits the water surface at an incidence angle with low variation.

The VQ-840-GE laser scanner is complemented with an inertial navigation sensor for subsequent estimation of the instrument's location and orientation. Further a high-resolution digital camera is integrated to supplement the data gained by the laser scanner.

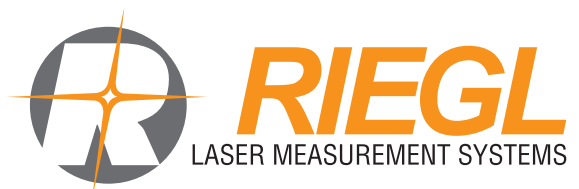
The rugged internal mechanical structure together with the dust-tight and splash-proof housing enables long-term operation on all airborne platforms from UAVs and helicopters to fixed-wing aircraft.

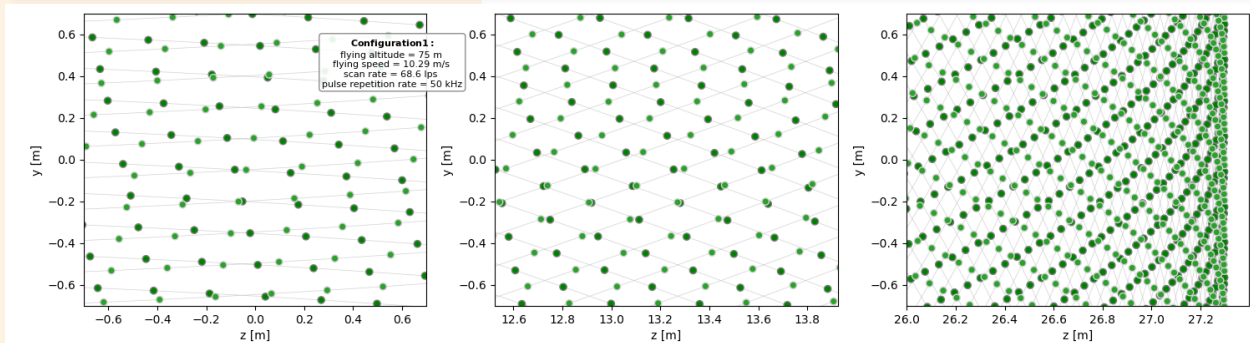
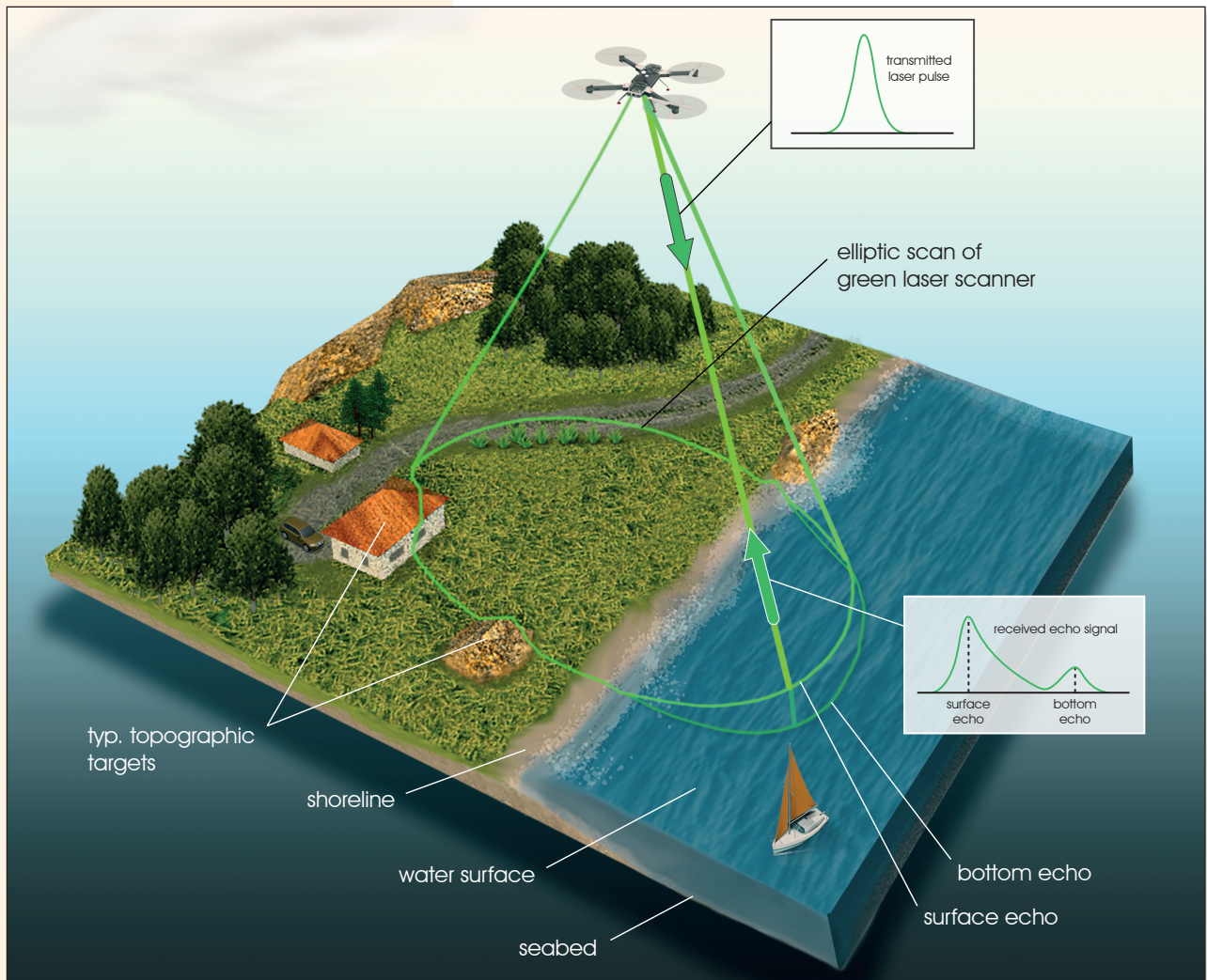
Typical applications include

- **coastline and shallow water mapping**
- **river surveying**
- **repeated survey of water reservoirs**



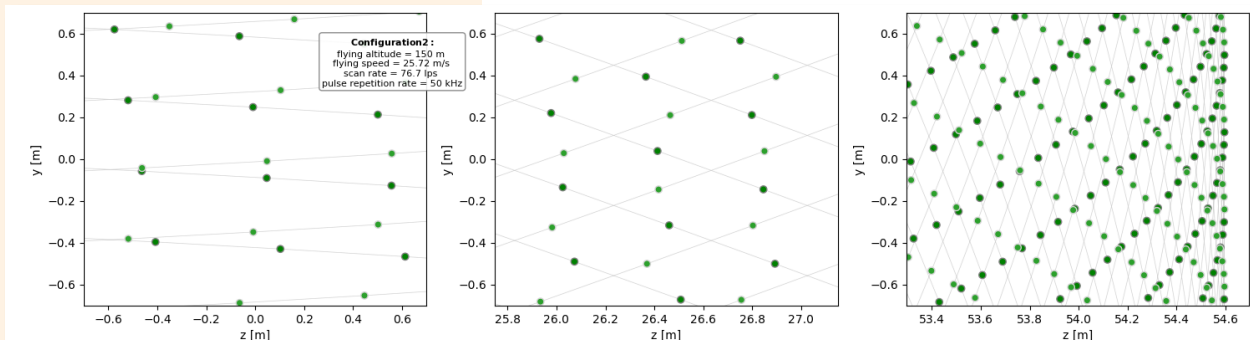
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Point pattern and density for UAV applications

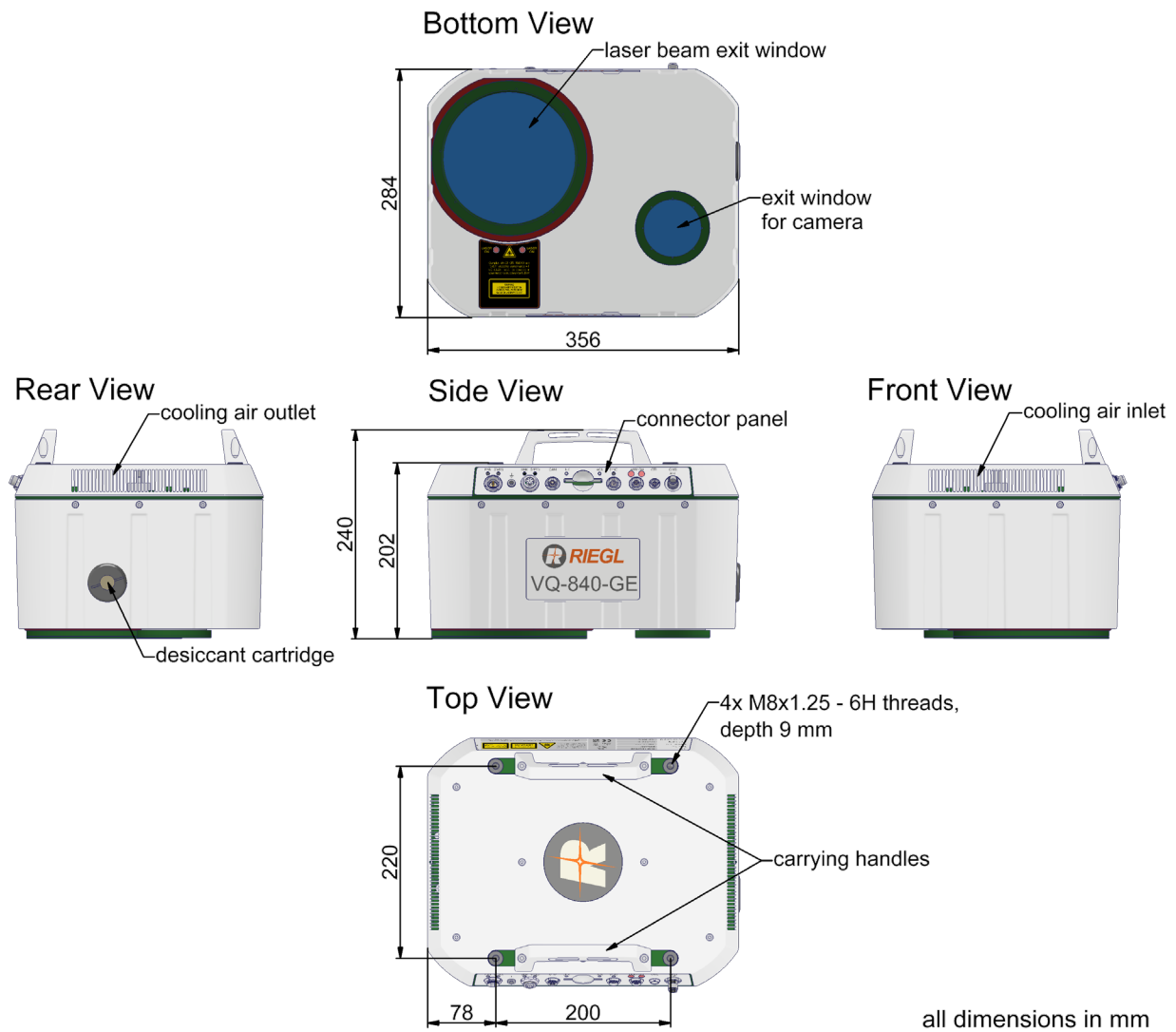
flying altitude 75 m, flying speed 10 m/sec, scan rate 69 lps, pulse repetition rate 50 kHz, average point density: 76 points/sqm
grey lines: scan trace on ground, green dots: points on the ground (dark green: forward look, light green: backward look)



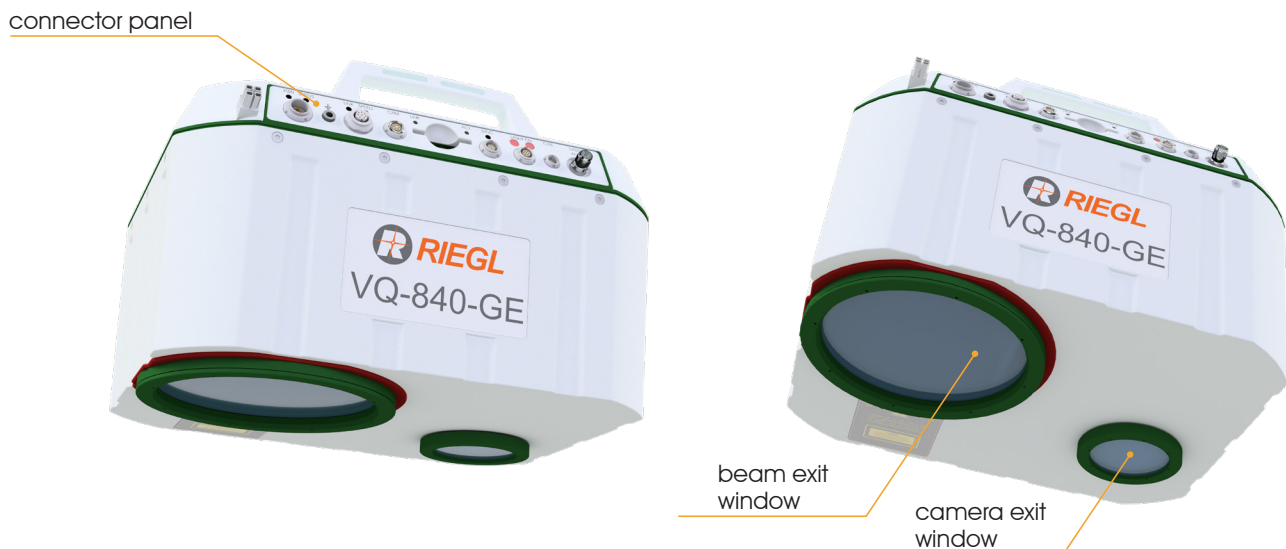
Point pattern and density for helicopter applications

flying altitude 150 m, flying speed 26 m/sec, scan rate 77 lps, pulse repetition rate 50 kHz, average point density: 18 points/sqm
grey lines: scan trace on ground, green dots: points on the ground (dark green: forward look, light green: backward look)

RIEGL VQ-840-GE Main Dimensions



RIEGL VQ-840-GE Perspective View



Export Classification

The Topo-Bathymetric Airborne Laser Scanner VQ-840-GE has been designed and developed for commercial topographic, hydrographic and bathymetric surveying applications.

Laser Product Classification

Class 3B Laser Product according to IEC60825-1:2014
The following clause applies for instruments delivered into the United States: Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed.3., as described in Laser Notice No. 56, dated May 8, 2019.

NOHD ^{1) 2) 3)}

- 1) NOHD ... Nominal Ocular Hazard Distance
2) beam divergence 6 mrad, laser PRR 50 kHz

The VQ-840-GE is subject to export restrictions as set up by the Wassenaar Arrangement. It is classified as dual-use good according to position number 6A8j3 of the official Dual-Use-List to be found on site <http://www.wassenaar.org>.
Within the European Union, (Regulation (EU) No. 2021/821) implements the export restrictions of the Wassenaar Arrangement. The corresponding position number is **6A008j3**.



15 m

- 3) provided that the instrument is operated on a moving platform

Range Measurement Performance

Measuring Principle

echo signal digitization, online waveform processing, full waveform recording, time-of-flight measurement, multiple target capability

Measurement Rate ⁴⁾	200 kHz	100 kHz	50 kHz	5 kHz ⁷⁾	0.5 kHz ⁷⁾
Max. Water Depth Penetration in Secchi Depths ^{5) 6)} (Flight altitude 75m above water level)	1.7	1.8	2.0	2.2	2.5

Minimum Range

Accuracy ^{8) 10)}

Precision ^{9) 10)}

Laser Pulse Repetition Rate

Echo Signal Intensity

Number of Targets per Pulse

Laser Wavelength

Laser Beam Divergence

Receiver Field of View

Laser Beam Footprint (Gaussian Beam Definition)

20 m

20 mm

15 mm

50 kHz to 200 kHz

for each echo signal, high-resolution 16 bit intensity information is provided
online waveform processing: up to 15 ¹¹⁾

532 nm, green

selectable, 1 up to 6 mrad ¹²⁾

12 mrad

50 mm @ 50 m, 100 mm @ 100 m, 150 mm @ 150 m ¹³⁾

Scanner Performance

Scanning Mechanism

Scan Pattern

Off Nadir Scan Angle Range

Scan Speed (selectable)

Angular Step Width $\Delta \theta$ (selectable)

between consecutive laser shots

Angle Measurement Resolution

rotating scan mirror

nearly elliptic

$\pm 20^\circ = 40^\circ$ perpendicular to flight direction, $\pm 14^\circ = 28^\circ$ in flight direction

10 - 100 lines/sec (lps) ¹⁴⁾

$0.072^\circ \leq \Delta \theta \leq 0.72^\circ$ (for PRR 50 kHz) ^{15) 16)}

0.001° (3.6 arcsec)

General Technical Data

Power Supply Input Voltage

Power Consumption

Main Dimensions (L x W x H)

Weight

Humidity

Protection Class

Max. Flight Altitude ¹⁷⁾

operating / not operating

Temperature Range

operation / storage

18 - 34 V DC

typ. 110 W

max. 220 W

360 mm x 285 mm x 200 mm

approx. 10.3 kg with integrated IMU/GNSS and camera

non condensing

IP64

18 500 ft (5 600 m) above Mean Sea Level (MSL)

-10 °C up to +40 °C / -20 °C up to +50 °C

4) rounded values

5) The Secchi depth is defined as the depth at which a standard black and white disc deployed into the water is no longer visible to the human eye.

6) The depth performance is specified for bright targets with size in excess of the laser beam diameter, for Secchi depths of 2 m to 5 m, and for clear atmospheric conditions.

7) Waveform averaging applied in postprocessing.
Laser PRR=50 kHz

8) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.

9) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.

10) One sigma @ 150 m rounded values

11) If the laser beam hits, in part, more than one target, the laser's pulse power is split accordingly. Thus, the achievable range is reduced.

12) Measured at the 1/e² points. 1.0 mrad corresponds to an increase of 100 mm of beam diameter per 100 m distance.

13) The laser beam footprint values correspond to a beam divergence of 1mrad.

14) One line corresponds to a full revolution (360°) of the scan mechanism which can be split into two user defined segments.

15) The angular step width limits depend on the selected laser PRR.

16) The maximum angular step width is limited by the maximum scan rate.

17) for standard atmospheric conditions: 1013 mbar, +15°C at sea level

Integrated IMU/GNSS

IMU Accuracy ¹⁾	
Roll, Pitch	0.015°
Heading	0.035°
IMU Sampling Rate	200 Hz
Position Accuracy (typ.)	
horizontal / vertical	<0.05 m / <0.1 m

Integrated Digital Camera

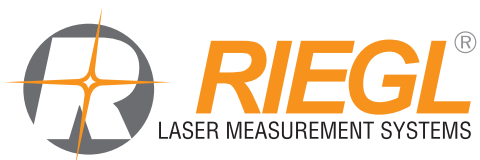
RGB Camera	
Sensor Resolution	24 MPixel
Sensor Dimensions (diagonal)	19.3 mm (5328 x 4608 px)
Focal Length of Camera Lens	16 mm
Field of View (FOV)	approx. 49° x 43°
Interface	GigE

Data Interfaces

Configuration	LAN 10/100/1 000 Mbit/sec,
Scan Data Output	LAN 10/100/1 000 Mbit/sec,
	high speed data link to <i>RIEGL</i> DR1560ii (optional) ³⁾
GNSS Interface ²⁾	Serial RS-232 interface for data string with GNSS-time information,
	TTL input for 1 PPS synchronization pulse
General IO & Control	1x TTL input/output, 1x Serial RS-232 Interface, 1x Remote on/off
Camera Interface	1x GNSS RS-232 Tx & PPS, Power, Trigger, Exposure
Removable Storage Card	CFast®, up to 1 TByte (optional) ³⁾
Internal Data Storage	2 TB SSD

1) accuracy specifications for post-processed data
2) to be used for external GNSS receiver

3) only one single option (CFast or data recorder interface) can be implemented



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