Waveform Processing Airborne Laser Scanning System

RIEGL VQ®-480 II

- *high accuracy ranging based on RIEGL Waveform-LiDAR technology*
- *high laser pulse repetition rate up to 2 MHz*
- *measurement rate up to 1,250,000 measurements/sec*
- *perfectly linear and parallel scan lines*
- *compact, & lightweight design: ready for integration in UAVs with higher payload capacity*
- *wide field of view of 75°*
- *interfaces for up to 5 optional cameras*
- *mechanical and electrical interface for IMU/GNSS integration*
- *removeable storage card and integrated Solid State Disk (SSD) for data storage*
- *compatible with stabilized platforms and even small hatches*
- *seamless integration and compatibility with other RIEGL ALS systems and software packages*

In further development of the *RIEGL* VQ-480 Airborne Laser Scanner Series – the *RIEGL* VQ-480 II presents itself in a completly new design that successfully takes up the already proven qualities and leads them to a new standard of performance and user-friendliness.

Its sophisticated design allows to further reduce the overall weight resulting in approx. 10 kg. Thus, the scanner is well suited for the use in manned but also in unmanned aircrafts. The VQ-480 II can seamlessly be integrated into stabilized platforms, e.g. standard gyromounts, and also into even small hatches.

Based on *RIEGL*'s proven Waveform-LiDAR technology, the scanner provides highly accurate point clouds, excellent vertical target resolution, calibrated reflectance readings, and pulse shape deviation for unsurpassed information content on each single measurement. With a measurement rate of up to 1,250,000 measurements/second and an extremely wide field of view of 75°, the VQ-480 II is the first choice for airborne surveying applications like corridor mapping, city modeling, and agriculture & forestry.

An easy to remove CFast® storage card and an integrated Solid State Disk and/or the option for streaming the scan data via LAN TCP/IP interface are provided for data transfer and storage.

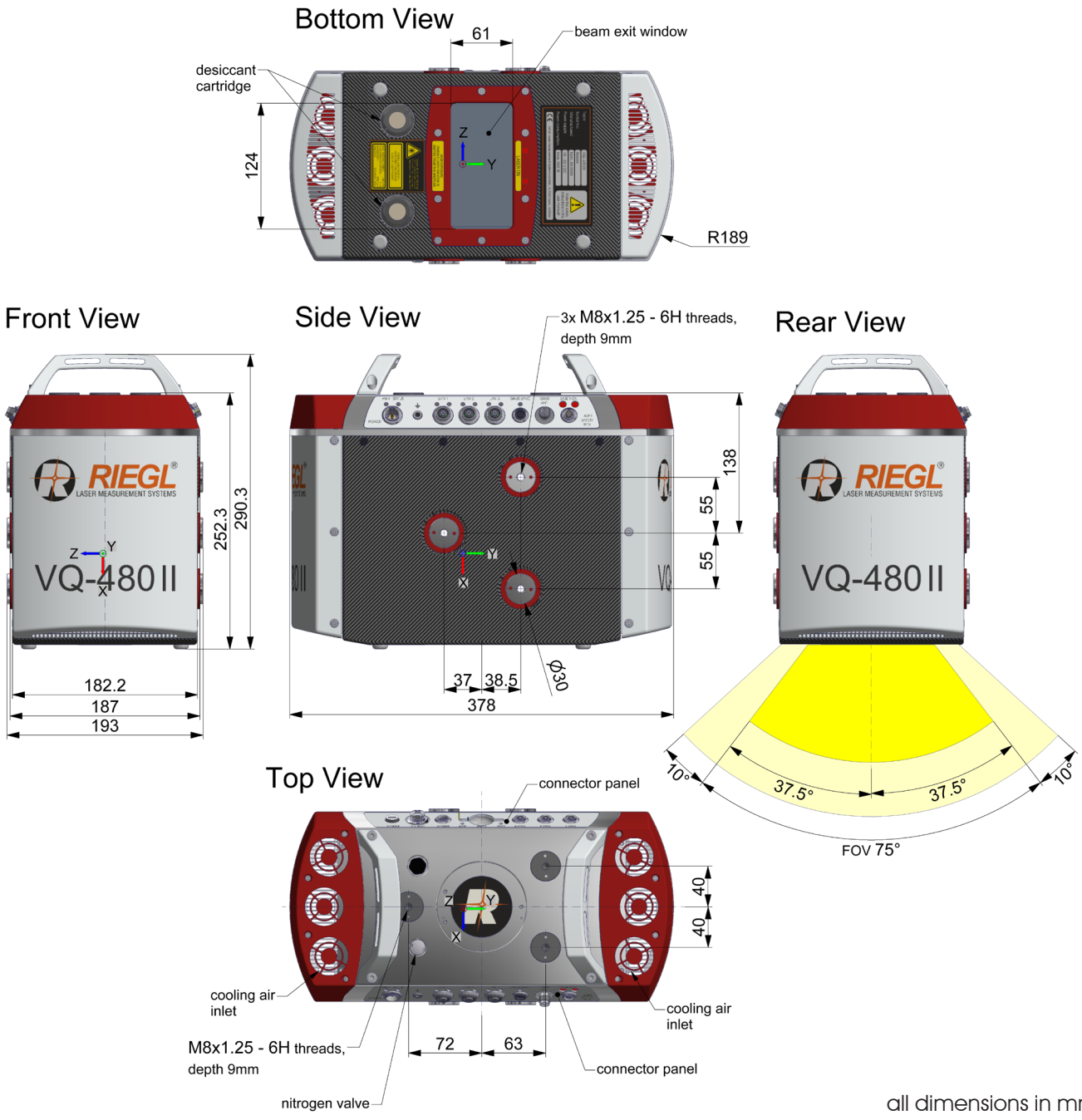
Typical applications include

- *Airborne Mapping using Manned or Unmanned Aircrafts*
- *Corridor Mapping*
- *City Modeling*
- *Agriculture & Forestry*

visit our website
www.riegl.com

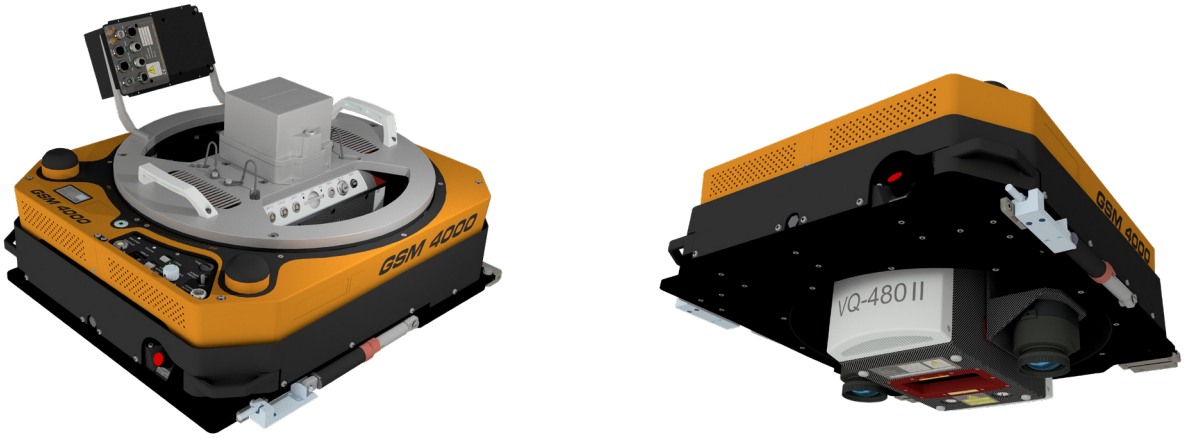
RIEGL®
LASER MEASUREMENT SYSTEMS

Dimensional Drawings *RIEGL* VQ®-480 II

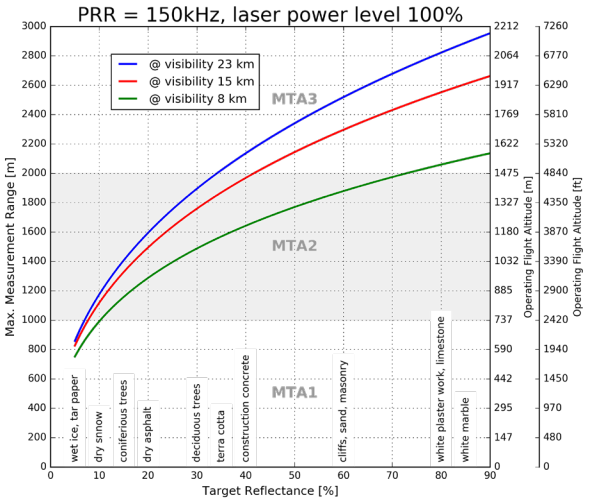


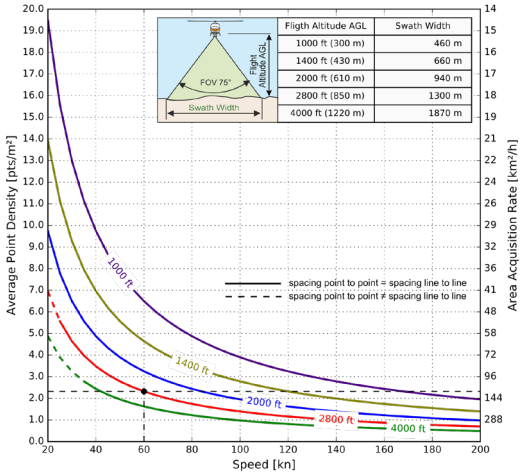
all dimensions in mm

RIEGL VQ®-480 II Installation Example



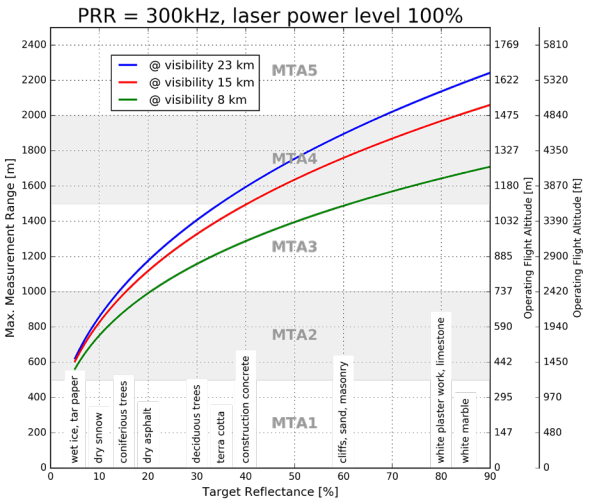
RIEGL VQ-480 II installed on GSM-4000 stabilized platform to be used in a helicopter or fixed-wing aircraft

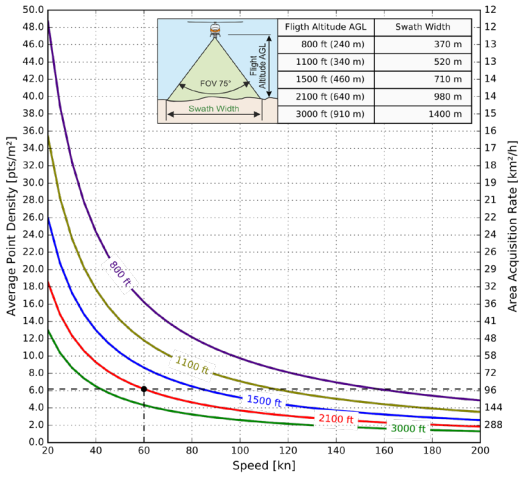




Example: VQ-480 II at 150,000 pulses/sec, laser power level 100%
Altitude = 2,800 ft AGL, Speed 60 kn

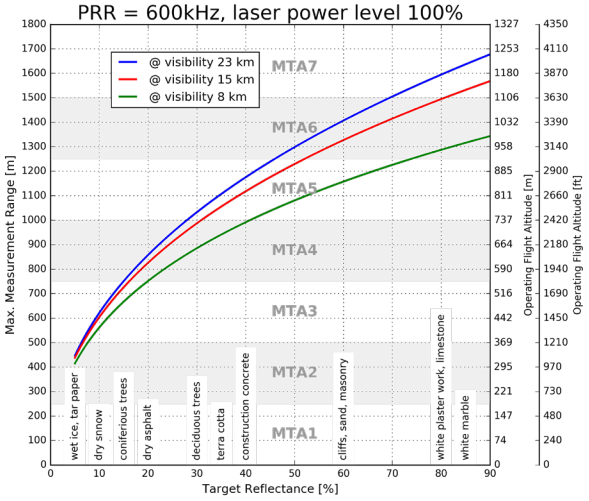
Results: Point Density ~ 2.32 pts/m²

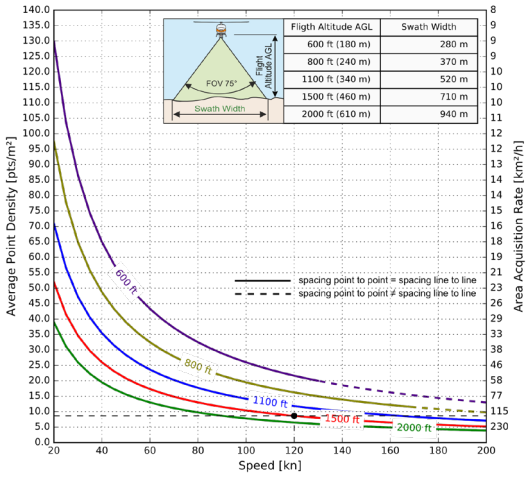




Example: VQ-480 II at 300,000 pulses/sec, laser power level 100%
Altitude = 2,100 ft AGL, Speed 60 kn

Results: Point Density ~ 6.18 pts/m²



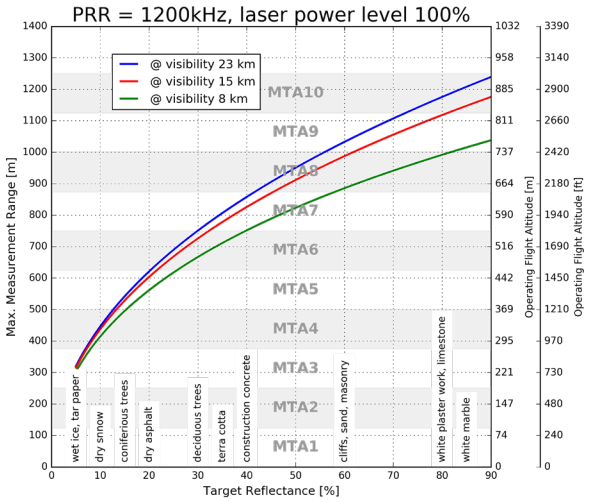


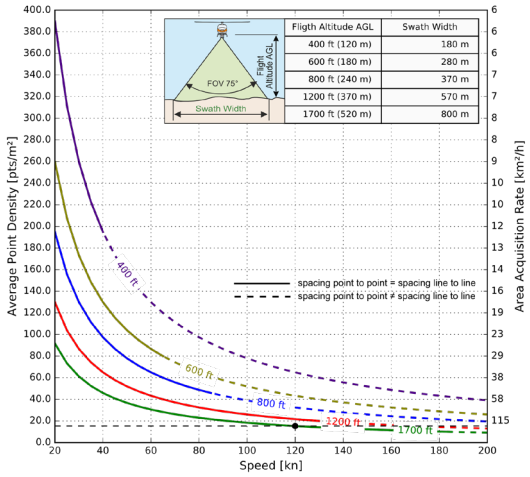
Example: VQ-480 II at 600,000 pulses/sec, laser power level 100%
Altitude = 1,500 ft AGL, Speed 120 kn

Results: Point Density ~ 8.66 pts/m²

The following conditions are assumed for the Operating Flight Altitude AGL

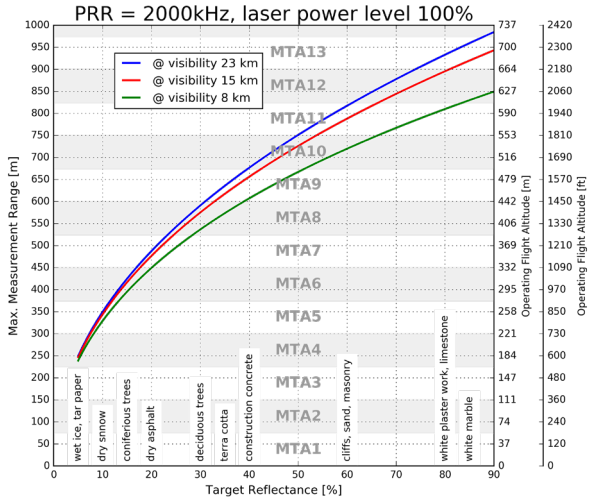
- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- average ambient brightness
- roll angle ±5°
- operating flight altitude given at a FOV of +/- 37.5°

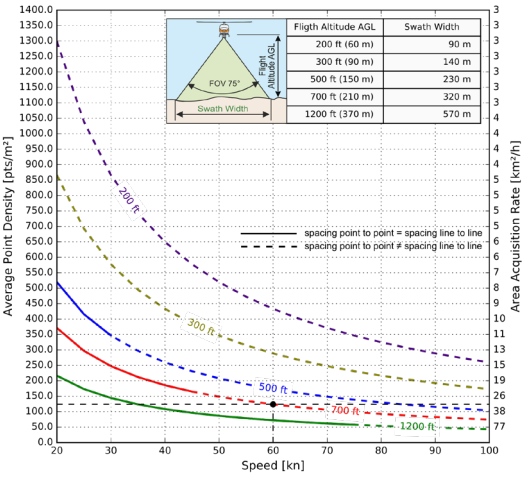




Example: VQ-480 II at 1,200,000 pulses/sec, laser power level 100%
Altitude = 1,700 ft AGL, Speed 120 kn

Results: Point Density ~ 15.28 pts/m²





Example: VQ-480 II at 2,000,000 pulses/sec, laser power level 100%
Altitude = 700 ft AGL, Speed 60 kn

Results: Point Density ~ 123.68 pts/m²

The following conditions are assumed for the Operating Flight Altitude AGL

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

Laser Product Classification	Class 3R 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.
Safe for the naked eye (NOHD[1])	> 0.5 m
Safe for the aided eye (ENOHD[2])	> 5 m

1) Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014

2) Extended Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014

Range Measurement Performance

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

Laser Pulse Repetition Rate PRR [3]	150 kHz	300 kHz	600 kHz	1200 kHz	2000 kHz
Max. Measuring Range [4] [5]					
natural targets ρ ≥ 20 %	1600 m	1200 m	850 m	650 m	500 m
natural targets ρ ≥ 60 %	2500 m	1900 m	1400 m	1050 m	800 m
Max. Operating Flight Altitude [4] [6] (AGL)					
natural targets ρ ≥ 20 %	1200 m 3950 ft	900 m 2950 ft	600 m 1950 ft	500 m 1650 ft	350 m 1150 ft
natural targets ρ ≥ 60 %	1850 m 6050 ft	1400 m 4600 ft	1050 m 3450 ft	800 m 2600 ft	600 m 1950 ft
Max. Number of Target per Pulse [7]	15	15	15	9	5

3) Rounded average PRR
4) Typical values for average conditions and average ambient brightness. In bright sunlight, the max. range is shorter than under an overcast sky.
5) 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.
6) Typical values for max. effective FOV 75°, additional roll angle ± 5°
7) If more than one target is hit, the total laser transmitter power is split and, accordingly, the achieveable range is reduced.

Minimum Range [8]	20 m
Accuracy [9] [11]	20 mm
Precision [10] [11]	20 mm
Laser Pulse Repetition Rate [12]	up to 2000 kHz
Max. Effective Measurement Rate	up to 1 250 000 meas./sec. (@ 2000 kHz PRR & 75° scan angle)
Echo Signal Intensity	provided for each echo signal
Laser Wavelength	near infrared
Laser Beam Divergence	≤ 0.35 mrad [13]

8) Limitation for range measurement capability, does not consider laser safety issues!
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) One sigma @ 150 m range under *RIEGL* test conditions.
12) User selectable.
13) Measured at $1/e^2$ points, 0.35 mrad corresponds to an increase of 35 mm of beam diameter per 100 m distance.

Scanner Performance

Scanning Mechanism	rotating polygon mirror
Scan Pattern	parallel scan lines
Scan angle range	± 37.5° = 75°
Total Scan Rate	30 – 300 lines/sec.
Angular Step Width Δ ϑ	0.002° ≤ Δ ϑ ≤ 0.24° [14] [15]
Angle Measurement Resolution	0.001°

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
Camera Interface	1 connector with power, RS-232, pps, trigger, exposure 2 connectors with power, 2x trigger, 2x exposure

Data Storage

Permanently Installed Data Storage	Solid State Disc SSD, 1 TByte
Removable Data Storage	Cardholder for CFAST® [16] storage cards (up to 256 GByte)

16) CFast is a registered trademark of CompactFlash Association.

General Technical Data

Power Supply Input Voltage	18 - 34 V DC
Power Consumption	typ. 150 W, max. 250 W [1]
Main Dimensions (L x W x H)	378 mm x 193 mm x 252 mm (without mounted carrying handles)
Weight	
without integrated IMU/GNSS	10.1 kg
with integrated IMU/GNSS	10.5 kg
Humidity	non condensing
Protection Class	IP54, dust-proof and splash-proof
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)

Integrated IMU & GNSS (optional) [2]

IMU Accuracy	
Roll, Pitch	0.015°
Heading	0.035°
IMU Sampling Rate	200 Hz
Position Accuracy (typ.)	
horizontal	≤ 0.05 m
vertical	≤ 0.1 m

1) Max. scan rate, all heaters in operation.
2) Accuracy specifications for post-processed data.

RIEGL LASER MEASUREMENT SYSTEMS

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

RIEGL USA Inc. | info@rieglusa.com | www.rieglusa.com
RIEGL Japan Ltd. | info@riegl-japan.co.jp | www.riegl-japan.co.jp
RIEGL China Ltd. | info@riegl.cn | www.riegl.cn
RIEGL Australia Pty Ltd. | info@riegl.com.au | www.riegl.com

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