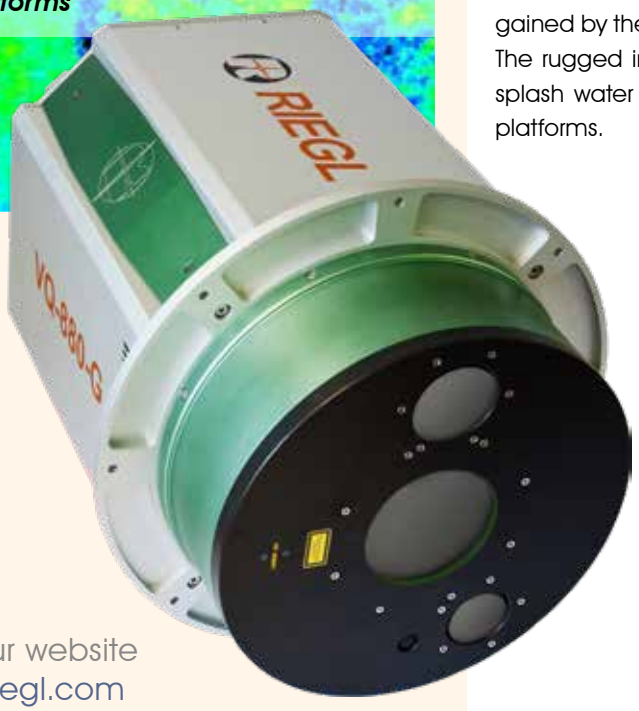
Topo-Hydrographic Airborne Laser Scanning System
with Online Waveform Processing and Full Waveform Recording

RIEGL VQ®-880-G

- *designed for combined topographic and hydrographic airborne survey*
- *high accuracy ranging based on echo digitization and online waveform processing with multiple-target capability*
- *multiple-time-around processing for straightforward mission planning and operation*
- *concurrent full waveform output for all measurements for subsequent full waveform analysis*
- *high spatial resolution due to measurement rate of up to 550 kHz and high scanning speed of up to 160 scans/sec*
- *integrated inertial navigation system*
- *additional, fully integrated infrared laser scanner (optional)*
- *integrated digital camera*
- *compact and robust housing compliant with typical hatches in aircrafts and with stabilized platforms*



The *RIEGL*® VQ-880-G is a fully integrated airborne laser scanning system for combined hydrographic and topographic surveying. The system is offered with integrated and factory-calibrated high-end GNSS/IMU system and camera. The design allows flexible adaptation of these components to specific application requirements. Complemented by a *RIEGL* data recorder, the *RIEGL* VQ-880-G is a complete LIDAR system to be installed on various platforms in a straightforward way.

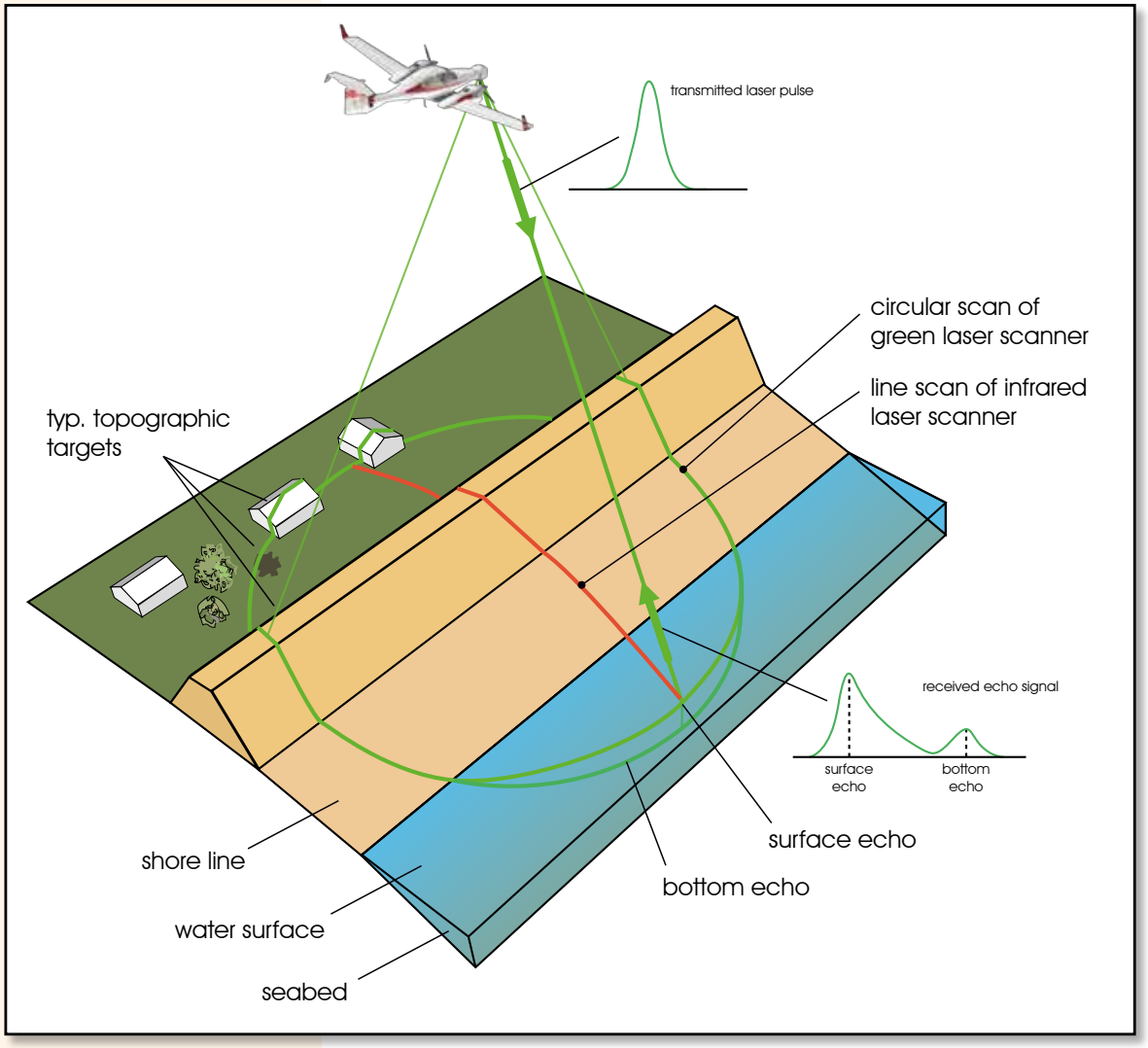
The *RIEGL* VQ-880-G carries out laser range measurements for high resolution surveying of underwater topography with a narrow, visible green laser beam, emitted from a powerful pulsed laser source. Subject to clarity, at this particular wavelength the laser beam penetrates water enabling measurement 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 *RIEGL* solid state data recorder for subsequent off-line waveform analysis.
The laser beam is deflected in a circular scan pattern and hits the water surface at a nominally constant incidence angle.
The VQ-880-G comprises a high precision inertial measurement sensor for subsequent precise estimation of the instrument's exact location and orientation. A high-resolution digital camera and optionally an additional infrared laser scanner are integrated to supplement the data gained by the green laser scanner.
The rugged internal mechanical structure together with the dust- und splash water proof housing enables long-term operation on airborne platforms.

Typical applications include
- ***coastline and shallow water mapping***
- ***acquiring base data for flood prevention***
- ***measurement for aggradation zones***
- ***habitat mapping***
- ***surveying for hydraulic engineering***
- ***hydro-archeological-surveying***

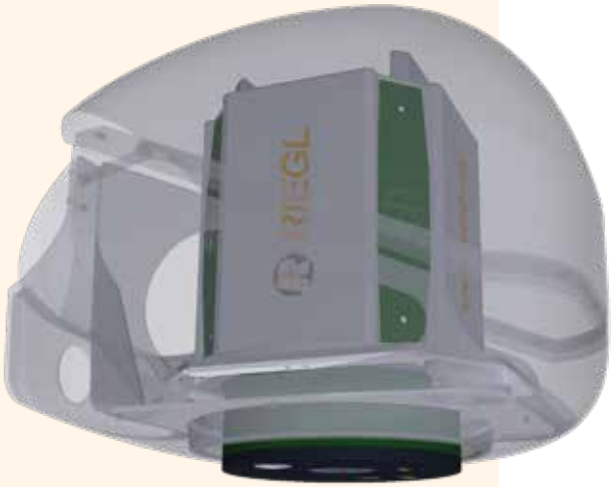
visit our website
www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS

RIEGL VQ-880-G Scan Pattern



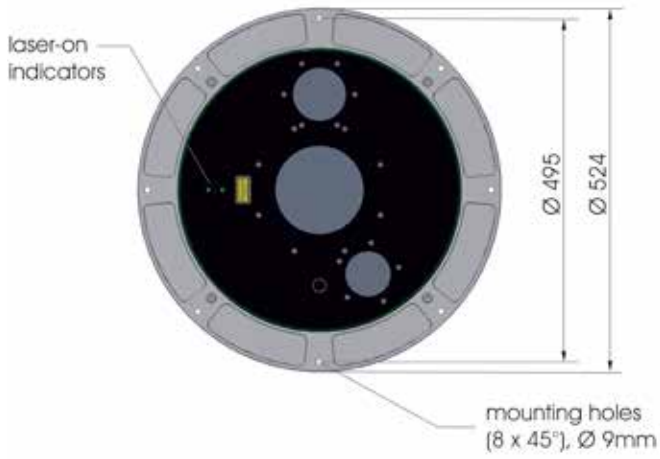
RIEGL VQ-880-G Installation Examples



RIEGL VQ-880-G installed in the nose pod of fixed-wing aircraft DA42 MPP

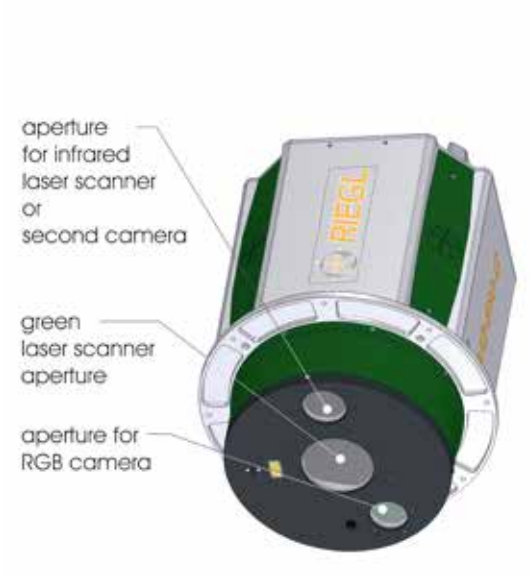
RIEGL VQ-880-G installed on GSM-3000 stabilized platform to be used in a helicopter or fixed-wing aircraft

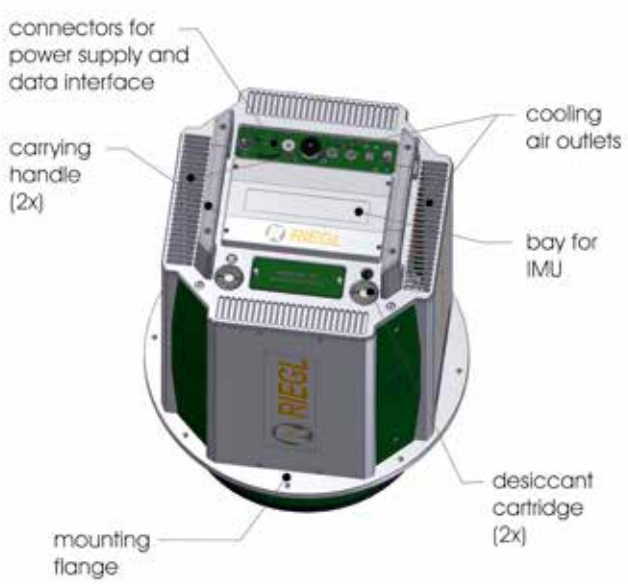
front view



top view

side view





Important Note:

The following technical data is relevant for a *RIEGL* VQ-880-G Topo-Hydrographic Airborne Laser Scanning System equipped with an additional Infrared Laser Scanner and is to be seen as a supplement to the Technical Data of the Basic System with Green Laser Scanner.

Laser Product Classification

Laser Class	**for *RIEGL* VQ-880-G with additional Infrared Laser Scanner** 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 deviations pursuant to Laser Notice No. 50, dated June 24, 2007. The Instrument must be used only in combination with the appropriate laser safety box.
NOHD [1]	175 m [2]

1) NOHD ... Nominal Ocular Hazard Distance, based upon MPE according to IEC60825-1:2007, for single pulse condition

2) NOHD for both wavelengths. NOHD of the infrared laser scanner: 8 m

Range Measurement Performance

Measuring Principle: time of flight measurement, echo signal digitization, online waveform processing

Max. Measurement Range [3] [4] [5]

@ Laser Pulse Repetition Rate	145 kHz	245 kHz	550 kHz
natural targets ρ≥20 %	900 m	700 m	500 m
natural targets ρ≥60 %	1500 m	1200 m	850 m
Max. Operating Flight Altitude [6] Above Ground Level (AGL)	800 m (2600 ft.)	650 m (2130 ft.)	450 m (1480 ft.)

Minimum Range [7]	10 m
Accuracy [8] [10]	25 mm
Precision [9] [10]	25 mm
Laser Pulse Repetition Rate [11] [12]	up to 550 kHz
Max. Effective Measurement Rate [6] [12]	45 000 meas./sec (@ 145 kHz PRR & 40° FOV) 79 000 meas./sec (@245 kHz PRR 40° FOV) 177 200 meas./sec (@ 550 kHz PRR & 40° FOV)
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Number of Targets per Pulse	practically unlimited (details on request) [13]
Laser Wavelength	1064 nm (near infrared)
Laser Beam Divergence	0.2 mrad [14]
Laser Beam Footprint (Gaussian Beam Definition)	22 mm @ 100 m, 105 mm @ 500 m, 200 mm @ 1000 m

Scanner Performance

Scanning Mechanism / Scan Pattern	rotating polygon mirror / curved parallel lines
Field of View (selectable)	± 20° = 40°
Scan Speed (selectable)	10 - 200 scans/sec
Angular Step Width $\Delta\ \vartheta$ (selectable) between consecutive laser shots	$0.002° \leq \Delta\ \vartheta \leq 0.033°$ (for PRR 550 kHz)
Angle Measurement Resolution	better 0.001° (3.6 arcsec)

3) The following conditions are assumed: target larger than the footprint of the laser beam, average ambient brightness, visibility 23 km, perpendicular angle of incidence.
4) In bright sunlight, the operational range may be considerably shorter and the operational flight altitude may be considerably lower than under an overcast sky.
5) Ambiguity to be resolved by post-processing with RiMTA ALS software.
6) Reflectivity ρ ≥ 20%, 20° FOV, additional roll angle ±5°
7) Limitations for range measurement capability does not consider laser safety.
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 range under *RIEGL* test conditions.
11) Rounded values.
12) User selectable.
13) 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.
14) Measured at the $1/e^2$ points. 0.20 mrad corresponds to an increase of 20 cm of beam diameter per 1000 m distance.

Export Classification

The Topo-Hydrographic Airborne Laser Scanner VQ-880-G has been designed and developed for commercial topographic, hydrographic and bathymetric surveying applications.

The VQ-880-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 Basic System with Green Laser Scanner
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 deviations pursuant to Laser Notice No. 50, dated June 24, 2007.
The Instrument must be used only in combination with the appropriate laser safety box.

NOHD [1) 2)]	175 m

1) NOHD ... Nominal Ocular Hazard Distance

2) If it can be assumed that potential viewers are hit by a single pulse only (e.g., when the instrument is mounted on a platform moving so fast that the pulses do not overlap at the NOHD.)

Range Measurement Performance

Measuring Principle	time of flight measurement, echo signal digitization, online waveform processing, full waveform recording for post processing
Hydrography	
Typ. Measurement Range [3)]	1.5 Secchi depth for bright ground (ρ≥80 %) [4)]
Typ. Operating Flight Altitude [5)] Above Ground Level (AGL)	600 m (1970 ft.)
Topography (diffusely reflecting targets)	
Max. Measurement Range [6) 7) 8)]	
natural targets ρ≥20 %	2500 m
natural targets ρ≥60 %	3600 m
Typ. Operating Flight Altitude [8) 5)] Above Ground Level (AGL)	2200 m (7200 ft.)
Minimum Range	10 m
Accuracy [9) 11)]	25 mm
Precision [10) 11)]	25 mm
Laser Pulse Repetition Rate	up to 550 kHz [5)]
Max. Effective Measurement Rate [5)]	up to 550 000 meas./sec (@ 550 kHz PRR)
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 9, depending on measurement program [12)]
Laser Wavelength	532 nm, green
Laser Beam Divergence	selectable, 0.7 up to 2.0 mrad [13)]
Laser Beam Footprint (Gaussian Beam Definition)	100 mm @ 100 m, 500 mm @ 500 m, 1000 mm @ 1000 m [14)]

Scanner Performance

Scanning Mechanism / Scan Pattern	rotating prism / circular
Field of View (selectable)	± 20° = 40°
Scan Speed (selectable)	10 - 80 revolutions/sec, equivalent to 20 - 160 scans/sec
Angular Step Width Δ ϑ (selectable) between consecutive laser shots	0.007° ≤ Δ ϑ ≤ 0.052° (for PRR 550 kHz)
Angle Measurement Resolution	better 0.001° (3.6 arcsec)

IMU/GNSS Performance [15) 16)]

IMU Accuracy [17)]	
Roll, Pitch	0.0025°
Heading	0.005°
IMU Sampling Rate	200 Hz
Position Accuracy (typ.)	
horizontal / vertical	<0.05 m / <0.1 m

3) 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.
4) at typ. operating flight altitude
5) rounded values
6) The following conditions are assumed: target larger than the footprint of the laser beam, average ambient brightness, visibility 23 km, perpendicular angle of incidence, ambiguity to be resolved multiple-time-around processing.
7) In bright sunlight, the operational range may be considerably shorter than under an overcast sky.
8) Reflectivity ρ ≥ 20%, 40° FOV, additional roll angle ±5°
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) Topography, one sigma @ 150m range under *RIEGL* test conditions.
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) The INS configuration of the *RIEGL* VQ-880-G Laser Scanning System can be modified to the customer's requirements.
16) The installed IMU is listed neither in the European Export Control List (i.e. Annex 1 of Council Regulation 428/2009) nor in the Canadian Export Control List. Detailed information on certain cases will be provided on request.
17) one sigma values, no GNSS outages, post-processed during base station data

RIEGL VQ-880-G Technical Data

Integrated Digital Camera [1]

RGB Camera

Sensor Resolution	29 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 Serial Dual Glass Fiber Link to *RIEGL* Data Recorder
GNSS Interface [2]	Serial RS232 interface for data string with GNSS-time information, TTL input for 1 PPS synchronization pulse

General Technical Data

Power Supply Input Voltage	18 - 32 V DC
Power Consumption	typ. 300 W (without IMU/GNSS/camera) typ. 360 W (with IMU/GNSS/camera) [3] max. 400 W
Main Dimensions (LxWxH)	444 x 444 x 695 mm, mounting flange diameter 524 mm
Weight	approx. 65 kg (with IMU/GNSS/camera and optional infrared laser scanner)
Humidity	non condensing
Protection Class Scan Head	IP54, dust and splash-proof
Max. Flight Altitude [4]	
operating	16 500 ft (5 000 m) above Mean Sea Level (MSL)
not operating)	18 000 ft (5 500 m) above MSL
Temperature Range	
operation / storage	0°C up to +40°C / -10°C up to +50°C

1) The camera configuration of the *RIEGL* VQ-880-G Laser Scanning System can be modified to the customer's requirements.

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

RIEGL LASER MEASUREMENT SYSTEMS

RIEGL Laser Measurement Systems GmbH
Riedenburgstraße 48
3580 Horn, Austria
Phone: +43 2982 4211 | Fax: +43 2982 4210
office@riegl.co.at
www.riegl.com

RIEGL USA Inc.
Orlando, Florida | info@rieglusa.com | www.rieglusa.com

RIEGL Japan Ltd.
Tokyo, Japan | info@riegl-japan.co.jp | www.riegl-japan.co.jp

RIEGL China Ltd.
Beijing, China | info@riegl.cn | www.riegl.cn

www.riegl.com