

High-Performance Online Waveform Processing Airborne LiDAR Scanning Module for Integration with Third-Party Camera Systems

NEW

RIEGL VQ-680 OEM

- **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**



The VQ-680 OEM is a compact airborne LiDAR scanner module designed for integration with large-format photogrammetric aerial camera systems that are configured for urban mapping applications. The VQ-680 OEM's form factor has been optimized to provide a compact scanner with a small exit aperture, given the limited space in, e.g., photogrammetric oblique camera configurations.

The LiDAR 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 of a power supply, PPS and NMEA time synchronization, and a laser safety connector. 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 featuring a GUI, real-time data visualization and remote control capabilities.

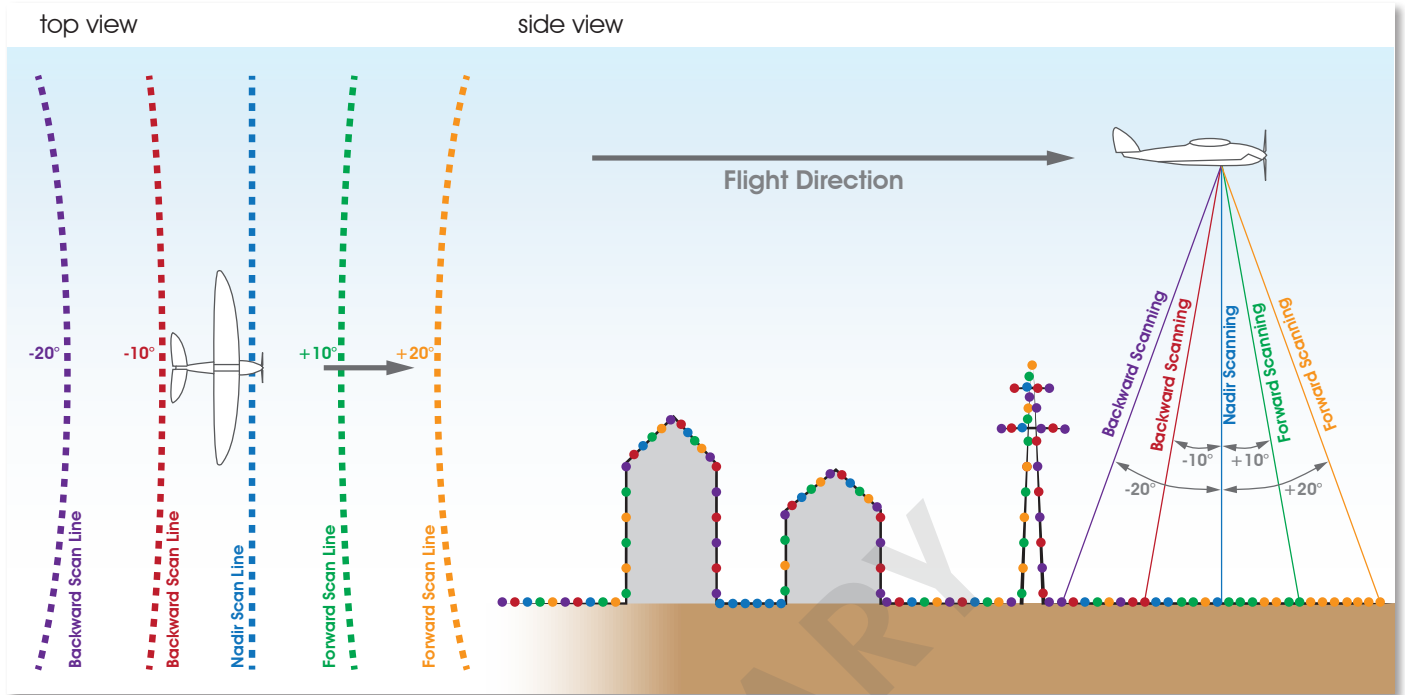
A sturdy mechanical interface enables mounting the LiDAR module inside a camera system rigidly connected with the IMU/GNSS system and various camera modules.

Applications:

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



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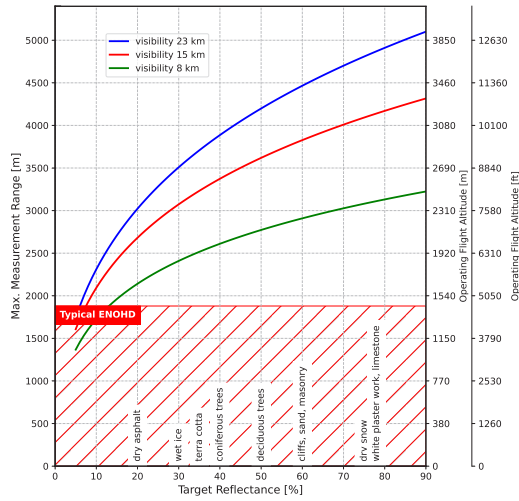
The RIEGL VQ-680 OEM offers a sophisticated, multi-axis scan geometry consisting of five parallel scan lines per scanner rotation, but with each scan line having its own unique scan direction. The scan directions change consecutively from nadir, to +10 and +20 degrees forward, and to -10 and -20 degrees 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 OEM 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.

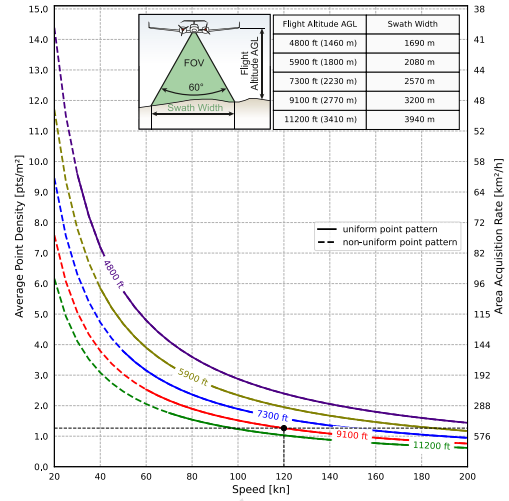
	Field of View		
Cross Flight Direction	± 30 deg (i.e. 60 deg HFOV)		
In-Flight Direction (at swath center)	nadir	± 10 deg	± 20 deg
In-Flight Direction (at swath edge)	nadir	± 11.5 deg	± 22.8 deg

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

PRR = 300 kHz

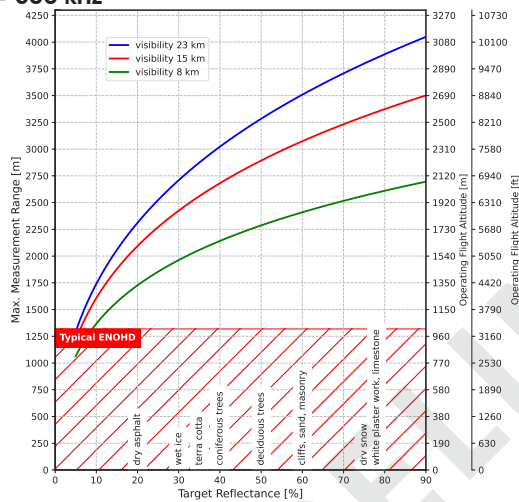


Example: VQ-680OEM at 300,000 pulses/sec, laser power level 100%
Altitude = 9,100 ft AGL, Speed 120 kn

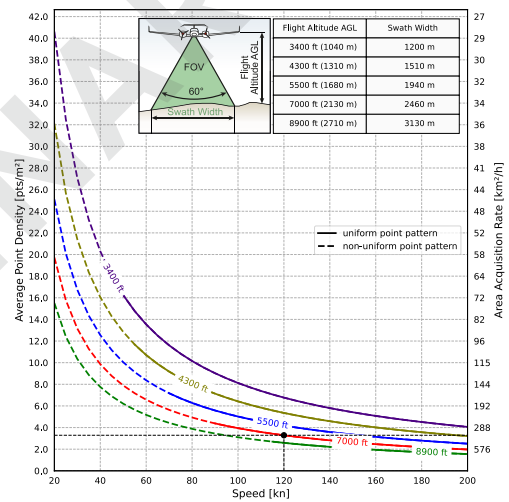


Results: Point Density ~ 1.3 pts/m²
Area Acquisition Rate ~ 456 km²/h

PRR = 600 kHz

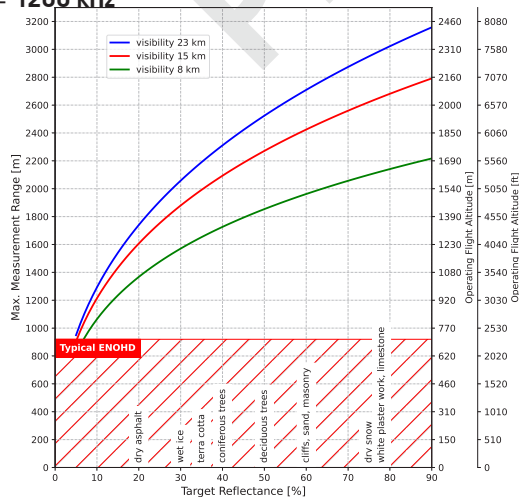


Example: VQ-680OEM at 600,000 pulses/sec, laser power level 100%
Altitude = 7,000 ft AGL, Speed 120 kn

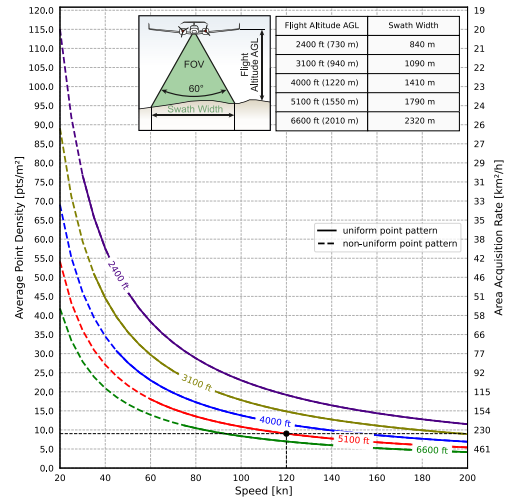


Results: Point Density ~ 3.3 pts/m²
Area Acquisition Rate ~ 350 km²/h

PRR = 1200 kHz



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



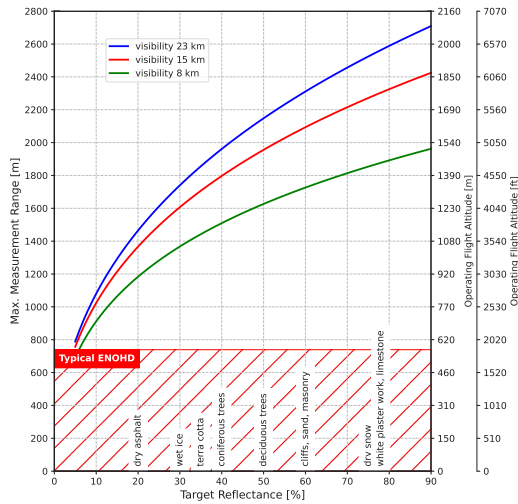
Results: Point Density ~ 9 pts/m²
Area Acquisition Rate ~ 255 km²/h

The following conditions are assumed for the Operating Flight Altitude AGL

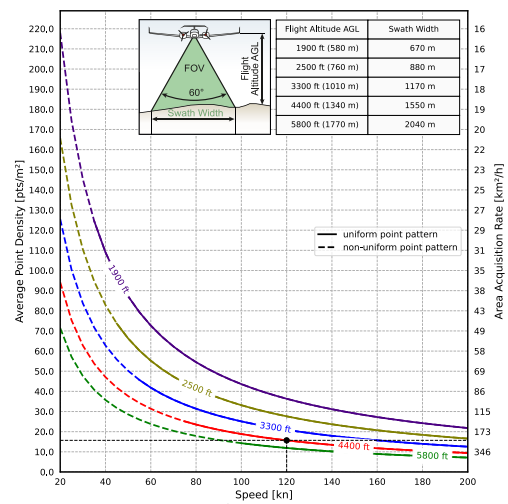
- ambiguity resolved by multiple-time-around (MTA) processing
- roll angle $\pm 5^\circ$
- target size $\geq$ laser footprint
- average ambient brightness
- operating flight altitude given at a FOV of $\pm 37.5^\circ$

Maximum Measurement Range & Point Density RIEGL VQ-680 OEM

PRR = 1800 kHz

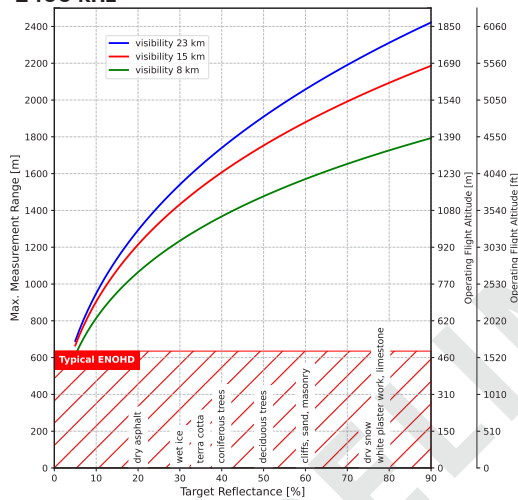


Example: VQ-680OEM at 1,800,000 pulses/sec, laser power level 100%
Altitude = 4,400 ft AGL, Speed 120 kn

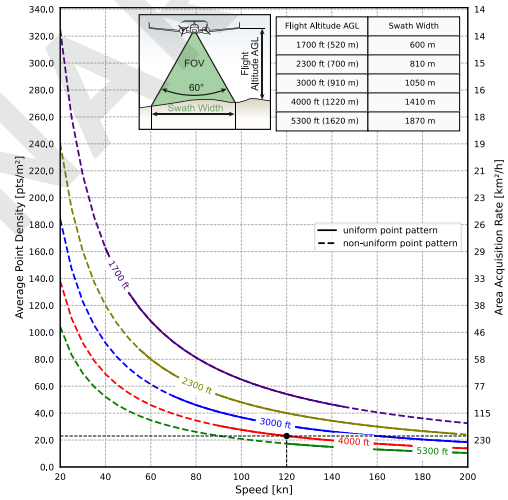


Results: Point Density ~ 16 pts/m²
Area Acquisition Rate ~ 220 km²/h

PRR = 2400 kHz



Example: VQ-680OEM at 2,400,000 pulses/sec, laser power level 100%
Altitude = 4,000 ft AGL, Speed 120 kn



Results: Point Density ~ 23 pts/m²
Area Acquisition Rate ~ 200 km²/h

The following conditions are assumed for the Operating Flight Altitude AGL

- ambiguity resolved by multiple-time-around (MTA) processing
- roll angle $\pm 5^\circ$
- target size $\geq$ laser footprint
- average ambient brightness
- operating flight altitude given at a FOV of $\pm 37.5^\circ$

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 $p \geq 20\%$	3000 m	2300 m	1750 m	1450 m	1300 m
natural targets $p \geq 60\%$	4450 m	3500 m	2700 m	2300 m	2050 m
Max. Operating Flight Altitude ^{2) 4)}					
Above Ground Level (AGL)					
natural targets $p \geq 20\%$	2300 m	1750 m	1350 m	1100 m	1000 m
	7550 ft	5750 ft	4450 ft	3600 ft	3300 ft
natural targets $p \geq 60\%$	3400 m	2700 m	2000 m	1750 m	1600 m
	11150 ft	8850 ft	6550 ft	5750 ft	5250 ft
NOHD ^{5) 7)}	200 m	138 m	95 m	75 m	62 m
ENOHD ^{6) 7)}	1447 m	1015 m	708 m	569 m	489 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 $\pm 5^\circ$, 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 achievable 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

$\pm 30^\circ = 60^\circ$

Scan angle range (horizontal FOV)

Total Scan Rate

50 - 500 lines/sec. ¹³⁾

Angular Step Width $\Delta \theta$

$0.008^\circ \leq \Delta \theta \leq 0.12^\circ$ ^{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

Data Storage

Permanently Installed Data Storage

Solid State Disc SSD, 2 TByte

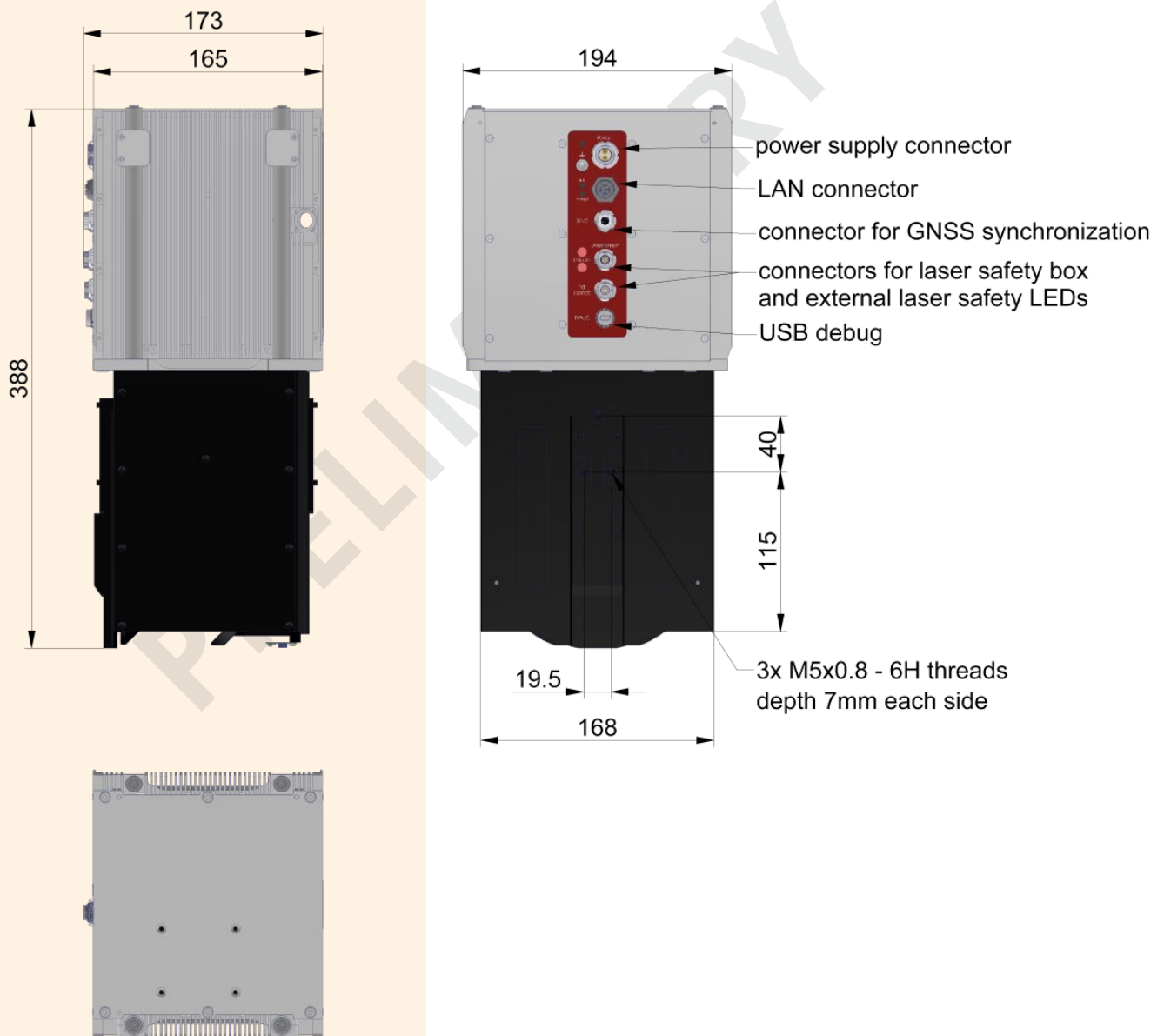
Technical Data VQ-680 OEM

General Technical Data

Power Supply Input Voltage	18 - 34 V DC
Power Consumption	typ. 100 W, max. 190 W ¹⁾
Main Dimensions (L x W x H)	165 mm x 195 mm x 388 mm (without external forced air-cooling)
Weight	< 10 kg
Humidity	non condensing
Protection Class	not specified (OEM laser scanner module intended to be integrated into general equipment by professional manufacturers.)
Max. Flight Altitude operating & not operating	18 500 ft (5 600 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 OEM



all dimensions in mm



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