UAV LiDAR Sensor for High-Speed Corridor Mapping

# RIEGL VUX®-180²⁴

- *scan speed up to 800 lines/second*
- *laser pulse repetition rate up to 2.4 MHz*
- *measurement rate up to 2,000,000 meas./sec*
- *operating flight altitude up to 980 m / 3,250 ft*
- *Field of View up to 75°*
- *compact & lightweight (2.7 kg / 5.9 lbs)*
- *cutting edge RIEGL technology providing:*
  - *echo signal digitization*
  - *multiple target capability*
  - *online waveform processing*
  - *multiple-time-around processing*
- *easily mountable to unmanned platforms (UAVs) and small manned aircraft*
- *mechanical and electrical interface for IMU/GNSS integration*
- ***NEW OPTION:***
  ***fully integrated IMU/GNSS system RIEGL RiLOC-F inside***
- *interfaces for up to 5 external cameras*
- *scan data storage on internal SSD Memory*
- *removeable CFAST® memory card*


**The *RIEGL* VUX-180²⁴ is a lightweight and versatile airborne laser scanner offering a wide field of view of 75 degrees and an extremely high pulse repetition rate of up to 2.4 MHz. These features – in combination with an increased scan speed of up to 800 lines/second – make the *RIEGL* VUX-180²⁴ perfectly suited for high speed surveying missions and applications where an optimal line and point distribution is required.**

The *RIEGL* VUX-180²⁴ makes use of *RIEGL's* unique Waveform-LiDAR technology, allowing echo digitization and online waveform processing. Multi-target resolution is the basis for penetrating even dense foliage.

For smooth and straight forward data storage, the scanner provides an internal data storage capacity of 2 TByte and a removeable CFast® card. Interfaces for up to five optional external cameras and the integration of an appropriate external IMU/GNSS system are available. It is also optionally available with the new RiLOC-F^inside IMU/GNSS system solution from *RIEGL*, which is fully integrated into the scanner housing, reducing the overall weight of the entire system.

The sophisticated design of the *RIEGL* VUX-180²⁴ enables smooth integration with fast-flying UAS/UAV/RPAS, small manned aeroplanes and helicopters. It is offered as stand-alone UAV LiDAR sensor and also in various fully-integrated UAV-based laser scanning system configurations with appropriate IMU/GNSS system and optional cameras. This allows the scanner to perfectly meet all the specific requirements of the customers' applications.

**Typical applications include**

- ***High-Speed Corridor Mapping and High-Density Applications: e.g. mapping and monitoring of critical infrastructure like power lines, railway tracks, pipelines, runways***
- ***Topography in Open-Cast Mining***
- ***Surveying of Urban Environments***
- ***Agriculture & Forestry***

visit our website
www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS

| | |
|---|---|
| Laser Product Classification | Class 3R Laser Product according to IEC60825-1:2014<br>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. |
| NOHD (Nominal Ocular Hazard Distance) [1) 2)] | 0 m |
| ENOHD (Extended Nominal Ocular Hazard Distance) [1) 3)] | 0 m |


1) NOHD and ENOHD stated for operating the device from an aircraft flying at a speed higher than 1 kn.
2) For a stationary operated device NOHD is 0.3 m.
3) For a stationary operated device ENOHD is 3.5 m.

## Range Measurement Performance

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

| *Laser Pulse Repetition Rate PRR* [4)] | *300 kHz* | *600 kHz* | *1200 kHz* | *1800 kHz* | *2400 kHz* |
|---|---|---|---|---|---|
| Max. Measuring Range [5) 6)] | | | | | |
| natural targets ρ ≥ 20 % | 810 m | 590 m | 420 m | 350 m | 300 m |
| natural targets ρ ≥ 60 % | 1340 m | 980 m | 710 m | 590 m | 510 m |
| natural targets ρ ≥ 80 % | 1520 m | 1120 m | 810 m | 670 m | 590 m |
| Max. Operating Flight Altitude AGL [5) 7)] | | | | | |
| @ ρ ≥ 20 % | 600 m (1950 ft) | 430 m (1400 ft) | 310 m (1000 ft) | 260 m (850 ft) | 220 m (750 ft) |
| @ ρ ≥ 60 % | 980 m (3250 ft) | 720 m (2350 ft) | 520 m (1700 ft) | 430 m (1400 ft) | 380 m (1250 ft) |
| Max. Number of Targets per Pulse [8)] | 32 | 24 | 11 | 7 | 5 |

4) Rounded average PRR.
5) Typical values for average conditions and average ambient brightness. In bright sunlight, the max. range is shorter than under an overcast sky.
6) 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.
7) Considering max. effective FOV 75°, additional roll angle <± 5 deg.
8) If the laser beam hits, in part, more than one target, the laser's pulse power is split accordingly. Thus the achievable range is reduced.

| | |
|---|---|
| Minimum Range | 5 m |
| Accuracy [9) 11)] | 10 mm |
| Precision [10) 11)] | 5 mm |
| Laser Pulse Repetition Rate [4) 12)] | up to 2400 kHz |
| Max. Effective Measurement Rate [4)] | up to 2,000,000 meas./sec. (@ 2400 kHz PRR & 75° scan angle) |
| Echo Signal Intensity | for each echo signal, high-resolution 16 bit intensity information is provided |
| Laser Wavelength | near infrared |
| Laser Beam Divergence | 0.4 mrad [13)] |
| Laser Beam Footprint (Gaussian Beam Definition) | 40 mm @ 100 m, 200 mm @ 500 m, 400 mm @ 1000 m |

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, setting of intermediate PRR values possible.
13) Measured at the $1/e^2$ points. 0.4 mrad corresponds to an increase of 40 mm of beam diameter per 100 m distance.

## Scanner Performance

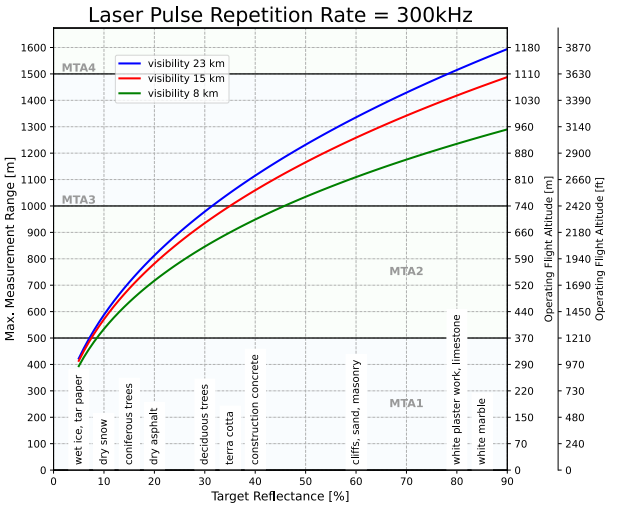
| | |
|---|---|
| Scanning Mechanism | rotating polygon mirror |
| Scan Pattern | parallel scan lines |
| Field of View (selectable) | ± 37.5°= 75° |
| Scan Speed (selectable) | 50 - 800 lines/sec |
| Angular Step Width Δ ϑ (selectable) between consecutive laser shots | 0.002° ≤ Δ ϑ ≤ 0.24° [14) 15)] |
| Angle Measurement Resolution | 0.001° |
| Scan Sync (optional) | scanner rotation synchronization |

## Data Interfaces

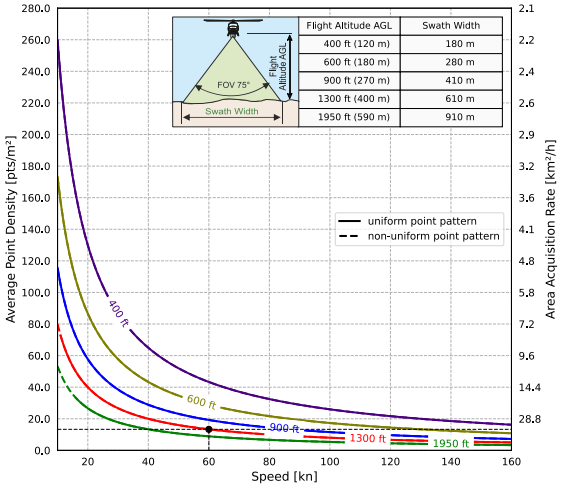
| | |
|---|---|
| Configuration, Scan Data Output & Communication with External Devices | LAN 10/100/1000 MBit/sec |
| GNSS Interface | Serial RS-232 interface, TTL input for 1pps synchronisation pulse, accepts different data formats for GNSS-time information |
| General IO & Control [16)] | 1x TTL input, 1x TTL output, 1 x Remote on/off |
| Camera Interfaces at connector panel | 5x power (max. 2.0 A), trigger, exposure, and GNSS RS-232 Tx & PPS |
| Camera Interfaces via multi purpose connector [17)] | 1x trigger and exposure |
| IMU Interface (optional) [18)] | IMU data, power |

14) The angular step width depends on the selected laser PRR.
15) The maximum angular step width is limited by the max. scan rate.
16) externally available via multi-purpose connector
17) externally available via connection board (including 1x power camera)
18) applies only with IMU/GNSS system

Technical Data to be continued at page 5

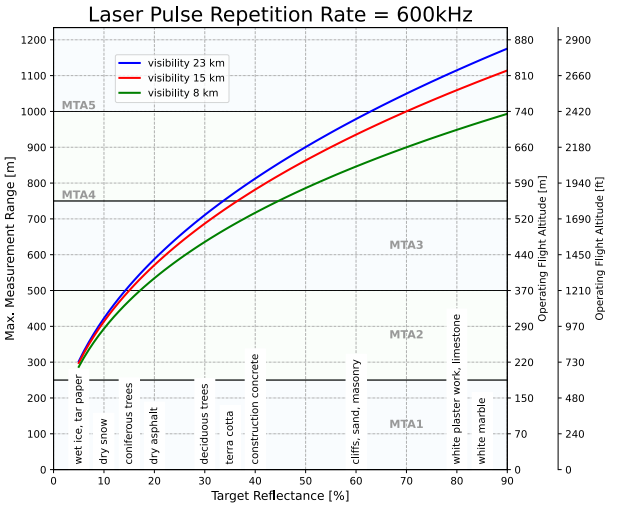



Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle <±5 deg

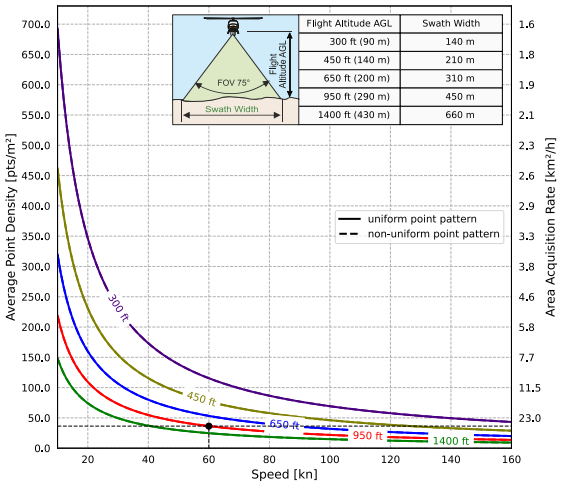



| Flight Altitude AGL | Swath Width |
|---|---|
| 400 ft (120 m) | 180 m |
| 600 ft (180 m) | 280 m |
| 900 ft (270 m) | 410 m |
| 1300 ft (400 m) | 610 m |
| 1950 ft (590 m) | 910 m |

Example: VUX-180[24] at 300,000 pulses/sec, laser power level 100% altitude 1,300 ft AGL, speed 60 kn, resulting point density ~ 13.3 pts/m²

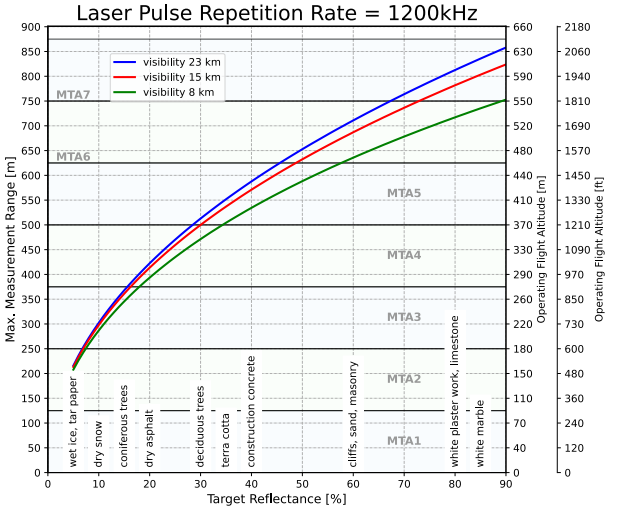



Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle <±5 deg

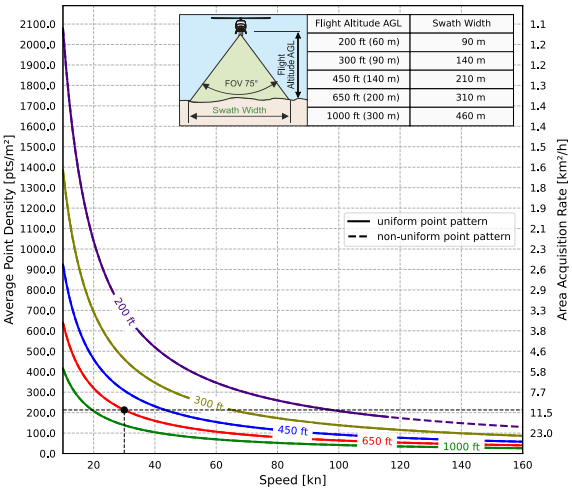



| Flight Altitude AGL | Swath Width |
|---|---|
| 300 ft (90 m) | 140 m |
| 450 ft (140 m) | 210 m |
| 650 ft (200 m) | 310 m |
| 950 ft (290 m) | 450 m |
| 1400 ft (430 m) | 660 m |

Example: VUX-180[24] at 600,000 pulses/sec, laser power level 100% altitude 950 ft AGL, speed 60 kn, resulting point density ~ 36.5 pts/m²



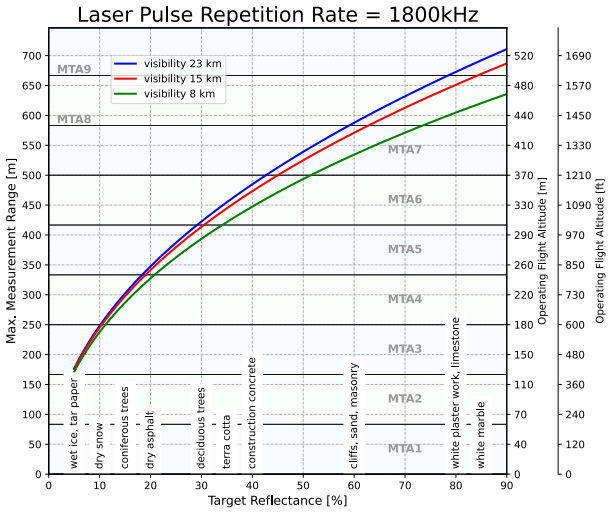

Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle <±5 deg



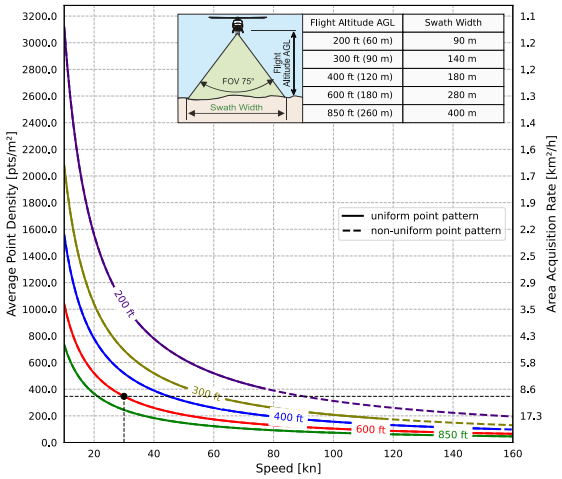

| Flight Altitude AGL | Swath Width |
|---|---|
| 200 ft (60 m) | 90 m |
| 300 ft (90 m) | 140 m |
| 450 ft (140 m) | 210 m |
| 650 ft (200 m) | 310 m |
| 1000 ft (300 m) | 460 m |

Example: VUX-180[24] at 1,200,000 pulses/sec, laser power level 100% altitude 650 ft AGL, speed 30 kn, resulting point density ~ 213.1 pts/m²

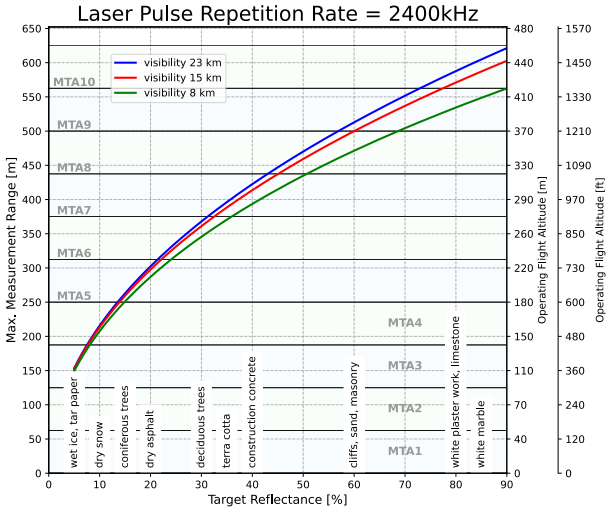
# Maximum Measurement Range & Point Density *RIEGL* VUX®-180$^{24}$



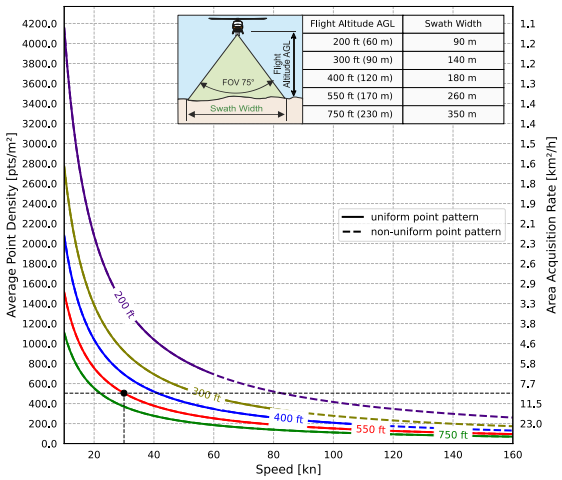

Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle <±5 deg




Example: VUX-180$^{24}$ at 1,800,000 pulses/sec, laser power level 100% altitude 600 ft AGL, speed 30 kn, resulting point density ~ 346.3 pts/m²




Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle <±5 deg




Example: VUX-180$^{24}$ at 2,400,000 pulses/sec, laser power level 100% altitude 550 ft AGL, speed 30 kn, resulting point density ~ 503.7 pts/m²

## General Technical Data

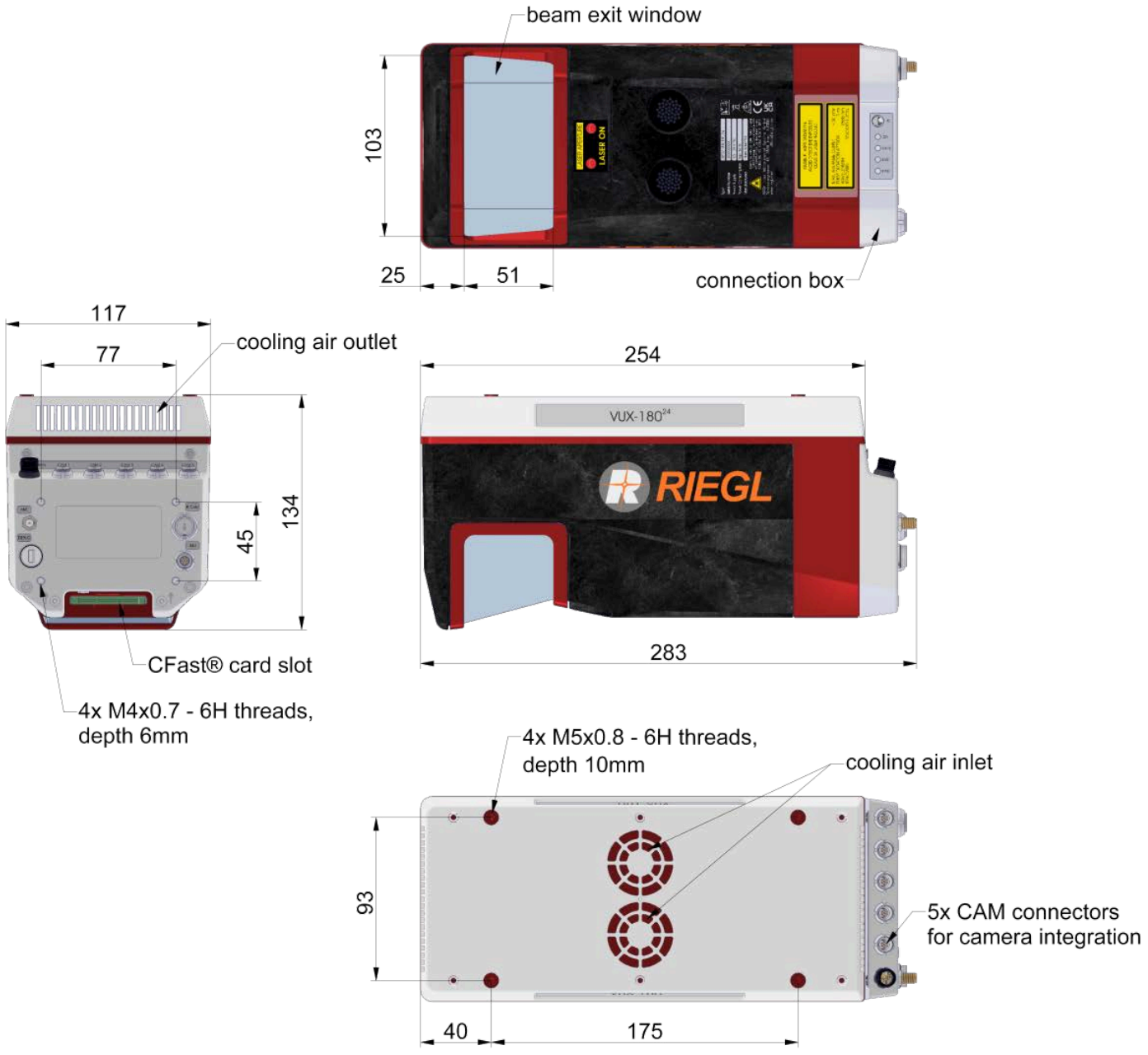
| | |
|---|---|
| Power Supply Input Voltage / Consumption [1] | 18 - 34 V DC / typ. 65 W |
| Main Dimensions (L x W x H) | 283 mm x 117 mm x 134 mm |
| Weight | 2.7 kg (with connection box, without IMU/GNSS system) |
| Humidity | max. 80 % non condensing @ 31°C |
| Protection Class | IP64, dust and splash-proof |
| Max. Flight Altitude (operating & not operating) | 18 500 ft (5 600 m) above MSL (Mean Sea Level) |
| Temperature Range | -10°C up to +40°C (operation) / -20°C up to +50°C (storage) |

## Data Storage

| | |
|---|---|
| Internal Data Storage | Solid State Disc SSD, 2 TByte |
| Memory Card Slot | for CFAST® [2] industrial memory card 1 TByte |

1) Separate input power connector for external cameras.
2) CFast® is a registered trademark of CompactFlash Association.

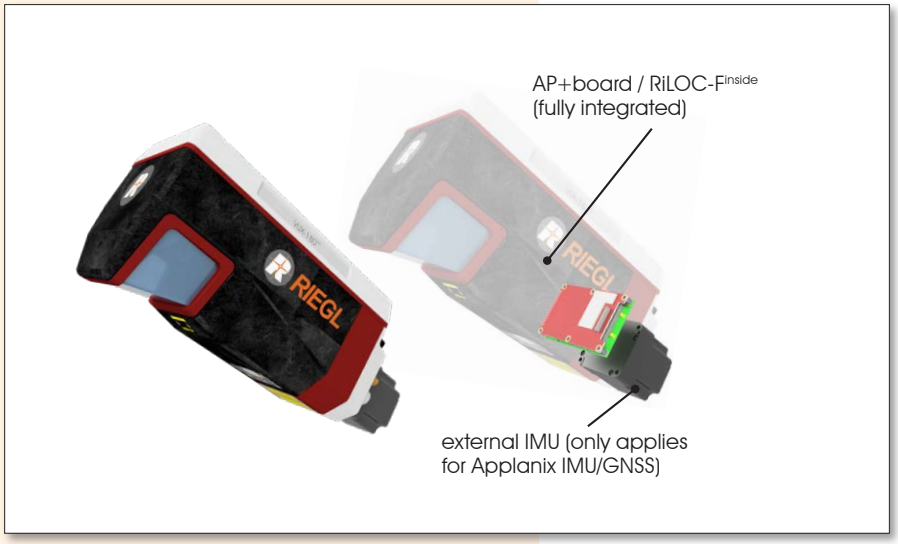





all dimensions in mm

# *RIEGL* VUX®-180[24] System Integration

The *RIEGL* VUX-180[24] can be optionally complemented with an appropriate IMU/GNSS system.




| **IMU & GNSS (optional)** | *RIEGL* RiLOC-F[inside] [1] | Applanix AP+30 [2] | Applanix AP+50 [2] |
|---|---|---|---|
| Orientation Accuracy [3] | | | |
| Roll, Pitch | 0.005° | 0.010° | 0.005° |
| Heading | 0.020° | 0.025° | 0.010° |
| Orientation Sampling Rate | 700 Hz | 200 Hz | 200 Hz |
| Position Accuracy (typ.) | 0.02 - 0.03 m | 0.02 - 0.05 m | 0.02 - 0.05 m |
| System Total Weight (approx.) | 3.0 kg | 3.15 kg[4] | 3.15 kg[4] |

1) See technical details at the RiLOC-F/RiLOC-F[inside] infosheet
2) See technical details at the according Applanix datasheet
3) Accuracy specifications for post-processed data
4) Single scanner with AP+board and with external IMU sensor


RIEGL LASER MEASUREMENT SYSTEMS

***RIEGL Laser Measurement Systems GmbH,*** *Headquarters*
***RIEGL USA Inc.,*** *Headquarters North America*

*RIEGL Japan Ltd.*
*RIEGL China Ltd.*
*RIEGL Australia Pty Ltd.*
*RIEGL Canada Inc.*
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