

Compact Topo-Bathymetric Airborne Laser Scanner with Online Waveform Processing and Full Waveform Recording

RIEGL® VQ-840-G

- *designed for combined topographic and bathymetric airborne and UAV-based survey*
- *high accuracy ranging based on echo digitization and online waveform processing with multiple-target capability*
- *concurrent comprehensive full waveform storage for all measurements for subsequent full waveform analysis*
- *high spatial resolution due to measurement rate of up to 200 kHz and high scanning speed of up to 100 scans/sec*
- *integrated inertial navigation system (optional)*
- *additional, fully integrated infrared laser rangefinder (optional)*
- *integrated digital camera (optional)*
- *compact, lightweight and robust housing compliant with typical hatches in aircrafts and with stabilized platforms*

The **RIEGL® VQ-840-G** is a fully integrated compact airborne laser scanner for combined topographic and bathymetric surveying. The system can be offered optionally with an integrated and factory-calibrated IMU/GNSS system and with an optional camera or IR rangefinder.

The **VQ-840-G** is a compact and lightweight LiDAR system to be installed on various platforms including UAVs.

The scanner carries out laser range measurements for high resolution 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. To handle target situations with most complex multiple echo signals, beside the online waveform processing the digitized echo waveforms can be stored on the removable data storage card for subsequent off-line full waveform analysis.

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-G** can be complemented with an inertial navigation sensor for subsequent estimation of the instrument's location and orientation. As an option either a high-resolution digital camera or an infrared laser rangefinder can be integrated to supplement the data gained by the green laser scanner.

The rugged internal mechanical structure together with the dust- and splash water proof housing enables long-term operation on airborne platforms.

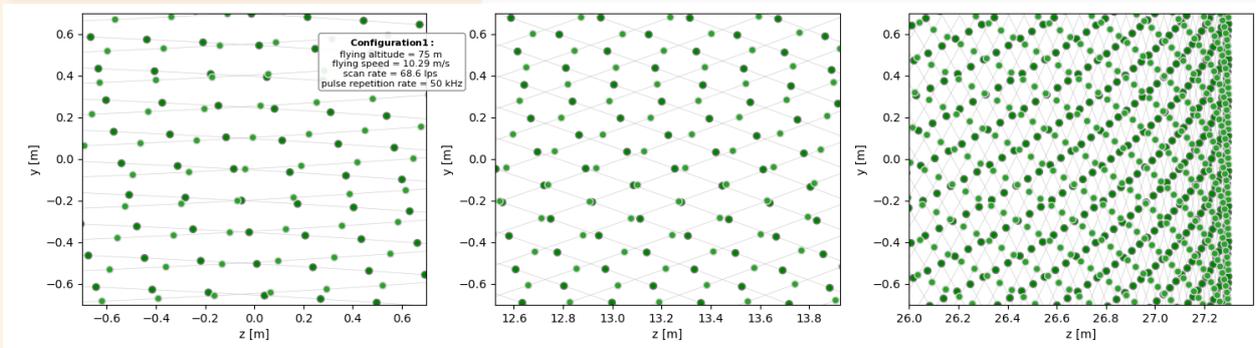
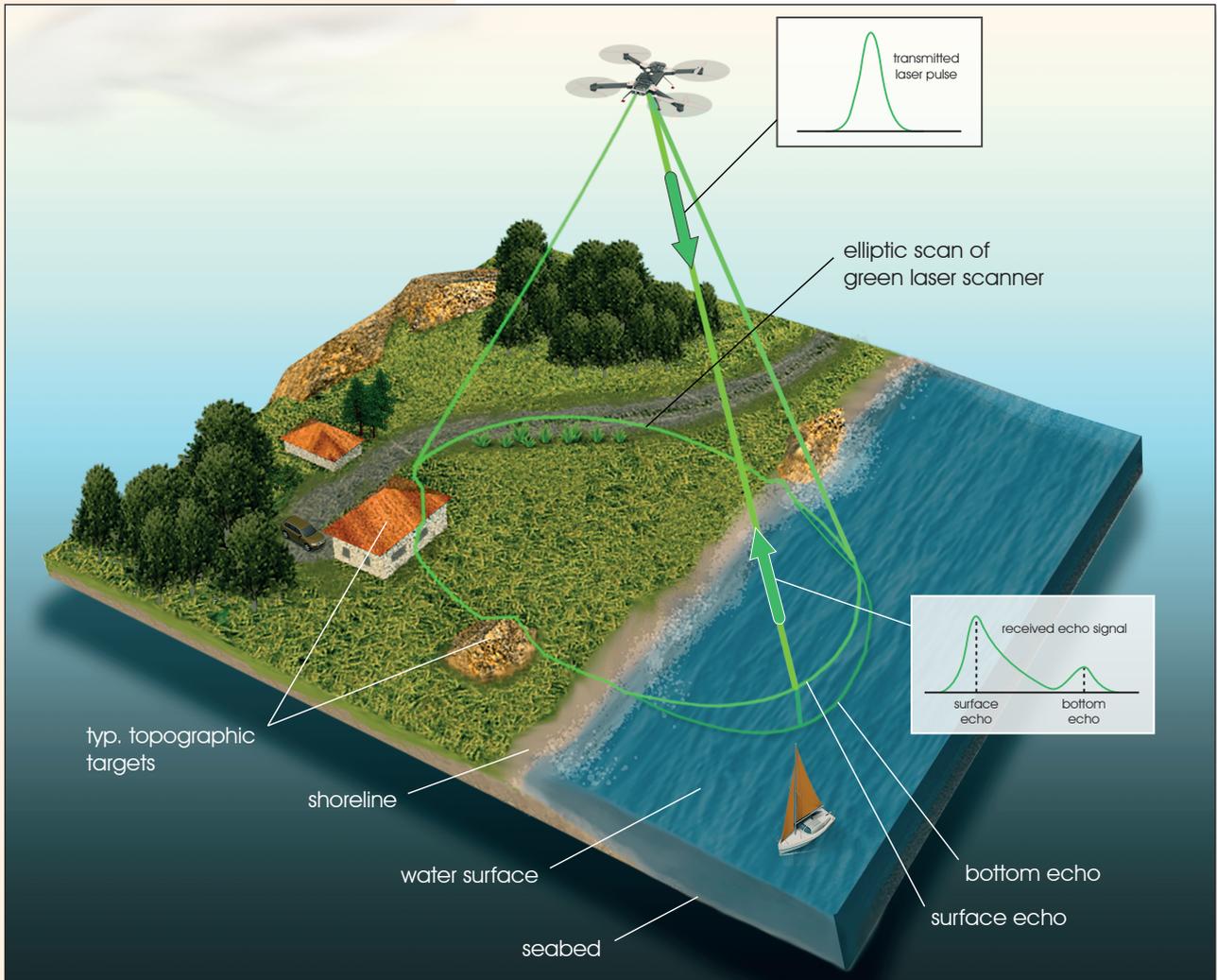
Typical applications include

- *coastline and shallow water mapping*
- *surveying for hydraulic engineering*
- *hydro-archeological-surveying*
- *river surveying*
- *repeated survey of water reservoirs*



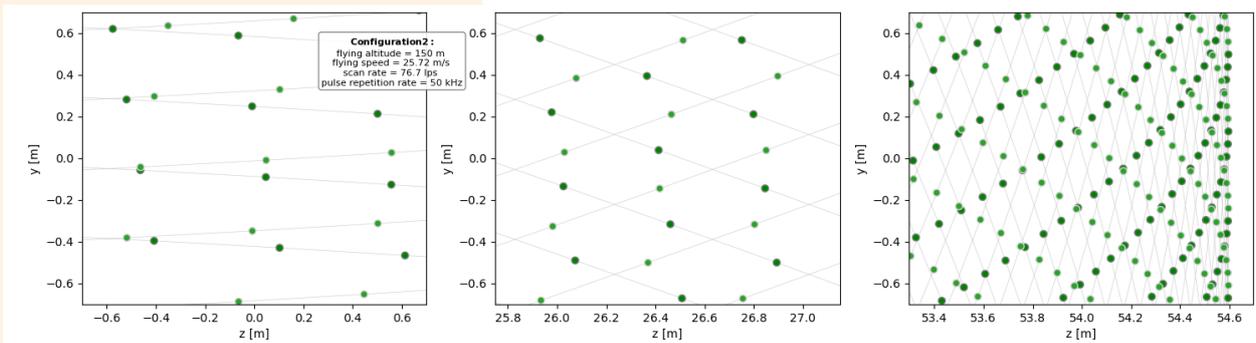
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Point pattern and density for UAV applications

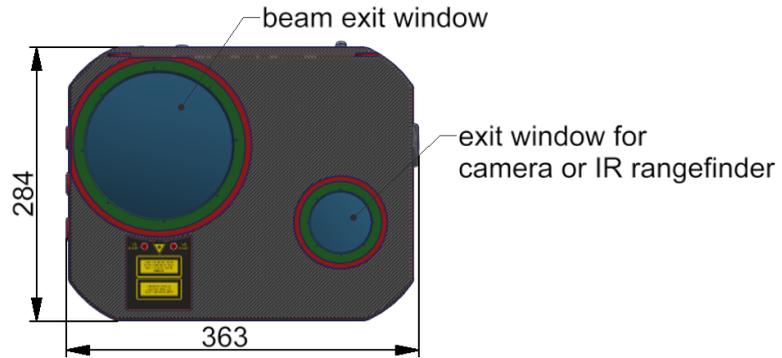
flying altitude 75 m, flying speed 10 m/sec, scan rate 69 lps, pulse repetition rate 50 kHz, average point density: 92 points/sqm
 grey lines: scan trace on ground, green dots: points on the ground (dark green: forward look, light green: backward look)



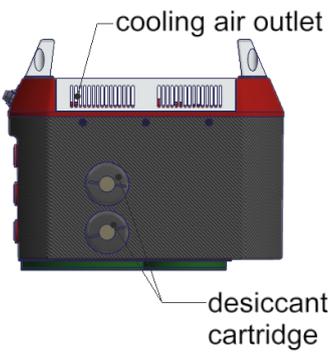
Point pattern and density for helicopter applications

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)

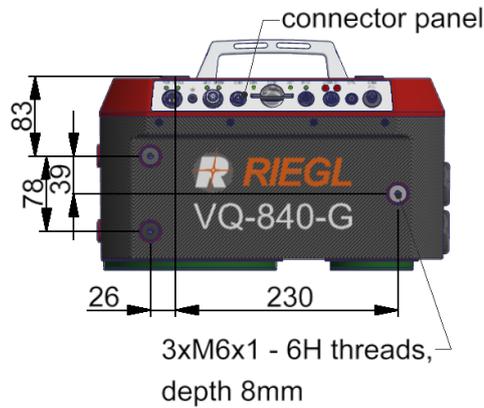
Bottom View



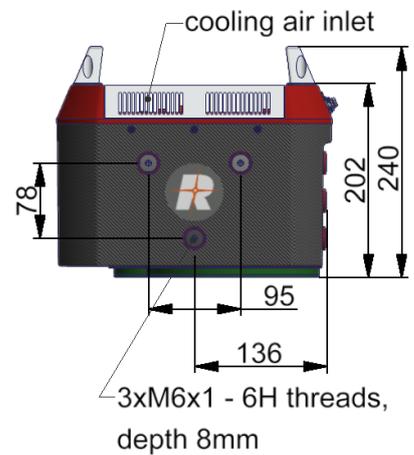
Rear View



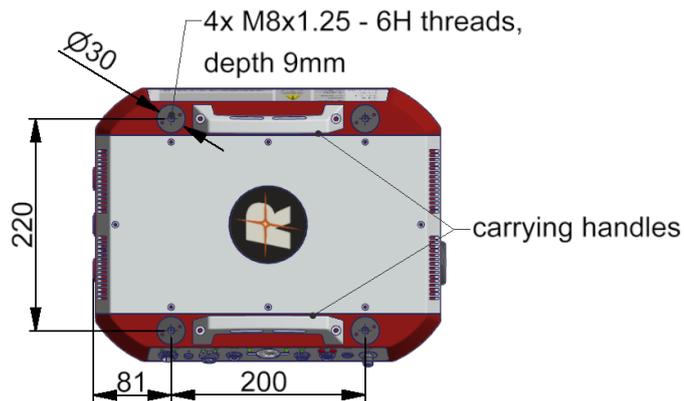
Side View



Front View



Top View



dimensions in mm

RIEGL VQ-840-G Perspective View

connector panel



exit window
for camera or
IR rangefinder

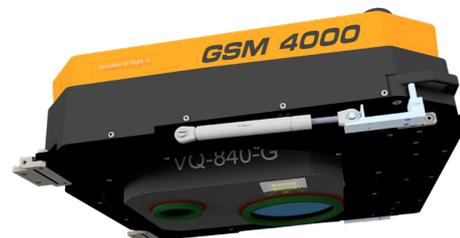
beam exit window

RIEGL VQ-840-G Installation Examples

Complemented by an optional IMU/GNSS system and further options like a high-resolution digital camera or an IR rangefinder, the RIEGL VQ-840-G represents a fully integrated system with low weight for integration on various aircraft platforms including UAVs.



UAV integration example:
RIEGL VQ-840-G installed on RiCOPTER-M



RIEGL VQ-840-G (with external IMU) installed on GSM-4000 stabilized platform to be used in a helicopter or fixed-wing aircraft

Export Classification

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

The VQ-840-G 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**.

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.

for System with Green Laser Scanner and optional Laser Rangefinder



NOHD ^{1) 3) 4)}
ENOHD ^{2) 3) 4)}

15 m
75 m

- 1) NOHD ... Nominal Ocular Hazard Distance
- 2) ENOHD ... Extended Nominal Ocular Hazard Distance

- 3) beam divergence 6 mrad, laser PRR 50kHz
- 4) provided that the instrument is mounted 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 ⁵⁾	200 kHz	100 kHz	50 kHz	5 kHz ⁸⁾	0.5 kHz ⁸⁾
Max. Water Depth Penetration in Secchi Depths ^{6) 7)} (Flight altitude 75m above water level)	1.7	1.8	2.0	2.2	2.5

Minimum Range
Accuracy ^{9) 11)}
Precision ^{10) 11)}
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 ¹²⁾
532 nm, green
selectable, 1 up to 6 mrad ¹³⁾
selectable, 3 up to 18 mrad
50 mm @ 50 m, 100 mm @ 100 m, 150 mm @ 150 m ¹⁴⁾

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) ¹⁵⁾
 $0.018^\circ \leq \Delta \theta \leq 0.72^\circ$ (for PRR 50 kHz) ^{16) 17)}
0.001° (3.6 arcsec)

- 5) rounded values
- 6) 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.
- 7) The depth performance is specified for bright targets with size in excess of the laser beam diameter and for clear atmospheric conditions.
- 8) Waveform averaging applied in postprocessing, Laser PRR=50kHz
- 9) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.
- 10) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.

- 11) One sigma @ 150m rounded values
- 12) 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.
- 13) Measured at the 1/e² points. 1.0 mrad corresponds to an increase of 100 mm of beam diameter per 100 m distance.
- 14) The laser beam footprint values correspond to a beam divergence of 1mrad.
- 15) One line corresponds to a full revolution (360°) of the scan mechanism which can be split into two user defined segments.
- 16) The angular step width depends on the selected laser PRR.
- 17) The maximum angular step width is limited by the maximum scan rate.

General Technical Data

Power Supply Input Voltage
Power Consumption

Main Dimensions (L x W x H)
Weight

Humidity
Protection Class
Max. Flight Altitude ¹⁸⁾
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. 12 kg
<15 kg (with IMU/GNSS and camera or IR rangefinder)
non condensing
IP64, dust and splash-proof

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

-10°C up to +40°C / -20°C up to +50°C

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

RIEGL VQ-840-G Technical Data (Optional Components)

IMU/GNSS (optional)

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 (optional) ²⁾

RGB Camera	
Sensor Resolution	12 MPixel
Sensor Dimensions (diagonal)	17,5 mm (4112 x 3008 px)
Focal Length of Camera Lens	16 mm
Field of View (FOV)	approx. 47° x 36°
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) ⁴⁾
GNSS Interface ³⁾	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 240 GByte (optional) ⁴⁾
Internal Data Storage	2 TB SSD

1) accuracy specifications for post-processed data

2) Please note that the camera is an optional component which cannot be integrated together with the optional infrared laser rangefinder.

3) to be used for external GNSS receiver

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

Infrared Laser Rangefinder (optional)

Important Note:

Please note that the rangefinder is an optional component which cannot be integrated together with the optional camera.

Measuring Principle

time of flight measurement, echo signal digitization, online waveform processing

Laser Pulse Repetition Rate PRR ⁴⁾ 100 kHz

Max. Measuring Range ⁵⁾

natural targets $\rho \geq 20\%$	150 m
natural targets $\rho \geq 60\%$	250 m

Max. Number of Targets per Pulse ⁶⁾ 5

4) Rounded values.

5) Typical values for average conditions. Maximum range is specified for flat targets with size in excess of the laser beam diameter, perpendicular angle of incidence, and for atmospheric visibility of 23 km. In bright sunlight, the max. range is shorter than under overcast sky.

6) If more than one target is hit, the total laser transmitter power is split and, accordingly, the achievable range is reduced.

Minimum Range	3 m
Accuracy ^{7) 9)}	15 mm
Precision ^{8) 9)}	10 mm
Laser Pulse Repetition Rate ⁴⁾	100 kHz
Max. Effective Measurement Rate ⁴⁾	up to 100 000 meas./sec.
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	near infrared
Laser Beam Divergence ¹⁰⁾	1.6 x 0.5 mrad
Laser Beam Footprint	160 mm x 50 mm @ 100 m

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

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

9) One sigma @ 50 m range under *RIEGL* test conditions.

10) Measured at 50% peak intensity, 1.6 mrad corresponds to an increase of 160 mm of beam diameter per 100 m distance.



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