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***

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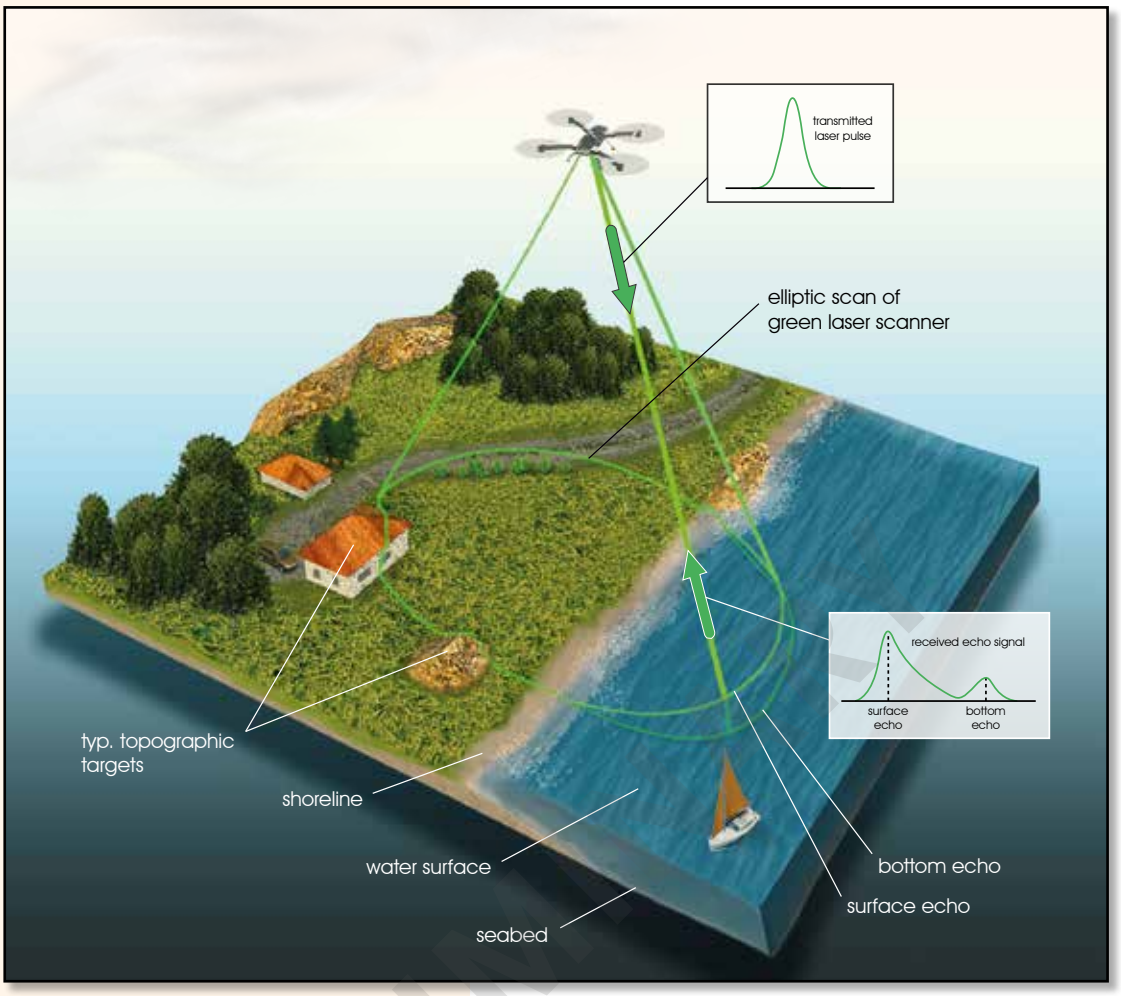
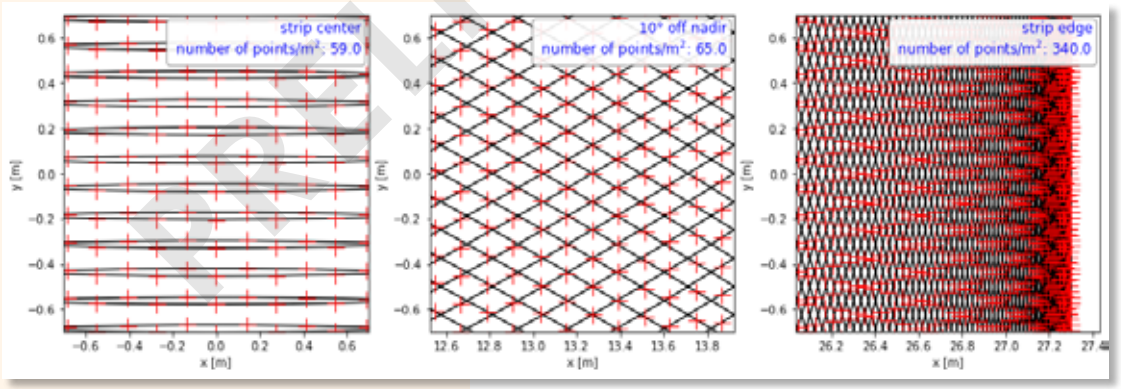
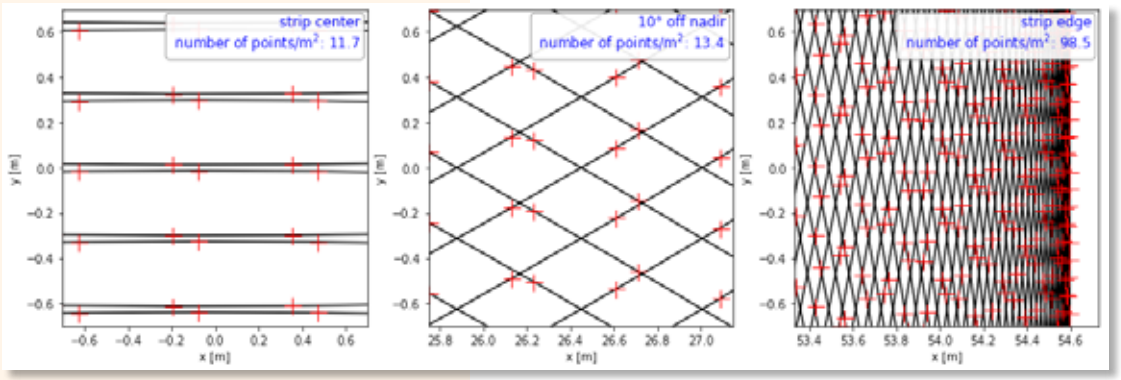
RIEGL
LASER MEASUREMENT SYSTEMS



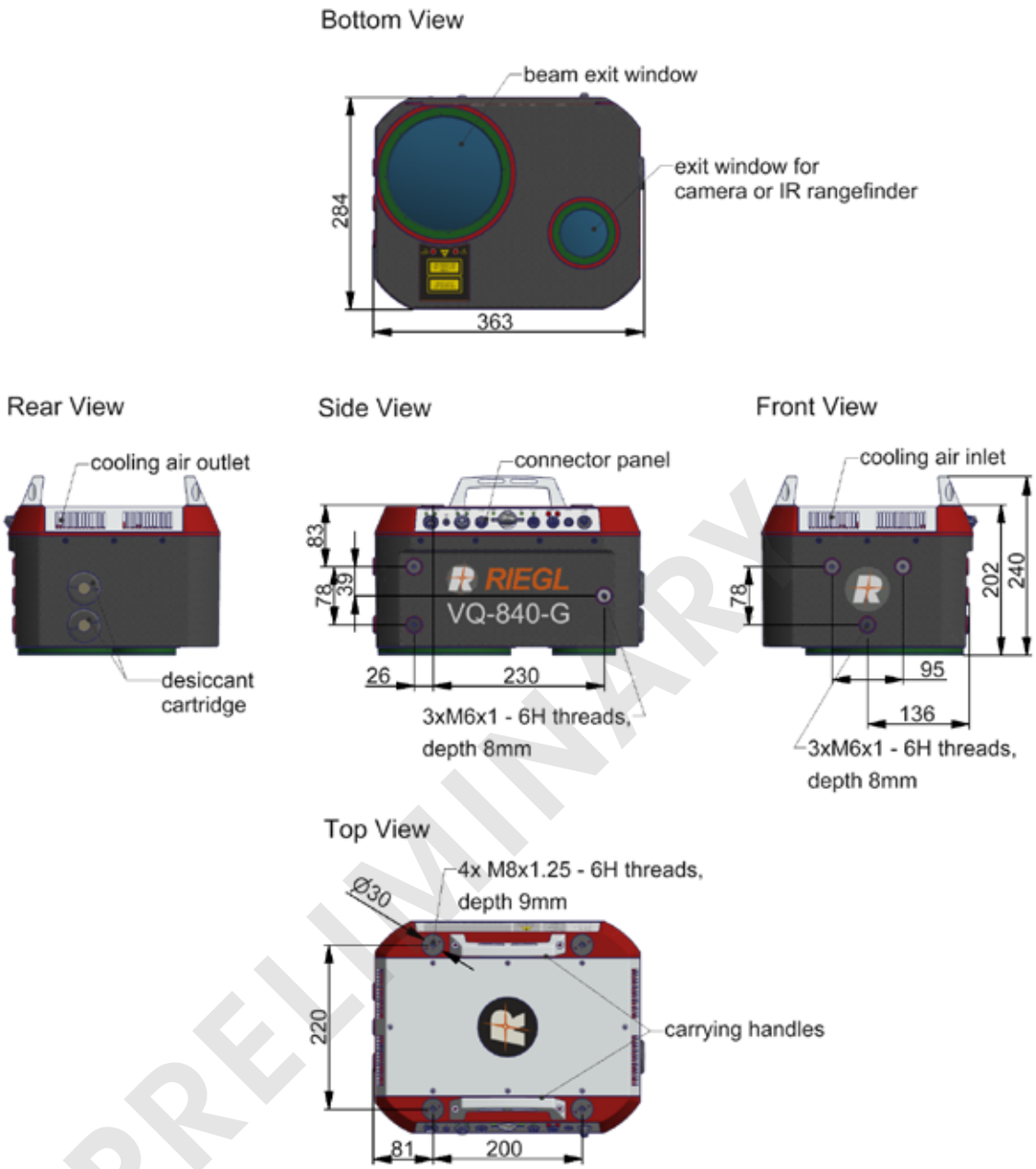


Point pattern and density for UAV applications
flying altitude 75 m, flying speed 20 kts, average point density: 92 points/sqm
black lines: scan trace on ground, red crosses: points on the ground



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

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 ρ ≥ 20 %	150 m
natural targets ρ ≥ 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 achieveable range is reduced.

Minimum Range	3 m
Accuracy [4] [6]	15 mm
Precision [5] [6]	10 mm
Laser Pulse Repetition Rate [1]	100 kHz
Max. Effective Measurement Rate [1]	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 [7]	1.6 x 0.5 mrad
Laser Beam Footprint	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 achieveable 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

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)]	15 m
ENOHD [2) 3) 4)]	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	5 m
Accuracy [8) 10)]	20 mm
Precision [9) 10)]	15 mm
Laser Pulse Repetition Rate	50 kHz to 200 kHz
Max. Effective Measurement Rate [5)]	up to 200 000 meas./sec
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Number of Targets per Pulse	online waveform processing: up to 15 [11)]
Laser Wavelength	532 nm, green
Laser Beam Divergence	selectable, 1 up to 6 mrad [12)]
Receiver Field of View	selectable, 3 up to 18 mrad
Laser Beam Footprint (Gaussian Beam Definition)	50 mm @ 50 m, 100 mm @ 100 m, 150 mm @ 150 m [13)]

Scanner Performance

Scanning Mechanism / Scan Pattern	rotating scan mirror
Scan Pattern	elliptic
Off Nadir Scan Angle Range	± 20° = 40°
Scan Speed (selectable)	10 - 100 lines/sec (lps) [14)]
Angular Step Width $\Delta\ \vartheta$ (selectable) between consecutive laser shots	0.018° ≤ $\Delta\ \vartheta$ ≤ 0.72° (for PRR 50 kHz) [15) 16)]
Angle Measurement Resolution	0.001° (3.6 arcsec)

IMU/GNSS (optional) Performance

IMU Accuracy [17)]	
Roll, Pitch	0.015°
Heading	0.035°
IMU Sampling Rate	200 Hz
Position Accuracy (typ.)	
horizontal / vertical	<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 rarounded 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 ist 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

Integrated Digital Camera (Optional)[1]

RGB Camera

Sensor Resolution	12 MPixel
Sensor Dimensions (diagonal)	43 mm (full format)
Focal Length of Camera Lens	50 mm
Field of View (FOV)	approx. 40° x 27°
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 *RIEGL* DR1560i (optional)
GNSS Interface [2]	Serial RS232 interface for data string with GNSS-time information, TTL input for 1 PPS synchronization pulse
Camera Interface	1x power, RS232,1pps, trigger exposure
Removable Storage Card	CFast®, up to 512 GByte (optional)

General Technical Data

Power Supply Input Voltage	18 - 34 V DC
Power Consumption	
without IMU/GNSS/camera	typ. 110 W
with internal IMU/GNSS/camera [3] or IR Rangefinder	160 W [3] max. 400 W
Main Dimensions (LxWxH)	360 mm x 285 mm x 200 mm
Weight	approx. 12 kg <15 kg (with IMU/GNSS and camera or infrared laser scanner)
Humidity	non condensing
Protection Class	IP64, dust and splash-proof
Max. Flight Altitude [4]	
operating / not operating	18 500 ft (5 600 m) above Mean Sea Level (MSL)
Temperature Range	
operation / storage	-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 rangfinder.

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

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