High-End Online Waveform Processing Airborne LiDAR Scanner with NFB (Nadir/Forward/Backward)-Scanning

NEW

RIEGL VQ-680

- *high pulse repetition rates of up to 2.4 MHz*
- *up to 2 MHz measurements on the ground*
- *forward / nadir / backward scan directions at +20 / +10 / 0 / -10 / -20 degrees*
- *wide field of view of 60 degrees*
- *excellent atmospheric clutter suppression*
- *multiple target capability*
- *online waveform processing*
- *prepared for the integration of up to 6 high resolution RGB/NIR cameras*
- *optimized for interfacing with typical hatches and stabilized platforms*

The VQ-680 is a compact airborne laser scanner optimized for urban mapping, forestry and power line survey applications – or wherever high-precision, high-accuracy surveying of complex environments are required. The scanner's vertical design and small aperture dimensions enable a compact integration with digital cameras in combination with a gyro-stabilized mount, for installation into typical aircraft hatches.

The laser scanner module includes an innovative scanning mechanism that provides forward, nadir, and backward scan lines at +20 / +10 / 0 / -10 / -20 degrees in the flight direction. In combination with a wide horizontal field of view of 60 degrees, a regular point spacing for each viewing direction is generated, enabling exceptional coverage of vertical structures such as building facades as well as coverage at the bottom of narrow street canyons with little to no shadowing.

The operational envelope ranges from typical flying altitudes of 1000 m AGL at a pulse repetition rate of 2.4 MHz (~ 24 pts/m2 at 120 kts), up to 2300 m AGL at a PRR of 300 kHz for targets with reflectivity in excess of 20%.

Electrical interfaces comprise a power supply, time synchronization with PPS and NMEA data, a laser safety switch, and interfaces for connecting up to six high-resolution RGB/NIR cameras. Detachable handgrips improve user ergonomics when mounting to airborne platforms. Scan data is stored on an external PC via Gigabit Ethernet, which is also used for configuring and controlling the laser scanner via RiACQUIRE, *RIEGL*'s versatile data acquisition software GUI, featuring real-time data visualization and remote control capabilities.

Applications:
- *Mapping of Complex Urban Environments*
- *City Modeling*
- *Ultra-High Resolution Mapping*
- *Oblique Mapping of Vertical Structures*
- *Corridor Mapping*

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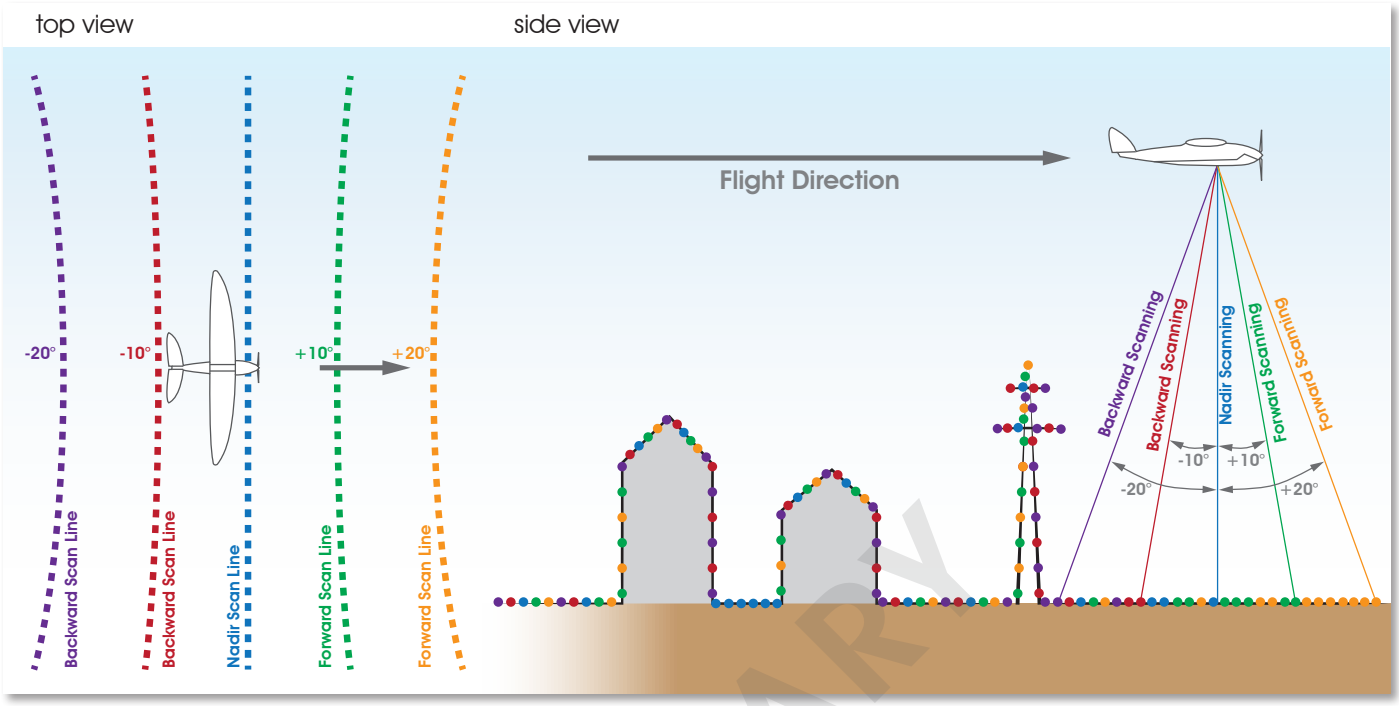
RIEGL®
LASER MEASUREMENT SYSTEMS

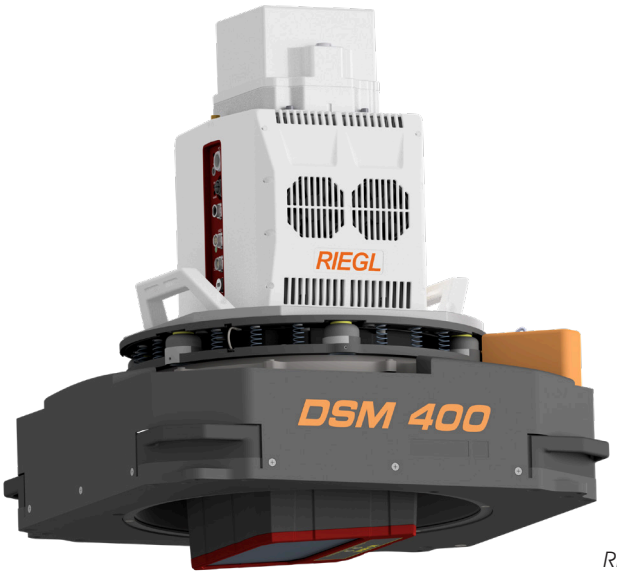
RIEGL VQ-680 Scan Pattern „NFB“ (Nadir/Forward/Backward)



The *RIEGL* VQ-680 offers a sophisticated, multi-axis scan geometry consisting of five parallel scan lines per scanner rotation, but with each scan line having its own unique scan direction. The scan directions change consecutively from nadir, to +10 and +20 degrees forward, and to -10 and -20 degrees backward. This scan geometry provides superior coverage of vertical features ahead of and behind the sensor, creating best-of-class 3D LiDAR data sets.
This is of value in urban, forestry and asset mapping applications where wholly complete coverages of vertical and planimetric features are now possible. By also maintaining a nadir scan direction, the new VQ-680 excels at city mapping applications and digital twins whereby inner courtyards and deep urban canyons are effectively mapped with little to no occlusions within the data sets.

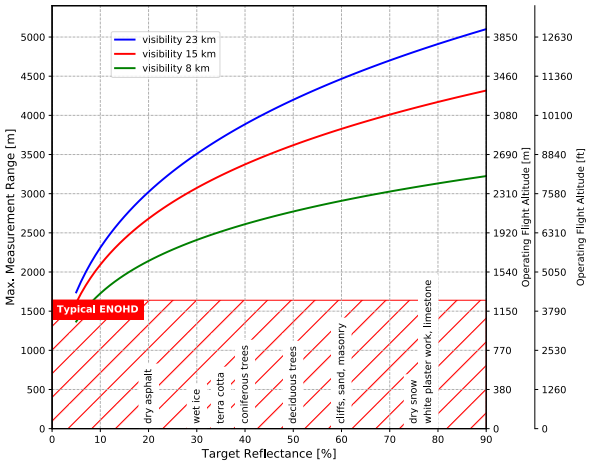
	Field of View		
Cross Flight Direction	± **30 deg** (i.e. 60 deg HFOV)		
In-Flight Direction (at swath center)	**nadir**	± **10 deg**	± **20 deg**
In-Flight Direction (at swath edge)	**nadir**	± **11.5 deg**	± **22.8 deg**

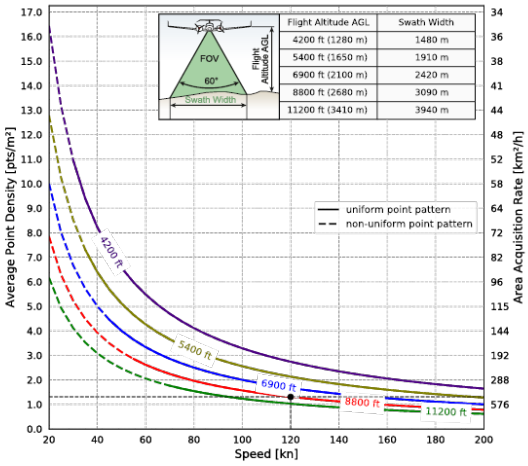
RIEGL VQ-680 Installation Example



RIEGL VQ-680 installed in a SOMAG DSM 400 gyro-stabilized mount.

PRR = 300 kHz

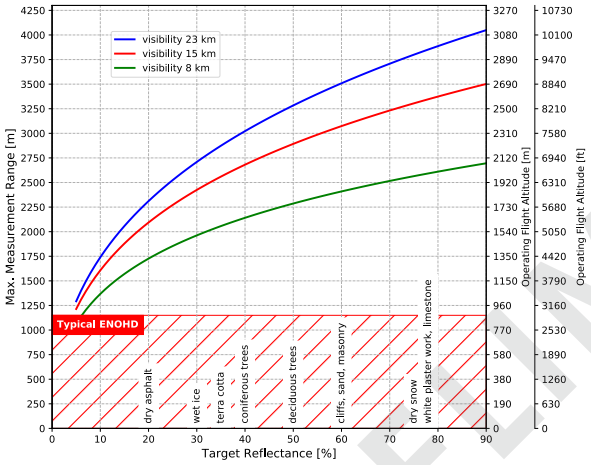


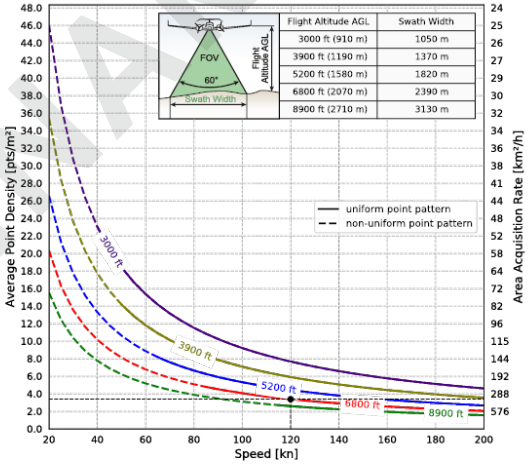


Example: VQ-680 at 300,000 pulses/sec, laser power level 100%
Altitude = 8,800 ft AGL, Speed 120 kn

Results: Point Density ~ 1.3 pts/m²
Area Acquisition Rate ~ 441 km²/h

PRR = 600 kHz

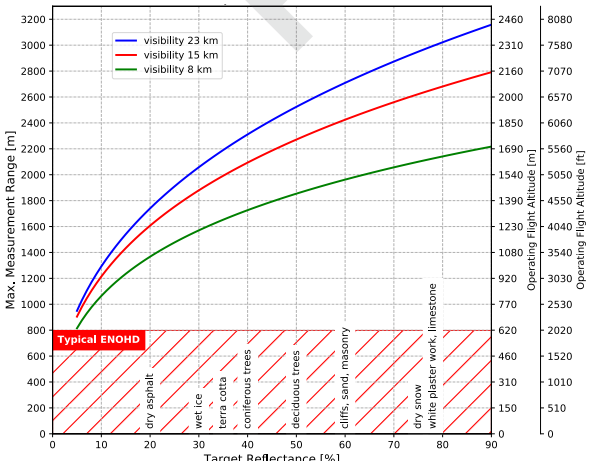


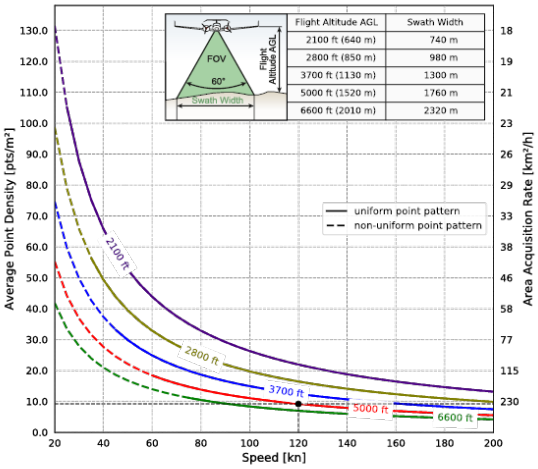


Example: VQ-680 at 600,000 pulses/sec, laser power level 100%
Altitude = 6,800 ft AGL, Speed 120 kn

Results: Point Density ~ 3.4 pts/m²
Area Acquisition Rate ~ 340 km²/h

PRR = 1200 kHz





Example: VQ-680 at 1,200,000 pulses/sec, laser power level 100%
Altitude = 5,000 ft AGL, Speed 120 kn

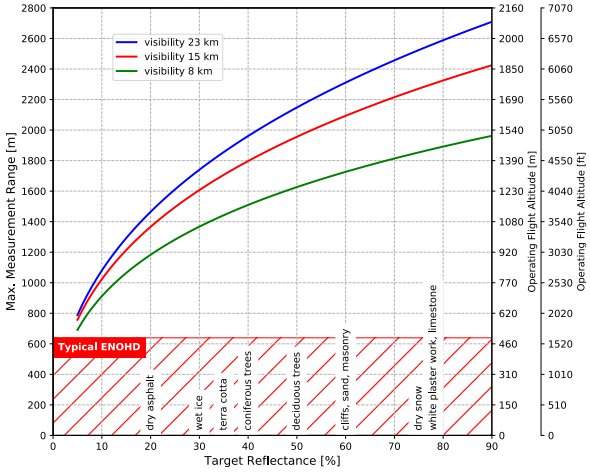
Results: Point Density ~ 9.2 pts/m²
Area Acquisition Rate ~ 250 km²/h

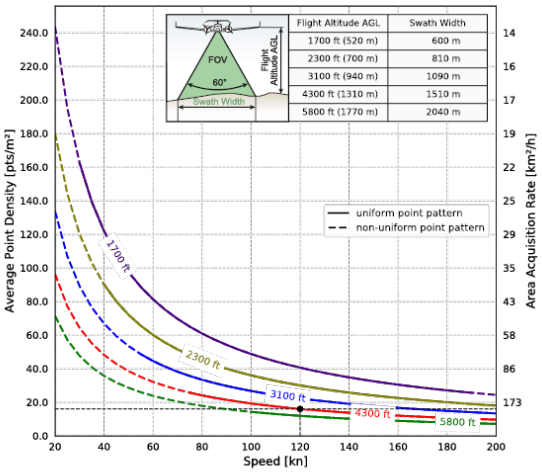
The following conditions are assumed for the Operating Flight Altitude AGL

- ambiguity resolved by multiple-time-around (MTA) processing
- roll angle ±5°
- target size ≥ laser footprint
- average ambient brightness
- operating flight altitude given at a FOV of +/- 37.5°

Maximum Measurement Range & Point Density *RIEGL* VQ-680

PRR = 1800 kHz



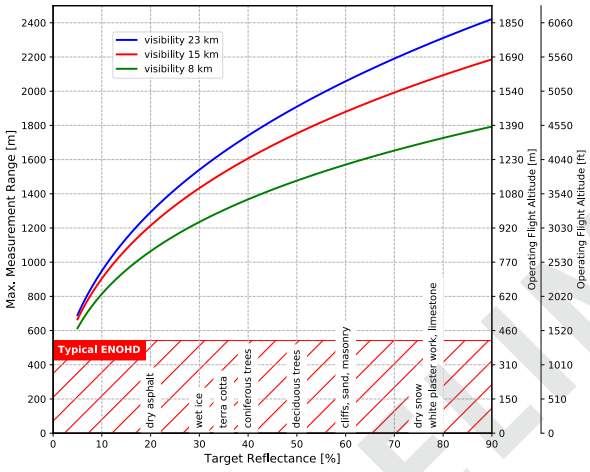


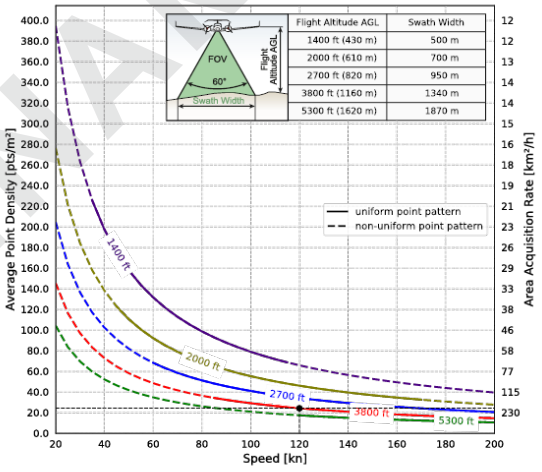
Flight Altitude AGL	Swath Width
1700 ft (520 m)	600 m
2300 ft (700 m)	810 m
3100 ft (940 m)	1090 m
4300 ft (1310 m)	1510 m
5800 ft (1770 m)	2040 m

Example: VQ-680 at 1,800,000 pulses/sec, laser power level 100%
Altitude =4,300 ft AGL, Speed 120 kn

Results: Point Density ~ 16 pts/m²
Area Acquisition Rate ~ 215 km²/h

PRR = 2400 kHz





Flight Altitude AGL	Swath Width
1400 ft (430 m)	500 m
2000 ft (610 m)	700 m
2700 ft (820 m)	950 m
3800 ft (1160 m)	1340 m
5300 ft (1620 m)	1870 m

Example: VQ-680 at 2,400,000 pulses/sec, laser power level 100%
Altitude = 3,800 ft AGL, Speed 120 kn

Results: Point Density ~ 24 pts/m²
Area Acquisition Rate ~ 190 km²/h

The following conditions are assumed for the Operating Flight Altitude AGL

- ambiguity resolved by multiple-time-around (MTA) processing
- roll angle ±5°
- target size ≥ laser footprint
- average ambient brightness
- operating flight altitude given at a FOV of +/- 37.5°

Laser Product Classification

Class 3B Laser Product according to IEC 60825-1:2014

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.

The instrument must be used only in combination with the appropriate laser safety box.

Range Measurement Performance

Measuring Principle: echo signal digitization, online waveform processing, time-of-flight measurement, multiple target capability

Laser Pulse Repetition Rate PRR [1]	300 kHz	600 kHz	1200 kHz	1800 kHz	2400 kHz
Max. Measuring Range [2] [3]					
natural targets ρ ≥ 20 %	3000 m	2300 m	1750 m	1450 m	1300 m
natural targets ρ ≥ 60 %	4450 m	3500 m	2700 m	2300 m	2050 m
Max. Operating Flight Altitude [2] [4] Above Ground Level (AGL)					
natural targets ρ ≥ 20 %	2300 m 7550 ft	1750 m 5750 ft	1350 m 4450 ft	1100 m 3600 ft	1000 m 3300 ft
natural targets ρ ≥ 60 %	3400 m 11150 ft	2700 m 8850 ft	2000 m 6550 ft	1750 m 5750 ft	1600 m 5250 ft
NOHD [5] [7]	200 m	138 m	95 m	75 m	62 m
ENOHD [6] [7]	1262 m	885 m	614 m	492 m	417 m
Max. Number of Targets per Pulse [8]	32	24	11	7	5

1) Rounded average PRR
2) Typical values for average conditions and average ambient brightness. In bright sunlight, the max. range is shorter than under an overcast sky.
3) The 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. Range ambiguities have to be resolved by multiple-time-around processing.
4) Typical values for max. effective FOV 60°, additional roll angle ± 5°, forward/backward scan angle 20°
5) Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014, for single line condition.
6) Extended Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014, for single line condition.
7) NOHD and ENOHD have been calculated for a typical angular step width with non-overlapping laser footprints and an aircraft speed higher than 10kn. NOHD and ENOHD increase when using overlapping laser footprints which may be intended e.g. for power line mapping.
8) If more than one target is hit, the total laser transmitter power is split and, accordingly, the achieveable range is reduced.

Minimum Range	20 m
Accuracy [7] [9]	20 mm
Precision [8] [9]	20 mm
Laser Pulse Repetition Rate [10]	up to 2400 kHz
Max. Effective Measurement Rate	up to 2,000,000 meas./sec. (@ 2400 kHz PRR & 60° scan angle)
Echo Signal Intensity	provided for each echo signal
Laser Wavelength	near infrared
Laser Beam Divergence	typ. 0.28 mrad @ 1/e² [11], typ. 0.22 mrad @ 1/e [12]

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) One sigma @ 150 m range under *RIEGL* test conditions.
10) User selectable.
11) Measured at 1/e² points, 0.28 mrad corresponds to an increase of 28 mm of beam diameter per 100 m distance.
12) Measured at 1/e points, 0.22 mrad corresponds to an increase of 22 mm of beam diameter per 100 m distance.

Scanner Performance

Scanning Mechanism	rotating polygon mirror
Scan Pattern	parallel scan lines, angular directions -20°, -10°, 0°, +10°, +20° transvers to the scan
Scan angle range	± 30° = 60°
Total Scan Rate	50 - 500 lines/sec. [13]
Angular Step Width Δ ϑ	0.008° ≤ Δ ϑ ≤ 0.12° [14] [15]
Angle Measurement Resolution	0.001°

13) The minimum scan rate depends on the selected laser PRR.
14) The angular step width depends on the selected laser PRR.
15) The maximum angular step width is limited by the maximum scan rate.

Data Interfaces

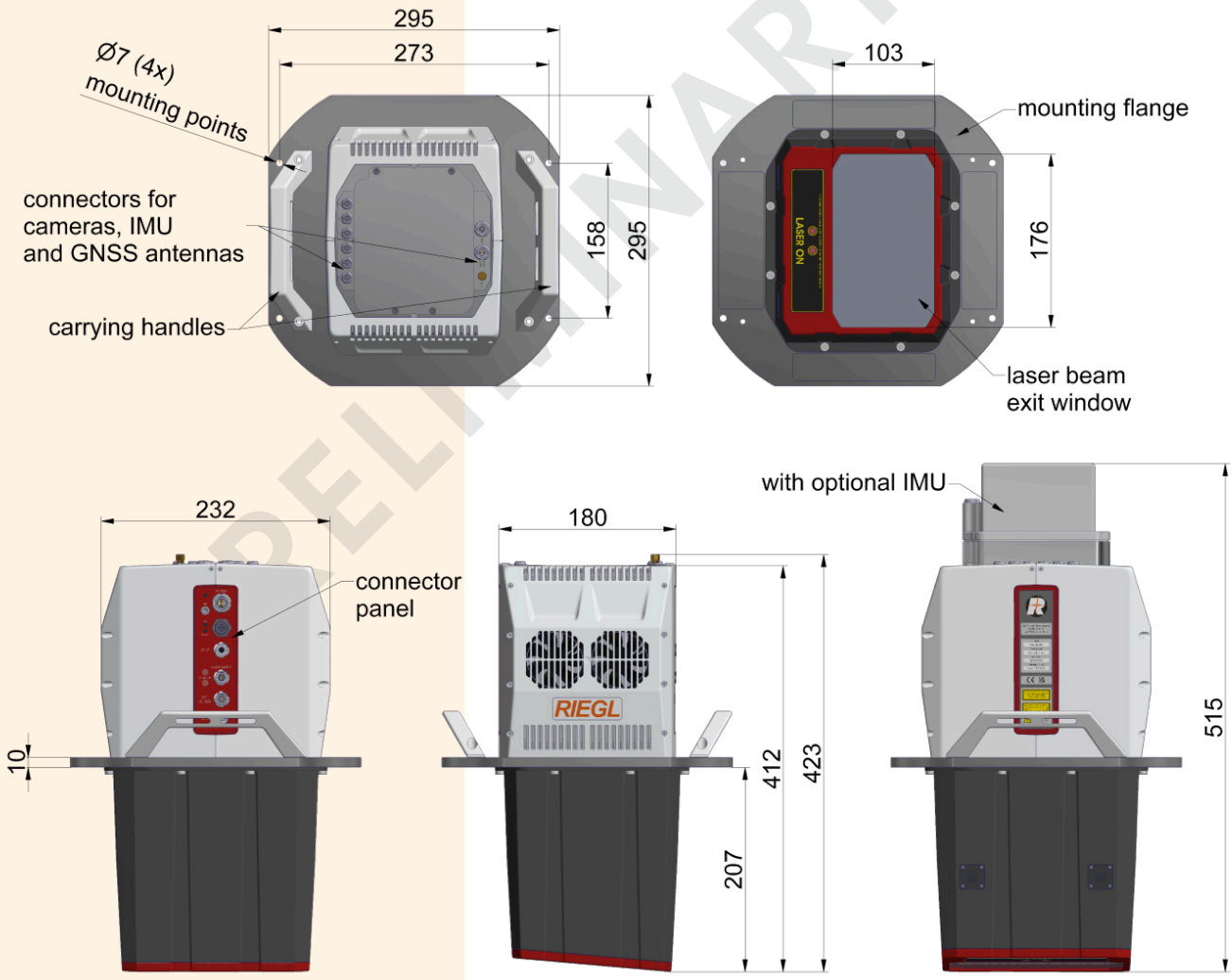
Configuration	LAN 10/100/1000 MBit/sec
Scan Data Output	LAN 10/100/1000 MBit/sec
Synchronization	Serial RS-232 interface, TTL input for 1 pps synchronization pulse, accepts different data formats for GNSS-time information

Technical Data VQ-680

Data Storage	
Permanently Installed Data Storage	Solid State Disc SSD, 2 TByte
General Technical Data	
Power Supply Input Voltage	18 - 34 V DC
Power Consumption	typ. 100 W, max. 240 W [1]
Main Dimensions (L x W x H)	232 mm x 180 mm x 412 mm (without mounting flange and IMU sensor)
Weight	approx. 12.5 kg (without IMU sensor)
Humidity	non condensing
Protection Class	IP64, dust and splash proof (tube below the mouning flange) IP20 (electronics aboce the mounting flange)
Max. Flight Altitude operating & not operating	18500 ft (5600 m) above MSL (Mean Sea Level)
Temperature Range	-5°C up to +40°C (operation) / -10°C up to +50°C (storage)

1) Max. scan rate, all heaters in operation.

Dimensional Drawings VQ-680



all dimensions in mm

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