Lightweight Airborne Laser Scanner with Online Waveform Processing

# RIEGL VUX®-240[24]

- *laser pulse repetition rate up to 2.4 MHz*
- *measurement rate up to 2,000,000 meas./sec*
- *scan speed up to 600 lines/second*
- *operating flight altitude up to 1,430m / 4,700 ft*
- *Field of View up to 75°*
- *perfectly linear and parallel scan lines*
- *cutting edge RIEGL technology providing:*
  - *echo signal digitization*
  - *multiple target capability*
  - *online waveform processing*
  - *multiple-time-around processing*
- *compact & lightweight*
- *easily mountable to unmanned platforms (UAVs) and to helicopters, gyrocopters, and other crewed aircraft*
- *mechanical and electrical interface for IMU/GNSS integration (optional)*
- *interfaces for up to 4 optional cameras*
- *scan data storage on internal 2 TByte SSD Memory*
- *removeable CFAST® memory card*


**The *RIEGL* VUX-240[24] is the new version of the proven *RIEGL* VUX-240, offering higher pulse repetition rates and faster scanning speed for further increased field performance and workflow efficiency. The sophisticated design enables integration with UAS/UAV/RPAS and adequate crewed aero planes or helicopters.**

With its wide field of view of 75 degrees and an extremely fast data acquisition rate of up to 2.4 MHz, the instrument is perfectly suited for high point density applications.

A continuously rotating polygon mirror wheel enables scan speeds of up to 600 lines per second, for efficiently covering large areas when operated from fast UAVs or aircraft.

The VUX-240[24] 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.

The scanner provides an internal data storage capacity of 2 TByte and is equipped with interfaces for an external IMU/GNSS system as well as to control up to four external cameras.

**Typical applications include**

- *Corridor Mapping: Power Line, Railway Track and Pipeline Inspection*
- *Topography in Open-Cast Mining*
- *Surveying of Urban Environments*
- *Archeology and Cultural Heritage Documentation*
- *Agriculture & Forestry*

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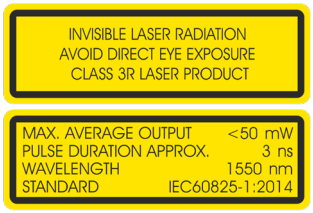
www.riegl.com

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 % | 1200 m | 880 m | 640 m | 530 m | 460 m |
| natural targets ρ ≥ 60 % | 1940 m | 1440 m | 1060 m | 880 m | 770 m |
| natural targets ρ ≥ 80 % | 2180 m | 1630 m | 1200 m | 1000 m | 880 m |
| Max. Operating Flight Altitude AGL [5) 7)] | | | | | |
| @ ρ ≥ 20 % | 890 m (2900 ft) | 650 m (2150 ft) | 470 m (1550 ft) | 390 m (1250 ft) | 340 m (1100 ft) |
| @ ρ ≥ 60 % | 1430 m (4700 ft) | 1060 m (3500 ft) | 780 m (2550 ft) | 650 m (2150 ft) | 570 m (1850 ft) |
| Max. Number of Targets per Pulse [8)] | 30 | 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) Effective FOV 75°, additional roll angle ± 5°.
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)] | 20 mm |
| Precision [10) 11)] | 15 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° FOV) |
| Echo Signal Intensity | for each echo signal, high-resolution 16 bit intensity information is provided |
| Laser Wavelength | near infrared |
| Laser Beam Divergence | 0.35 mrad [13)] |
| Laser Beam Footprint (Gaussian Beam Definition) | 35 mm @ 100 m, 175 mm @ 500 m, 350 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. 0.35 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 |
| Field of View (selectable) | ± 37.5° = 75° |
| Scan Speed (selectable) | 40 - 600 lines/sec |
| Angular Step Width Δ ϑ (selectable) between consecutive laser shots | 0.002° ≤ Δ ϑ ≤ 0.18° [14) 15)] |
| Angle Measurement Resolution | 0.001° |
| Scan Sync (optional) | scanner rotation synchronization |

## Data Interfaces

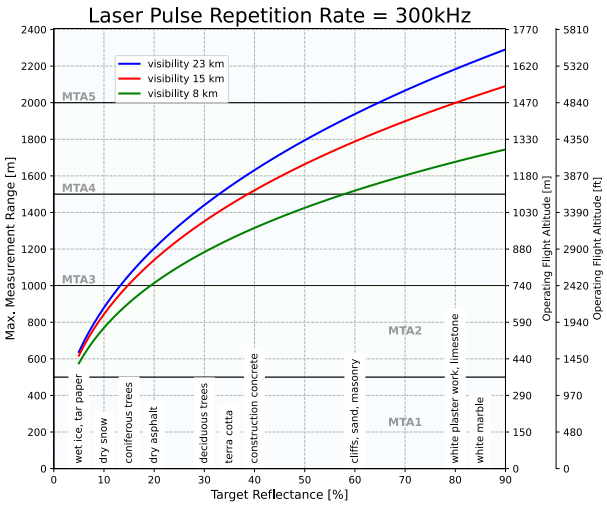
| | |
|---|---|
| Configuration | LAN 10/100/1000 Mbit/sec |
| Scan Data Output | LAN 10/100/1000 Mbit/sec |
| GNSS Interface | Serial RS-232 interface, TTL input for 1pps synchronization pulse, accepts different data formats for GNSS-time information |
| General IO & Control [16)] | 1x TTL input, 1x TTL output, 1x Remote on/off |
| Camera Interfaces at connector panel | 4x power (each max. 2.0 A), trigger, exposure, and GNSS RS-232 Tx & PPS |
| Camera Interfaces via multi purpose connector [16)] | 1x trigger and exposure |
| IMU Interface (optional) [17)] | IMU data, power |

## General Technical Data

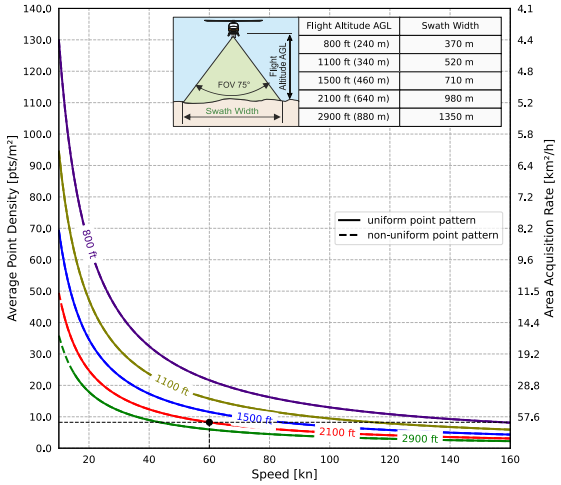
| | |
|---|---|
| Power Supply Input Voltage / Consumption [18)] | 18 - 34 V DC / typ. 77 W |
| Main Dimensions (L x W x H) | 292 mm x 162 mm x 185 mm (without IMU) |
| Weight | approx. 4.3 kg |
| Humidity | max. 80 % non condensing @ 31°C |
| Protection Class | IP64, dust and splash-proof |
| Max. Flight 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) |

14) The angular step width depends on the selected laser PRR.
15) The maximum angular step width is limited by the maximum scan rate.
16) externally available via connection board (including 1x power camera)
17) applies only with IMU/GNSS system
18) Separate input power connector for external cameras, without external IMU/GNSS.

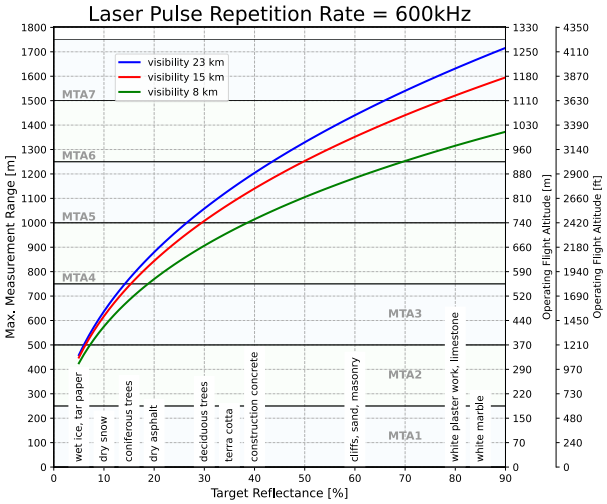
to be continued at page 6



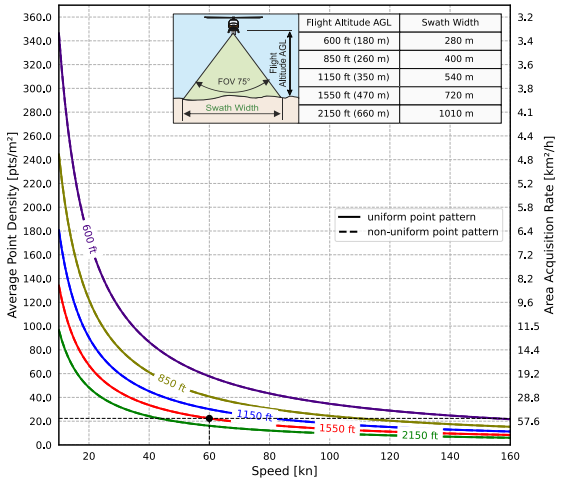

Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing,
average ambient brightness, target size ≥ laser footprint, roll angle ±5



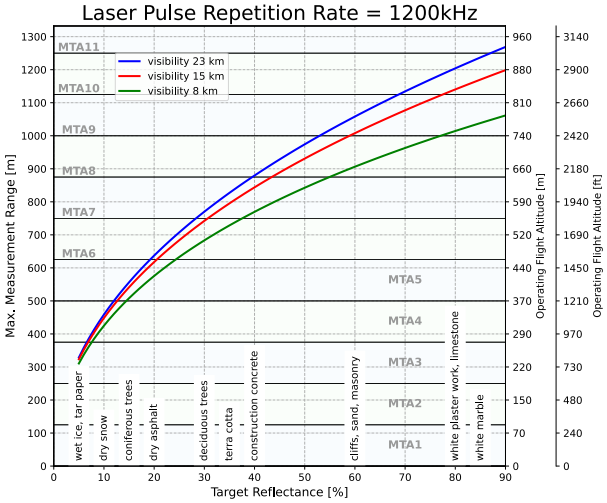

Example: VUX-240[24] at 300,000 pulses/sec, laser power level 100%
Altitude = 2,100 ft AGL, Speed 60 kn, resulting point density ~ 8.3 pts/m²



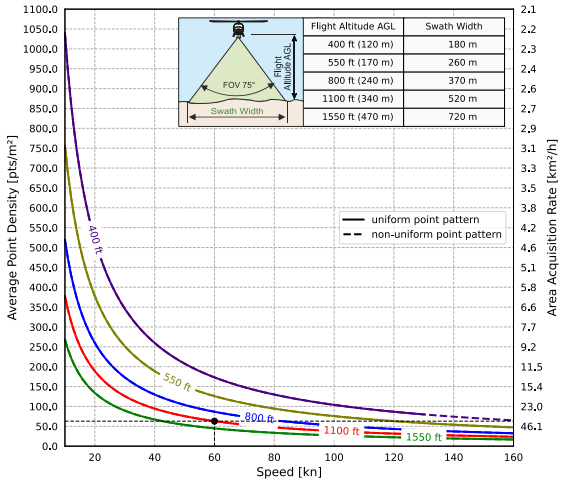

Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing,
average ambient brightness, target size ≥ laser footprint, roll angle ±5




Example: VUX-240[24] at 600,000 pulses/sec, laser power level 100%
Altitude = 1,550 ft AGL, Speed 60 kn, resulting point density ~ 22.3 pts/m²

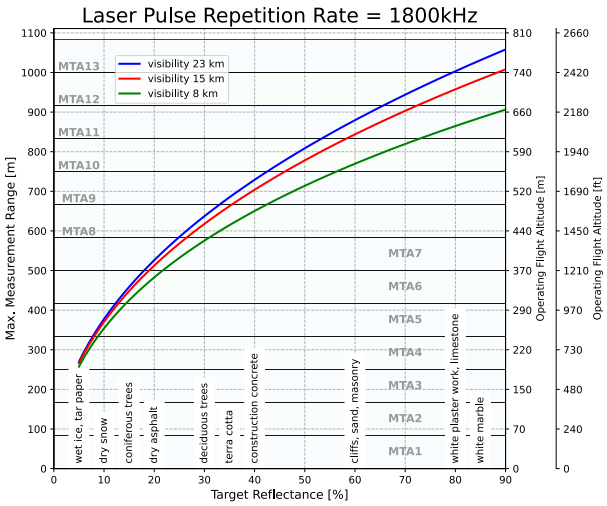



Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing,
average ambient brightness, target size ≥ laser footprint, roll angle ±5

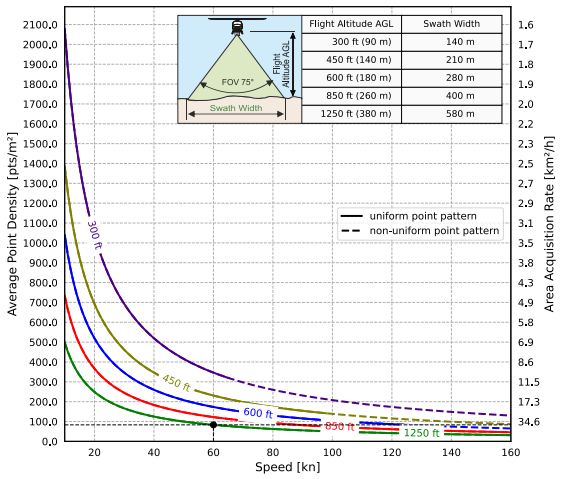



Example: VUX-240[24] at 1,200,000 pulses/sec, laser power level 100%
Altitude = 1,100 ft AGL, Speed 60 kn, resulting point density ~ 63 pts/m²

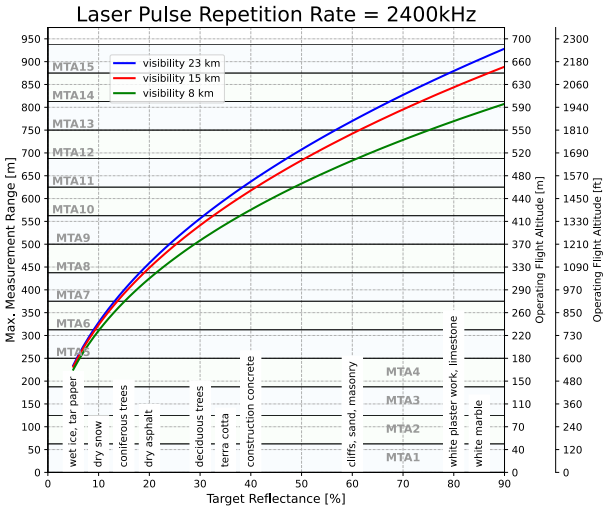
# Maximum Measurement Range & Point Density *RIEGL* VUX®-240[24]



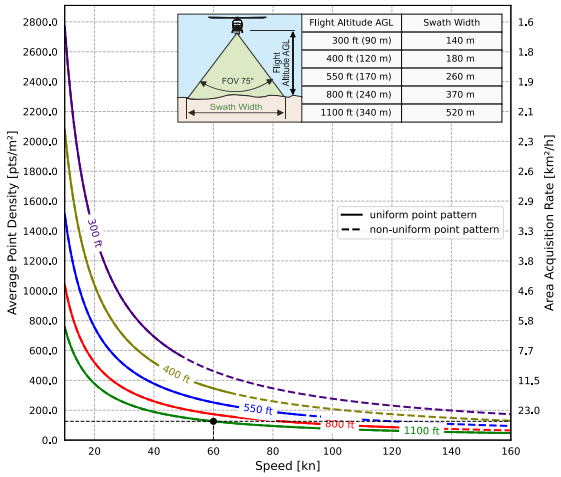

Operating Flight Altitude AGL given for the following conditions:
FOV 75°, ambiguity resolved by multiple-time-around (MTA) processing,
average ambient brightness, target size ≥ laser footprint, roll angle ±5



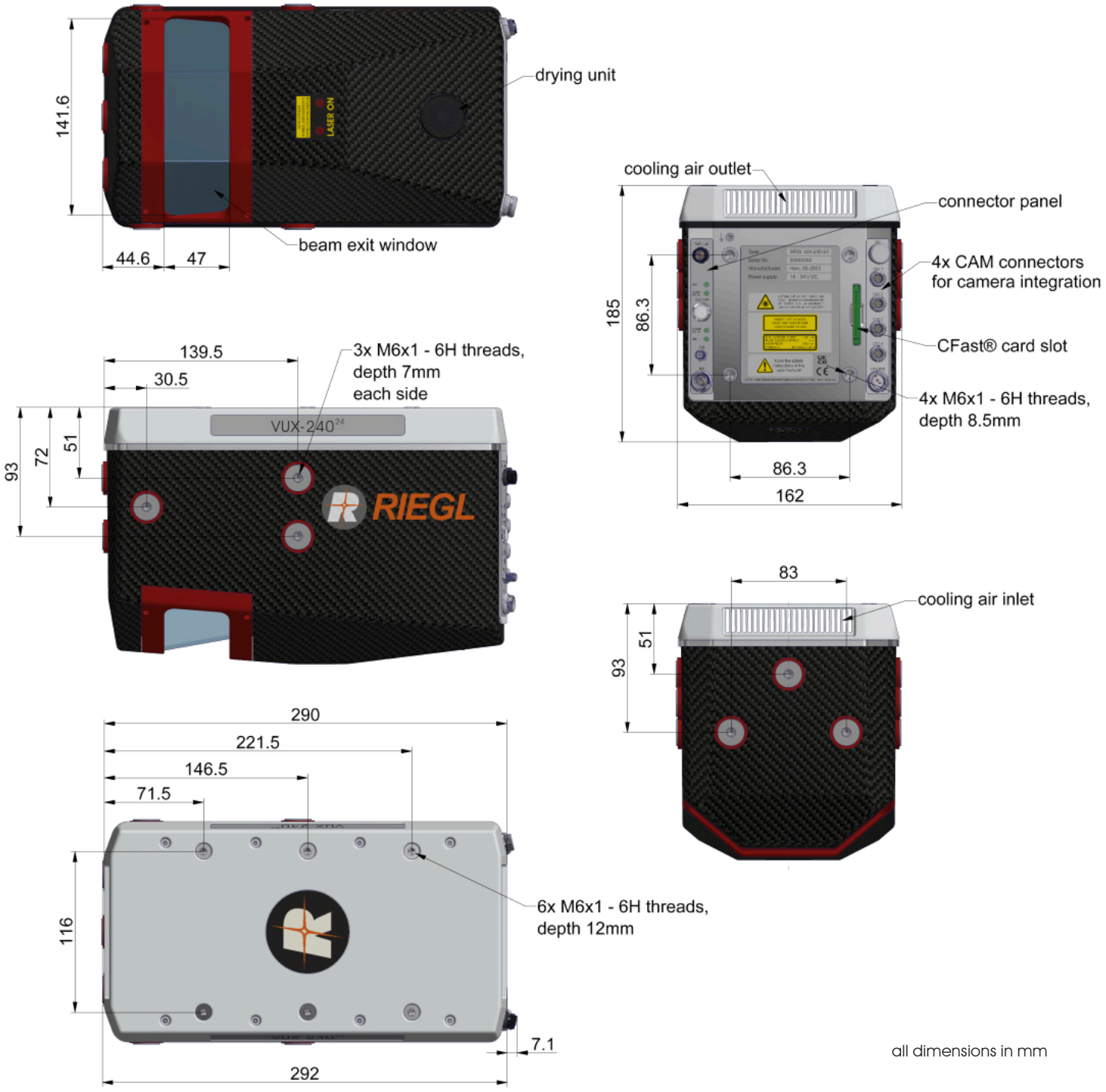

Example: VUX-240[24] at 1,800,000 pulses/sec, laser power level 100%
Altitude = 1,250 ft AGL, Speed 60 kn, resulting point density ~ 83.1 pts/m²




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




Example: VUX-240[24] at 2,400,000 pulses/sec, laser power level 100%
Altitude = 1,100 ft AGL, Speed 60 kn, resulting point density ~ 125.93 pts/m²




all dimensions in mm

## Data Storage

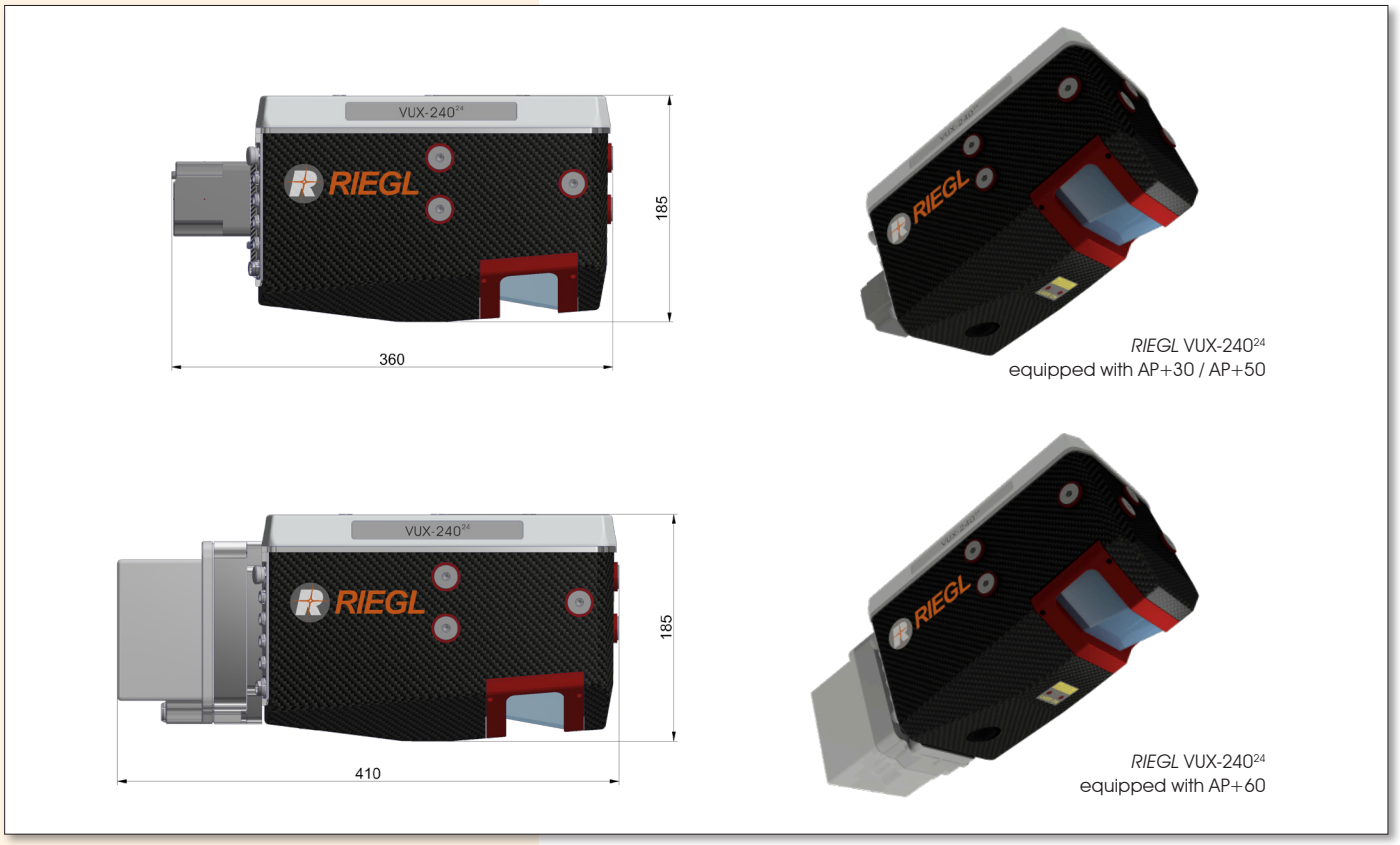
| | |
|---|---|
| Internal Data Storage | Solid State Disc SSD, 2 TByte |
| Memory Card Slot | for CFAST® [1] industrial memory card 480 GByte (can be upgraded to 1 TByte) |

1) CFast is a registered trademark of CompactFlash Association

## External IMU & GNSS (optional)

| | Applanix AP+30 [2] | Applanix AP+50 [2] | Applanix AP+60 [2] |
|---|---|---|---|
| IMU Accuracy [3] | | | |
| Roll, Pitch | 0.010° | 0.005° | 0.0025° [4] |
| Heading | 0.025° | 0.010° | 0.005° |
| IMU Sampling Rate | 200 Hz | 200 Hz | 200 Hz |
| Position Accuracy (typ.) | 0.02 - 0.05 m | 0.02 - 0.05 m | 0.02 - 0.05 m |
| System Total Weight (approx.) [5] | 4.9 kg | 4.9 kg | 6.8 kg |

2) See technical details at the according Applanix datasheet
3) Accuracy specifications for post-processed data
4) May require local gravity model to achieve full accuracy
5) Single scanner with AP+board and with external IMU sensor




*RIEGL* VUX-240[24] equipped with AP+30 / AP+50

*RIEGL* VUX-240[24] equipped with AP+60

RIEGL® LASER MEASUREMENT SYSTEMS

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