

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 range-finder can be integrated to supplement the data gained by the green laser scanner.

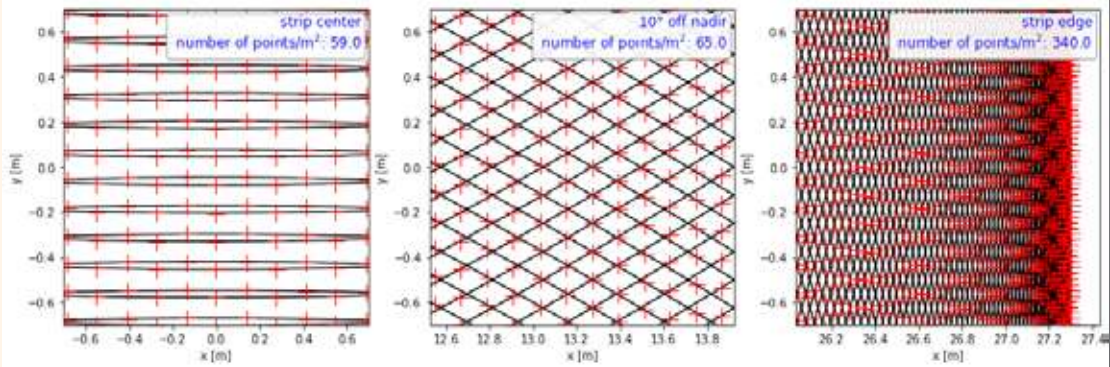
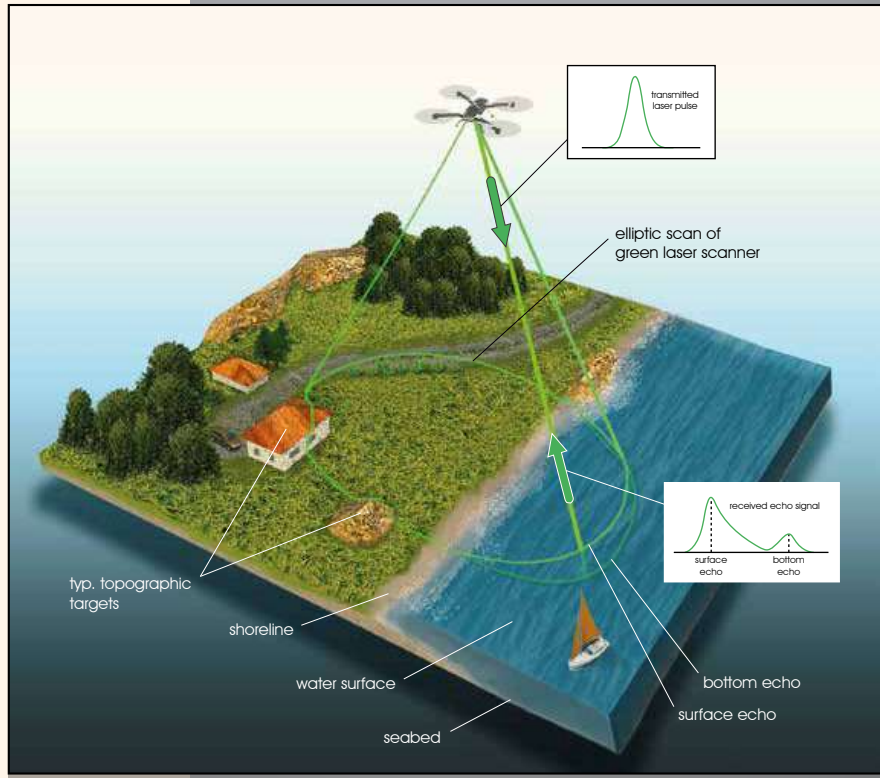
The rugged internal mechanical structure together with the dust- and splash water proof housing enables long-term operation on airborne platforms.

Typical applications include

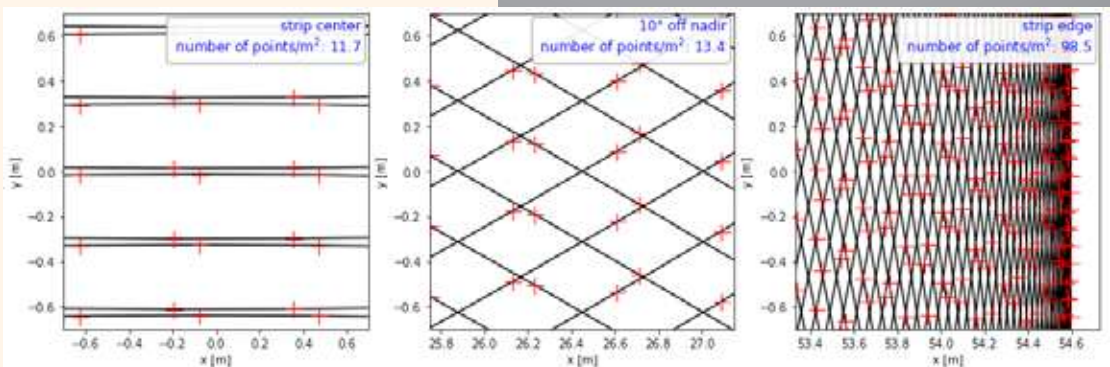
- *coastline and shallow water mapping*
- *surveying for hydraulic engineering*
- *hydro-archeological-surveying*
- *river surveying*
- *repeated survey of water reservoirs*



RIEGL VQ-840-G Scan Pattern

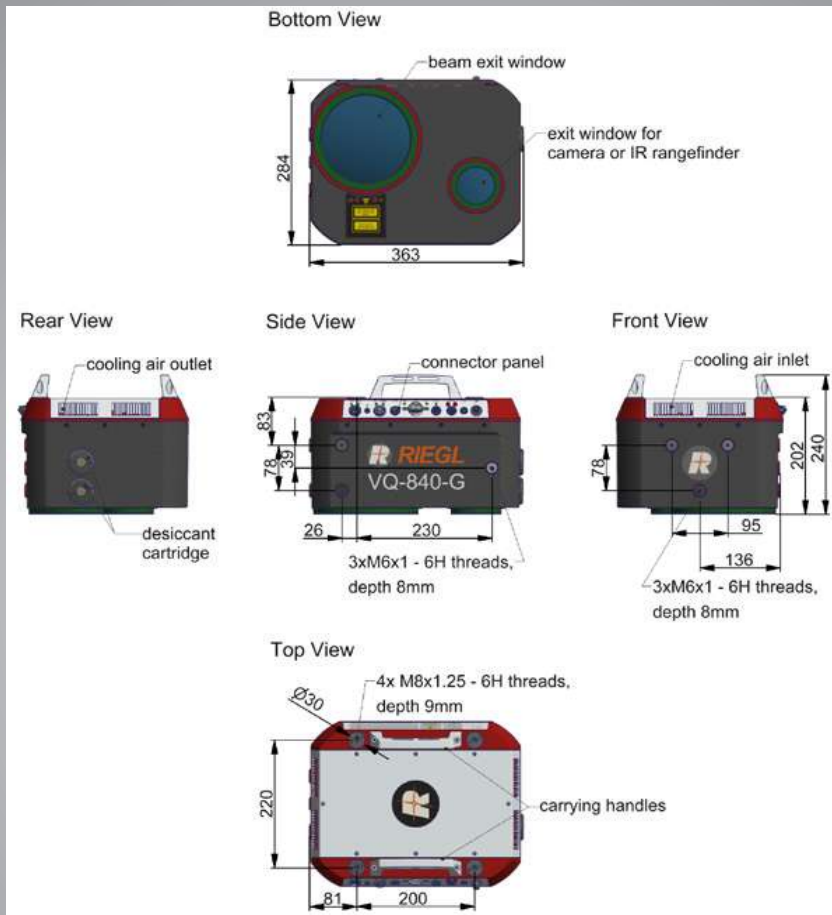


Point pattern and density for UAV applications
 flying altitude 75 m, flying speed 20 kts, average point density: 92 points/sqm black lines: scan trace on ground, red crosses: points on the ground



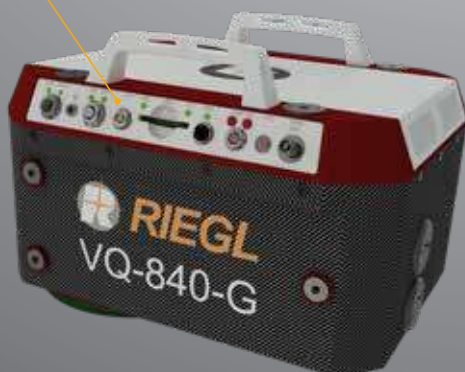
Point pattern and density for helicopter applications
 flying altitude 150 m, flying speed 50 kts, average point density: 18 points/sqm black lines: scan trace on ground, red crosses: points on the ground

RIEGL VQ-840-G Main Dimensions



RIEGL VQ-840-G Perspective View

connector panel



beam exit window for camera or IR rangefinder

beam exit window

RIEGL VQ-840-G Technical Data of Optional Infrared Laser Rangefinder

Important Note:

The following technical data is relevant for a *RIEGL VQ-840-G* Topo-Bathymetric Airborne Laser Scanner equipped with an additional optional Infrared Laser Rangefinder and is to be seen as a supplement to the Technical Data of the Basic System with Green Laser Scanner.
Please note that the rangefinder is an optional component which cannot be integrated together with the optional camera.

Range Measurement Performance

Measuring Principle

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

Laser Pulse Repetition Rate PRR ¹⁾	100 kHz
Max. Measuring Range ²⁾	
natural targets $\rho \geq 20\%$	150 m
natural targets $\rho \geq 60\%$	250 m
Max. Number of Targets per Pulse ³⁾	5

1) Rounded values.

2) 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.

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

Minimum Range

Accuracy ^{4) 6)}

Precision ^{5) 6)}

Laser Pulse Repetition Rate ¹⁾

Max. Effective Measurement Rate ¹⁾

Echo Signal Intensity

Laser Wavelength

Laser Beam Divergence ⁷⁾

Laser Beam Footprint

3 m
15 mm
10 mm
100 kHz
up to 100 000 meas./sec.
for each echo signal, high-resolution 16 bit intensity information is provided
near infrared
1.6 x 0.5 mrad
160 mm x 50 mm @ 100 m

1) Rounded values.

2) 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.

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

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

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

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

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

RIEGL VQ-840-G Installation Examples



RIEGL VQ-840-G installed on RiCOPTER-M, RIEGL's remotely piloted aircraft system with exceptional payload capacity



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

RIEGL VQ-840-G Technical Data of Green Laser Scanner

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 has to be found on site <http://www.wassenaar.org>. Within the European Union, Council Regulation (EC) No 428/2009 implements the export restrictions of the Wassenaar Arrangement. The corresponding position number is **6A008j3**.

Laser Product Classification

Laser Class

for System with Green Laser Scanner and optional Laser Rangefinder

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) 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

Laser Pulse Repetition Rate PRR ⁵⁾	200 kHz	100 kHz	50 kHz	5 kHz ⁷⁾	0.5 kHz ⁷⁾
Max. Water Depth Penetration in Secchi Depths ⁶⁾	1.7	1.8	2.0	2.2	2.5

Minimum Range
Accuracy ^{8) 10)}
Precision ^{9) 10)}
Laser Pulse Repetition Rate
Max. Effective Measurement Rate ⁵⁾
Echo Signal Intensity
Number of Targets per Pulse
Laser Wavelength
Laser Beam Divergence
Receiver Field of View
Laser Beam Footprint (Gaussian Beam Definition)

5 m
20 mm
15 mm
50 kHz to 200 kHz
up to 200 000 meas./sec
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⁾
selectable, 3 up to 18 mrad
50 mm @ 50 m, 100 mm @ 100 m, 150 mm @ 150 m ¹³⁾

Scanner Performance

Scanning Mechanism / Scan Pattern
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
elliptic
 $\pm 20^\circ = 40^\circ$
10 - 100 lines/sec (lps) ¹⁴⁾
 $0.018^\circ \leq \Delta \theta \leq 0.72^\circ$ (for PRR 50 kHz) ^{15) 16)}

0.001° (3.6 arcsec)

IMU/GNSS (optional) Performance

IMU Accuracy ¹⁷⁾
Roll, Pitch
Heading
IMU Sampling Rate
Position Accuracy (typ.)
horizontal / vertical

0.015°
0.035°
200 Hz

<0.05 m / <0.1 m

5) rounded values
6) The depth performance is specified for bright targets with size in excess of the laser beam diameter and for clear atmospheric conditions. Flight altitude 75 m above water level.
7) Waveform averaging applied
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 @ 150m (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 depends on the selected laser PRR.
16) The maximum angular step width is limited by the maximum scan rate.
17) accuracy specifications for post-processed data

RIEGL VQ-840-G Technical Data

Integrated Digital Camera (Optional)¹⁾

RGB Camera

Sensor Resolution
Sensor Dimensions (diagonal)
Focal Length of Camera Lens
Field of View (FOV)
Interface

12 MPixel
43 mm (full format)
50 mm
approx. 40° x 27°
GigE

Data Interfaces

Configuration
Scan Data Output

GNSS Interface ²⁾

Camera Interface
Removable Storage Card

LAN 10/100/1 000 Mbit/sec
LAN 10/100/1 000 Mbit/sec,
high speed data link to *RIEGL* DR1560i (optional)
Serial RS232 interface for data string with GNSS-time information,
TTL input for 1 PPS synchronization pulse
1x power, RS232, 1pps, trigger exposure
CFast[®], up to 512 GByte (optional)

General Technical Data

Power Supply Input Voltage
Power Consumption
without IMU/GNSS/camera
with internal IMU/GNSS/camera ³⁾ or IR Rangefinder

Main Dimensions (LxWxH)
Weight

Humidity
Protection Class
Max. Flight Altitude ⁴⁾
operating / not operating
Temperature Range
operation / storage

18 - 34 V DC
typ. 110 W
160 W ³⁾
max. 400 W
360 mm x 285 mm x 200 mm
approx. 12 kg
<15 kg (with IMU/GNSS and camera or infrared laser scanner)
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

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

2) to be used for external GNSS receiver
3) @ 20°C ambient temperature, 100 kHz PRR, 100 scans/sec
4) for standard atmospheric conditions: 1013 mbar, +15°C at sea level

