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.

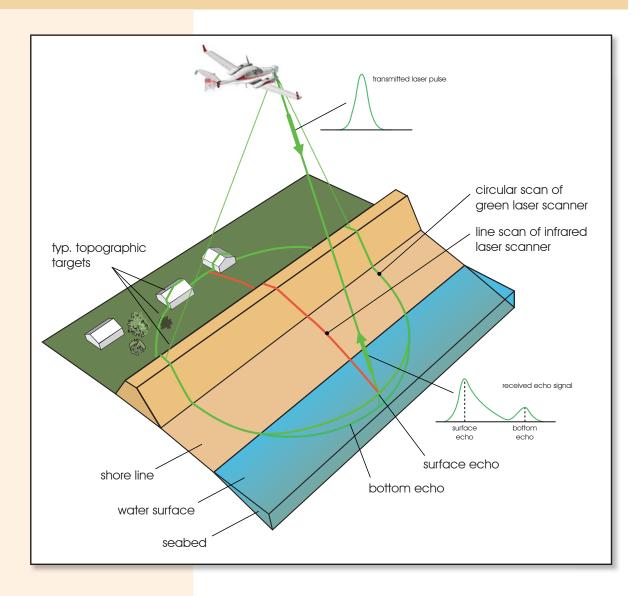
The rugged internal mechanical structure together with the dust- und splash water proof housing enables long-term operation on airborne platforms.

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







RIEGL VQ-880-G Installation Examples



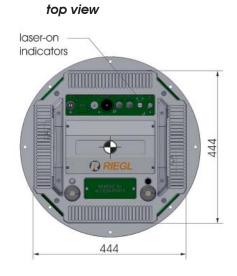
 $\it RIEGL\ VQ-880-G$ installed in the nose pod of fixed-wing aircraft DA42 MPP



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

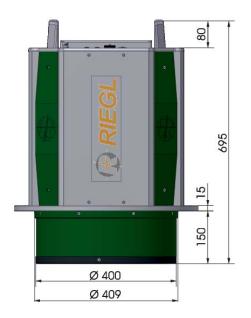
Data Sheet

laser-on indicators | Market | Market

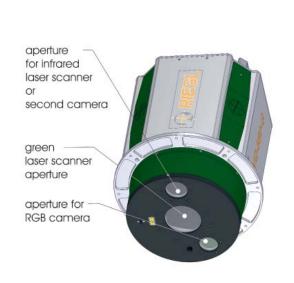


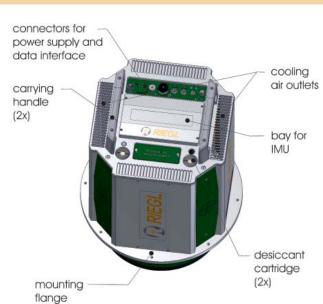
side view





RIEGL VQ-880-G Elements of Function and Operation





Data Sheet

RIEGL VQ-880-G Technical Data of Additional Infrared Laser Scanner

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

IEC60825-1:2007

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.





550 kHz

500 m

850 m

450 m (1480 ft.)



NOHD 1)

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

100 m²⁾

2) NOHD for both wavelengths. NOHD of the infrared laser scanner: 34 m

Range Measurement Performance

Measuring Principle

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

245 kHz

700 m

1200 m

Max. Unambiguous Measurement Range 3) 4) 5)

@ Laser Pulse Repetition Rate natural targets p≥20 % natural targets p≥60 % Max. Operating Flight Altitude 6) Above Ground Level (AGL)

800 m (2600 ft.) 650 m (2130 ft.) 10 m 25 mm

145 kHz

900 m

1500 m

Minimum Range 7) Accuracy 8) 10) Precision 9) 10)

Laser Pulse Repetition Rate 11) 12)

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 Number of Targets per Pulse Laser Wavelength Laser Beam Divergence

Laser Beam Footprint (Gaussian Beam Definition)

for each echo signal, high-resolution 16 bit intensity information is provided practically unlimited (details on request)

1.064 nm (near infrared)

0.2 mrad 13)

25 mm

up to 550 kHz

22 mm @ 100 m, 105 mm @ 500 m, 200 mm @ 1000 m

Scanner Performance

Scanning Mechanism / Scan Pattern Field of View (selectable) Scan Speed (selectable) Angular Step Width $\Delta \theta$ (selectable) between consecutive laser shots

Anale Measurement Resolution

rotating polygon mirror / curved parallel lines

 $\pm 20^{\circ} = 40^{\circ}$

10 - 200 scans/sec

 $0.002^{\circ} \le \Delta \ \vartheta \le 0.045^{\circ}$

better 0.001° (3.6 arcsec)

General Technical Data 14)

Additional Power Consumption Additional Weight

4

typ. 30 W approx. 3 kg

- The following conditions are assumed: target larger than the footprint of the laser beam, average ambient brightness, visibility 23 km, perpendicular angle of
- ambient brightness, visibility 23 km, perpendicular angle of incidence. In bright sunlight, the operational range may be considerably shorter and the operational flight altitude may be considerably lower than under an overcast sky. Ambiguity to be resolved by post-processing with RiMTA ALS software. Reflectivity $\rho \geq 20\%, 20^\circ$ FOV, additional roll angle $\pm 5^\circ$ Limitations for range measurement capability does not consider laser safety.

- Accuracy is the degree of conformity of a measured quantity to its actual (true) value. Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.

 One sigma @ 150m range under RIEGL test conditions.

 Rounded values.

 User selectable.

- 12) Oser selectable.
 13) Measured at the 1/e² points. 0.20 mrad corresponds to an increase of 20 cm of beam diameter per 1000 m distance.
 14) Values to be added to the values given for the standard system with green laser scanner.

RIEGL VQ-880-G Technical Data of Green Laser Scanner

Export Classification

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

Laser Product Classification

Laser Class

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.

for Basic System with Green Laser Scanner

Class 3B Laser Product according to

IEC60825-1:2007

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)

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

Hydrography

Typ. Measurement Range 3) Typ. Operating Flight Altitude 5) Above Ground Level (AGL)

Topography (diffusely reflecting targets)

Max. Measurement Range 6) 7) 8) natural targets p≥20 % natural targets ρ≥60 % Typ. Operating Flight Altitude 8) 5) Above Ground Level (AGL)

Minimum Range Accuracy 9) 11)

Precision 10) 11) Laser Pulse Repetition Rate

Max. Effective Measurement Rate 5)

Echo Signal Intensity Number of Targets per Pulse

Laser Wavelength Laser Beam Divergence

Laser Beam Footprint (Gaussian Beam Definition)

time of flight measurement, echo signal digitization, online waveform processing, full waveform recording for post processing

1.5 Secchi depth for bright ground (p≥80 %) 4) 600 m (1970 ft.)

2500 m 3600 m

2200 m (7200 ft.)

10 m 25 mm 25 mm

up to 550 kHz ⁵⁾

up to 550 000 meas./sec (@ 550 kHz PRR)

for each echo signal, high-resolution 16 bit intensity information is provided online waveform processing: up to 9, depending on measurement program 532 nm, areen

selectable, 0.7 up to 2.0 mrad 12)

 $100\,\mathrm{mm}$ @ $100\,\mathrm{m}$, $500\,\mathrm{mm}$ @ $500\,\mathrm{m}$, $1000\,\mathrm{mm}$ @ $1000\,\mathrm{m}$ $^{13)}$

Scanner Performance

Scanning Mechanism / Scan Pattern Field of View (selectable) Scan Speed (selectable) Angular Step Width $\Delta \ \vartheta$ (selectable) between consecutive laser shots

Angle Measurement Resolution

IMU/GNSS Performance 14) 15)

IMU Accuracy 16) Roll, Pitch Heading IMU Sampling Rate Position Accuracy (typ.) horizontal / vertical

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.

processing. In bright, the operational range may be considerably shorter than under an overcast sky. Reflectivity $\rho \geq 20\%,\,40^\circ$ FOV, additional roll angle $\pm 5^\circ$

rotating prism / circular

 $\pm 20^{\circ} = 40^{\circ}$

10 - 80 revolutions/sec, equivalent to 20 - 160 scans/sec

 $\Delta \vartheta \ge 0.0523^{\circ}$ (for PRR 550 kHz)

better 0.001° (3.6 arcsec)

0.0025° 0.005° 200 Hz

 $<0.05 \, \text{m} / < 0.1 \, \text{m}$

Accuracy is the degree of conformity of a measured quantity to its actual (true) value. Precision, also called reproducibility or repeatability, is the degree to which further measurements show

the same result

the same result.
Topography, one sigma @ 150m range under *RIEGL* test conditions.

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

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

The INS configuration of the *RIEGL* VQ-880-G Laser Scanning System can be modified to the customer's

reauirements

requirements. 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.

16) one sigma values, no GNSS outages, post-processed during base station data

Data Sheet

RIEGL VQ-880-G Technical Data

Integrated Digital Camera 1)

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

Data Interfaces

Configuration Scan Data Output

GNSS Interface 2)

General Technical Data

Power Supply Input Voltage Power Consumption

Main Dimensions (LxWxH) Weight

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

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

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

LAN 10/100/1000 Mbit/sec LAN 10/100/1000 Mbit/sec. High Speed Serial Dual Glass Fiber Link to RIEGL Data Recorder Serial RS232 interface for data string with GNSS-time information, TTL input for 1 PPS synchronization pulse

18 - 32 V DC

typ. 300 W (without IMU/GNSS/camera) typ. 360 W (with IMU/GNSS/camera) 3)

max. 400 W

 $444 \times 444 \times 695$ mm, mounting flange diameter 524 mm

approx. 62 kg (with IMU/GNSS/camera)

approx. 65 kg (with IMU/GNSS/camera and optional infrared laser scanner)

non condensing

IP54, dust and splash-proof

16 500 ft (5 000 m) above Mean Sea Level (MSL) 18 000 ft (5 500 m) above MSL

 0° C up to $+40^{\circ}$ C / -10° C up to $+50^{\circ}$ C

to be used for external GNSS receiver @ 20° C ambient temperature, 100 kHz PRR, 100 scans/sec For standard atmospheric conditions: 1013 mbar, $+15^{\circ}$ C at sea level



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