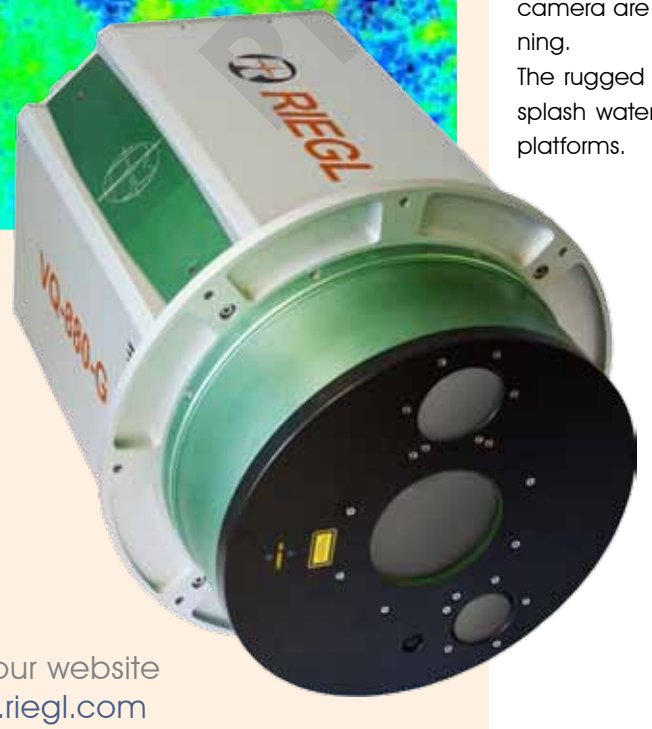
Topo-Hydrographic Airborne Laser Scanning System
with Online Waveform Processing and Full Waveform Recording

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*
- *integrated digital cameras*
- *compact and robust housing compliant with typical hatches in aircrafts and with stabilized platforms*



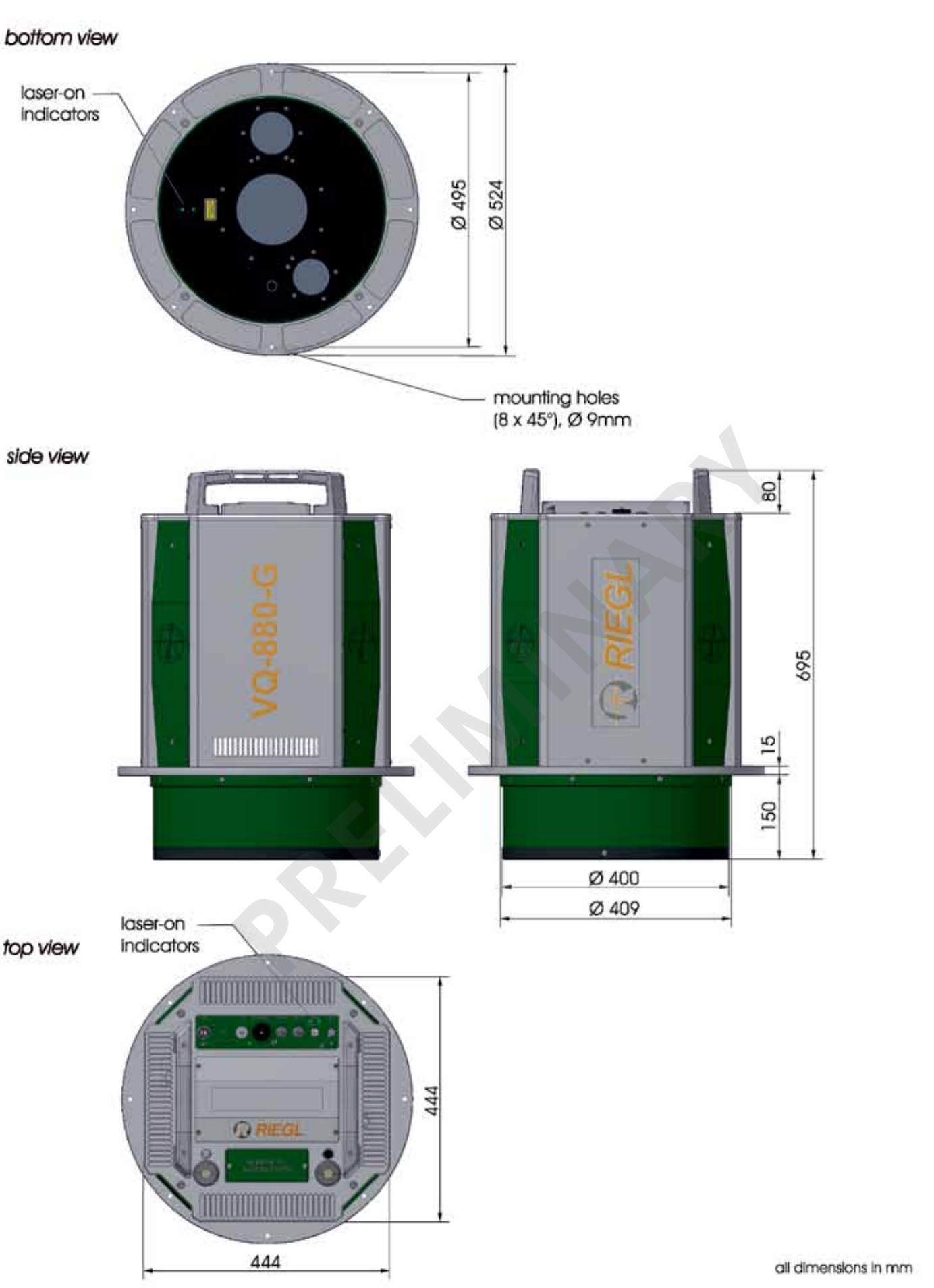
The new *RIEGL*® VQ-880-G is a fully integrated airborne laser scanning system for combined hydrographic and topographic surveying. The system is offered with integrated and factory-calibrated high-end GNSS/IMU system and cameras. The design allows flexible adaptation of these components to specific 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.

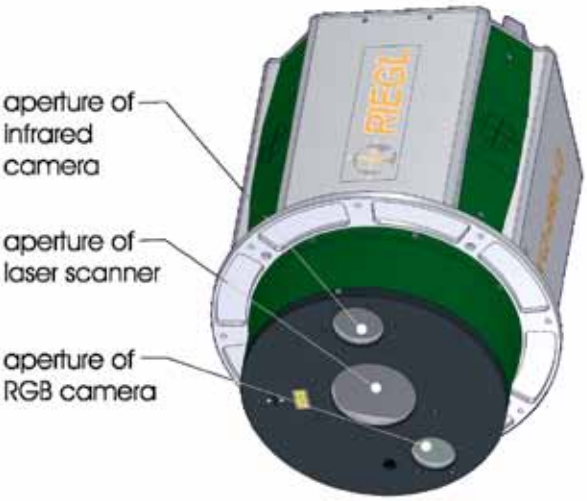
The *RIEGL* VQ-880-G carries out laser range measurements for high resolution surveying of underwater topography with a narrow, visible green laser beam, emitted from a powerful pulsed laser source. Subject to clarity, at this particular wavelength the laser beam penetrates water enabling measurement 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 infrared camera are integrated to supplement the data gained by laser scanning.
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-archaeological-surveying*

visit our website
www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS

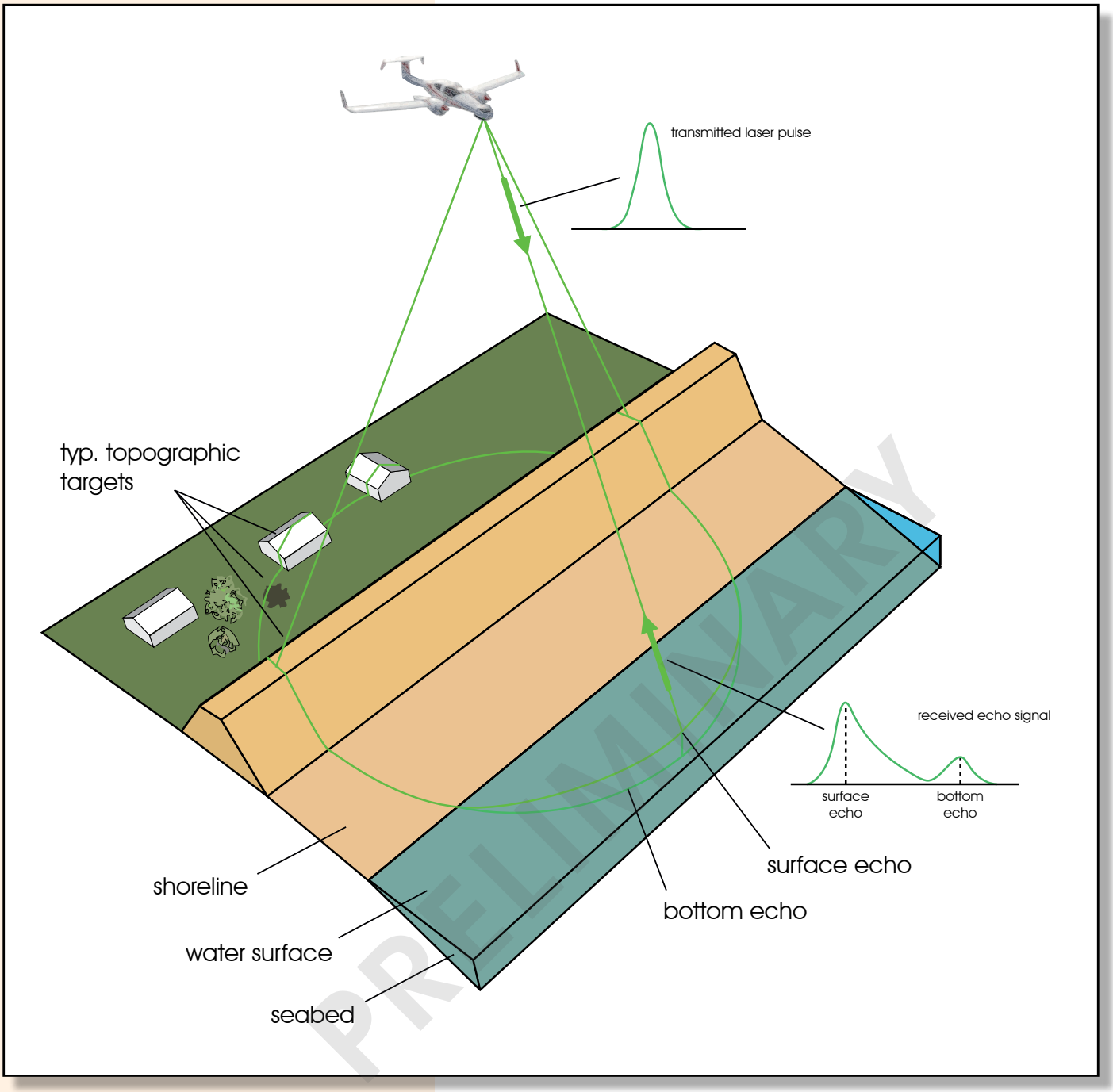




RIEGL VQ-880-G Installation Examples

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


transmitted laser pulse
typ. topographic targets
received echo signal
surface echo
bottom echo
surface echo
bottom echo
shoreline
water surface
seabed
PRELIMINARY

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 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

Class 4 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.

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 [1]	1.5 Secchi depth for bright ground (ρ≥80 %) [2]
Typ. Operating Flight Altitude [3] Above Ground Level (AGL)	600 m (1970 ft.)
Topography (diffusely reflecting targets)	
Max. Measurement Range [4] [5] [6]	
natural targets ρ≥20 %	2500 m
natural targets ρ≥60 %	3600 m
Typ. Operating Flight Altitude [6] [3] Above Ground Level (AGL)	2200 m (7200 ft.)
Minimum Range	10 m
Accuracy [7] [9]	25 mm
Precision [8] [9]	25 mm
Laser Pulse Repetition Rate	up to 550 kHz [3]
Max. Effective Measurement Rate [3]	up to 550 000 meas./sec (@ 550 kHz PRR)
Echo Signal Intensity	for each target, high-resolution 16 bit intensity information is provided
Number of Targets per Pulse	unlimited (digitized waveform processing)
Laser Wavelength	green
Laser Beam Divergence	selectable, 0.7 up to 2.0 mrad [10]
Laser Beam Footprint (Gaussian Beam Definition)	100 mm @ 100 m, 1000 mm @ 1000 m [11]

Scanner Performance

Scan Pattern	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	Δ ϑ ≥ 0.0023° (for PRR 550 kHz)
Angle Measurement Resolution	0.001°

IMU/GNSS Performance [12] [13]

IMU Accuracy [14]	
Roll, Pitch	0.005°
Heading	0.015°
IMU Sampling Rate	200 Hz
Position Accuracy (typ.)	0.05 m

1) 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.
2) at typ. operating flight altitude
3) rounded values
4) 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.
5) In bright sunlight, the operational range may be considerably shorter than under an overcast sky.
6) Reflectivity ρ ≥ 20%, 40° FOV, additional roll angle ±5°
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) Topography, one sigma @ 150m range under *RIEGL* test conditions.
10) Measured at the 1/e² points. 1.0 mrad corresponds to an increase of 100 mm of beam diameter per 100 m distance.
11) The laser beam footprint values correspond to a beam divergence of 1mrad.
12) The INS configuration of the *RIEGL* VQ-880-G Laser Scanning System can be modified to the customer's requirements.
13) 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.
14) one sigma values, no GNSS outages, post-processed during base station data

Integrated Digital Cameras [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

Infrared Camera (optional)

Spectral Range	7.5 - 14 µm
Sensor Resolution	640 x 480 Pixel
Sensor Dimensions (diagonal)	13.6 mm
Focal Length of Camera Lens	13.1 mm
Field of View (FOV)	approx. 45° x 34°
Interface	GigE

Data Interfaces

Configuration	LAN 10/100/1 000 Mbit/sec
Scan Data Output	LAN 10/100/1 000 Mbit/sec, High Speed 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
Current Consumption	typ. 280 W (without IMU/GNSS/Camera) typ. 360 W (with IMU/GNSS/Camera) [3] max. 550 W
Main Dimensions (LxWxH)	444 x 444 x 615 mm, mounting flange diameter 524 mm
Weight	approx. 60 kg (with optional components) approx. 55 kg (without optional components)
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	0°C up to +40°C
storage	-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

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