„NFB" (Nadir/Forward/Backward) Scanning UAV LiDAR Sensor

RIEGL VUX®-120²³

- *laser pulse repetition rate up to 2.4 MHz*
- *measurement rate up to 2,000,000 meas./sec*
- *scan speed up to 400 lines/second*
- *operating flight altitude up to 720 m / 2,350 ft*
- *Field of View up to 100°*
- *compact & lightweight (2.3 kg / 4.4 lbs)*
- *Nadir/Forward/Backward Scanning for unrivaled completeness of scan data even on vertical structures and narrow canyons*
- *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:***
  RIEGL RiLOC IMU/GNSS system solutions available
- *interfaces for up to 2 external cameras*
- *scan data storage on internal SSD Memory*
- *removeable CFAST® memory card*

The *RIEGL* VUX-120²³ is a lightweight and versatile airborne laser scanner offering a wide field of view of 100 degrees and an extremely high pulse repetition rate of up to 2.4 MHz. Thus, it is perfectly suited for high point density corridor mapping applications.
The measuring beam of the *RIEGL* VUX-120²³ is consecutively emitted in three different directions: it alternates from strictly nadir, to +10 degrees forward, and to -10 degrees backward. This allows data acquisition with an unrivaled completeness in data capture, especially in challenging environments with vertical surfaces and narrow canyons.

The scanner provides an internal data storage capacity of 2 TByte and a removeable CFast card. Interfaces for up to two optional external cameras and for integration of an external IMU/GNSS system are available. Additionally, the *RIEGL* VUX-120²³ can be equipped with one of *RIEGL*`s RiLOC IMU/GNSS system solutions.

The sophisticated design of the *RIEGL* VUX-120²³ allows smooth integration on UAS/UAV/RPAS, small manned aeroplanes (like gyrocopters), but also on 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 to perfectly meet specific customer requirements.

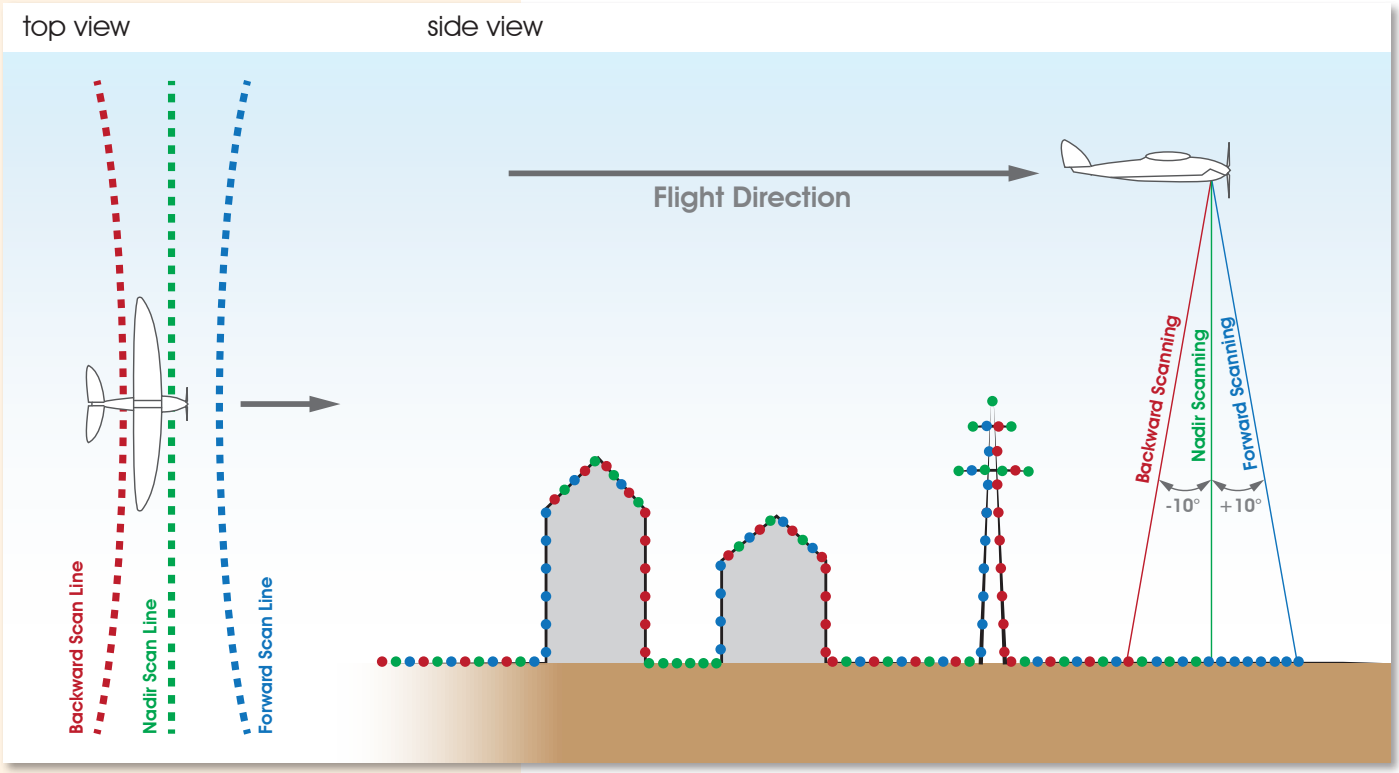
Typical applications include

- ***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***

visit our website
www.riegl.com

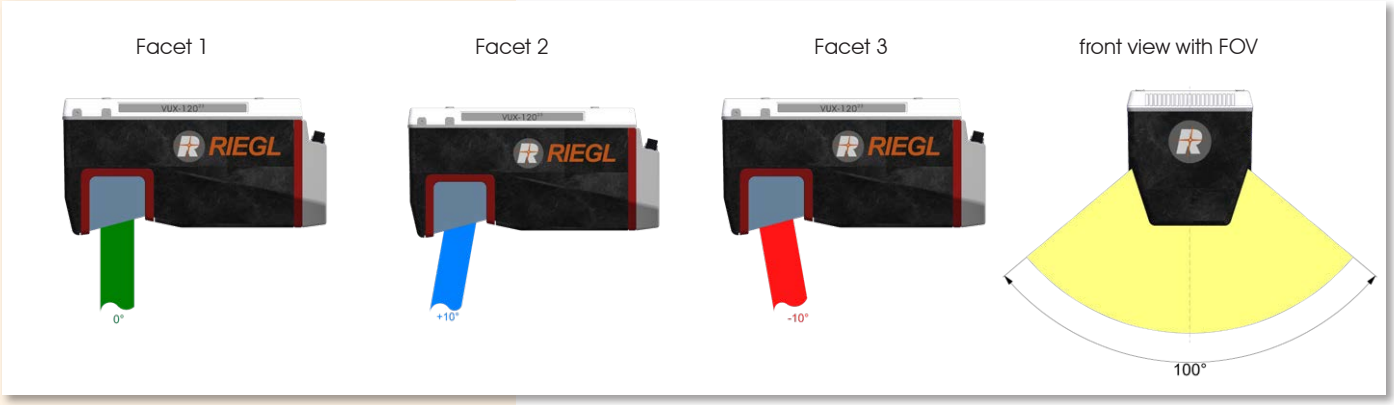
RIEGL®
LASER MEASUREMENT SYSTEMS

RIEGL VUX-120[23] Scan Pattern „NFB“ (Nadir/Forward/Backward)

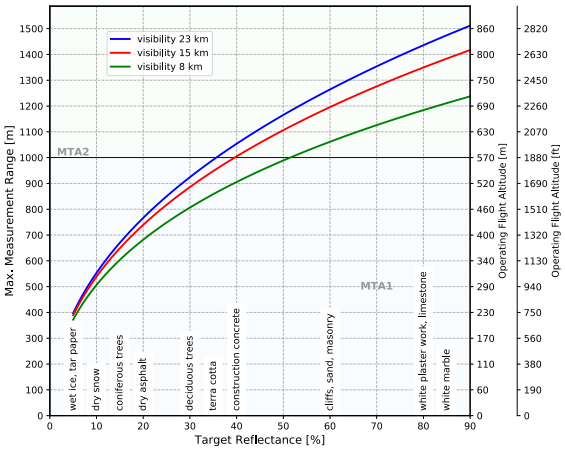


Field of View	± **50° (100°)**
Forward/Backward Scan Angle in Swath Center	± **10°**
Forward/Backward Scan Angle at Swath Edges	± **15°**

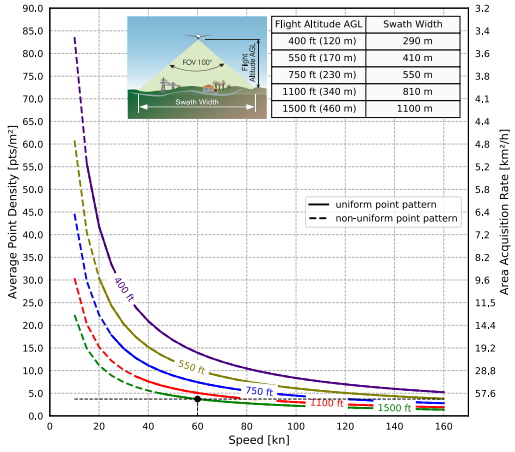
The *RIEGL* VUX-120[23] offers a sophisticated scan pattern consisting of scan lines with periodically changing directions. The scan directions in the center of the scan lines change consecutively from strictly nadir, to +10 degrees forward and to -10 degrees backward. This scan pattern provides an almost complete 3D data set, as also vertical surfaces like the facades of buildings and objects (e.g. masts and poles) are accurately sampled by laser range measurements. In addition, the nadir direction enables the reliable data acquisition down to the bottom of narrow canyons.



PRR = 150 kHz

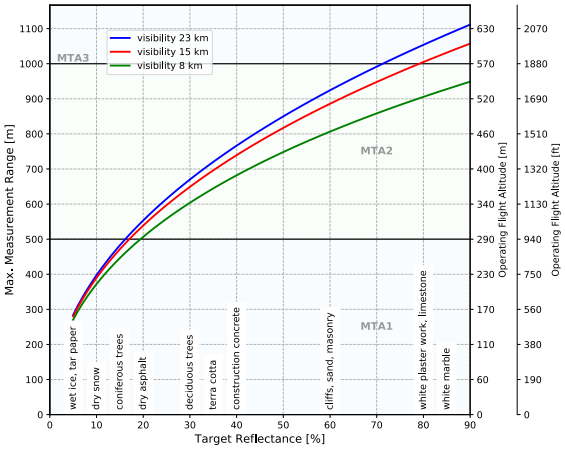


Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5

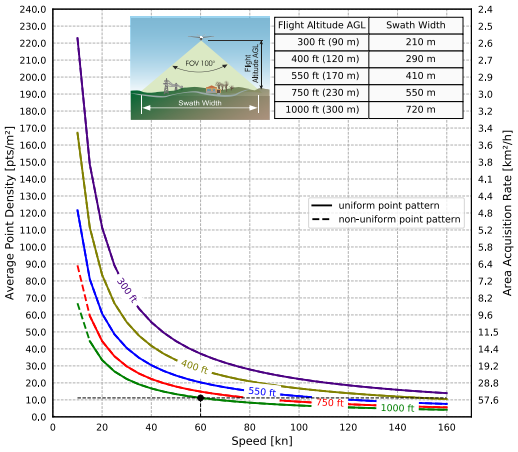


Example: VUX-120[23] at 150,000 pulses/sec, laser power level 100%
Altitude = 1,500 ft AGL, Speed 60 kn, resulting point density ~ 4 pts/m²

PRR = 300 kHz

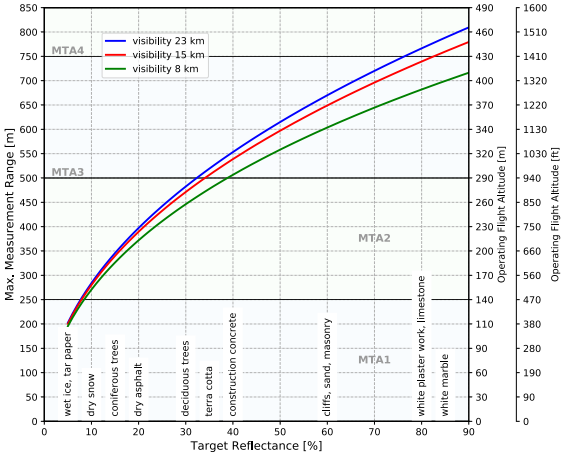


Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5

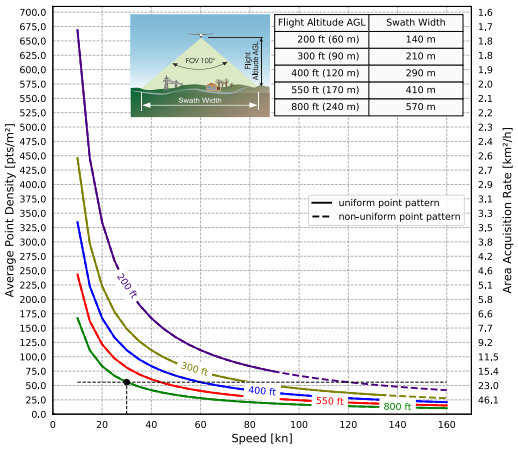


Example: VUX-120[23] at 300,000 pulses/sec, laser power level 100%
Altitude = 1,000 ft AGL, Speed 60 kn, resulting point density ~ 11 pts/m²

PRR = 600 kHz

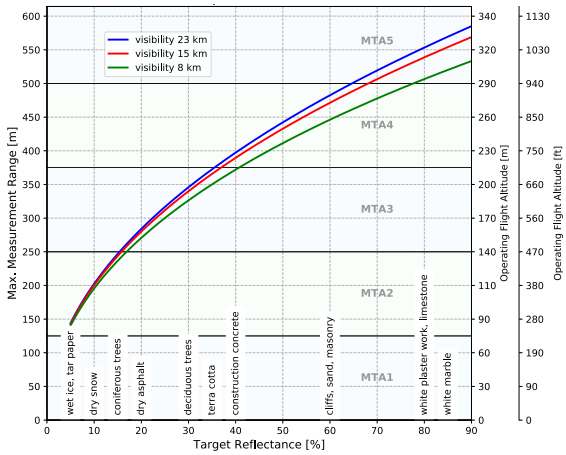


Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5

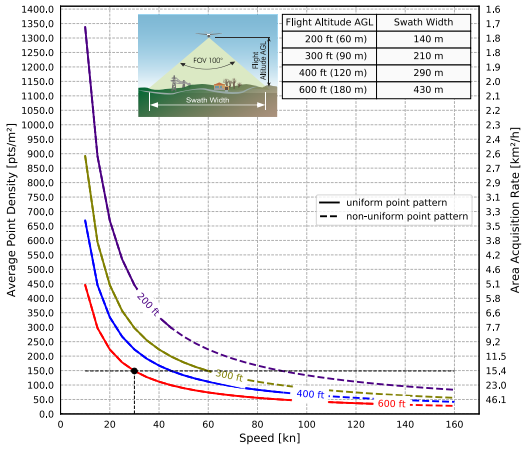


Example: VUX-120[23] at 600,000 pulses/sec, laser power level 100%
Altitude = 800 ft AGL, Speed 30 kn, resulting point density ~ 55 pts/m²

PRR = 1200 kHz

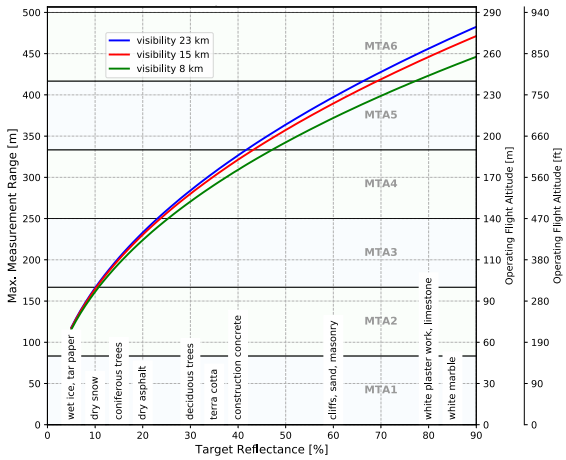


Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5

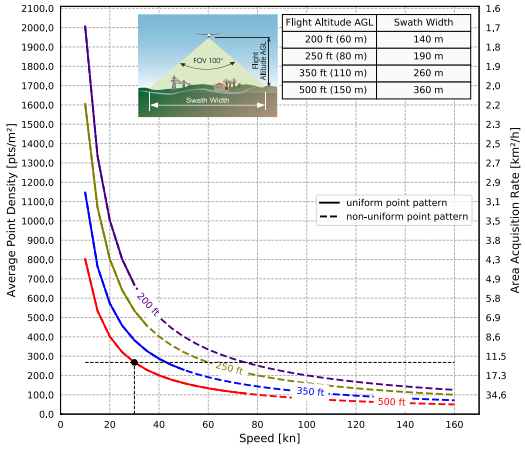


Example: VUX-120[23] at 1,200,000 pulses/sec, laser power level 100%
Altitude = 600 ft AGL, Speed 30 kn, resulting point density ~ 150 pts/m²

PRR = 1800 kHz

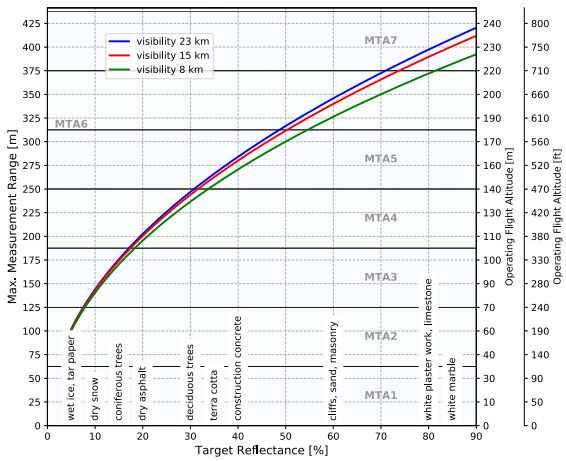


Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5

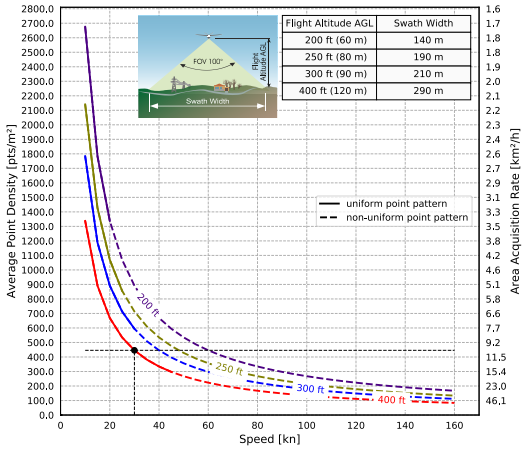


Example: VUX-120[23] at 1,800,000 pulses/sec, laser power level 100%
Altitude = 500 ft AGL, Speed 30 kn, resulting point density ~ 270 pts/m²

PRR = 2400 kHz

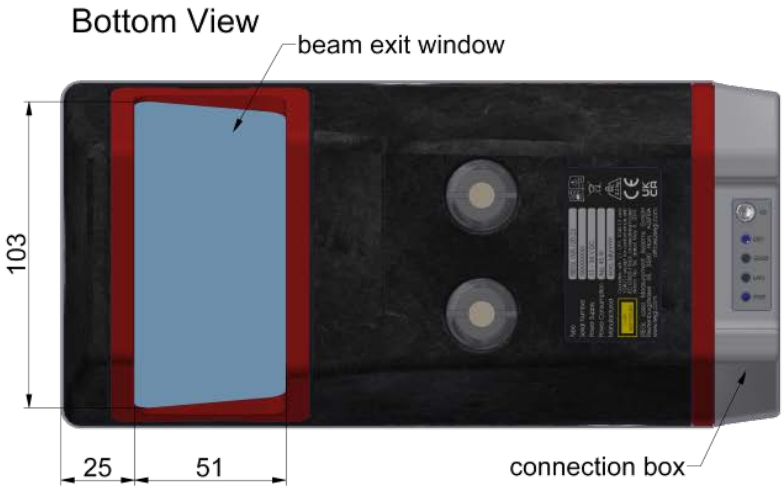


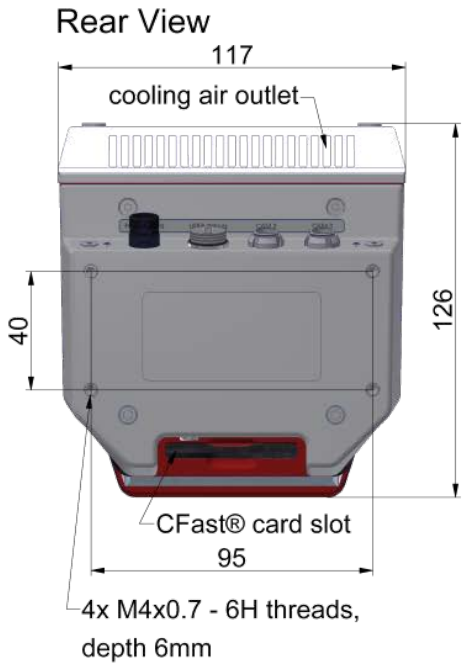
Operating Flight Altitude AGL given for the following conditions:
FOV 100°, ambiguity resolved by multiple-time-around (MTA) processing, average ambient brightness, target size ≥ laser footprint, roll angle ±5

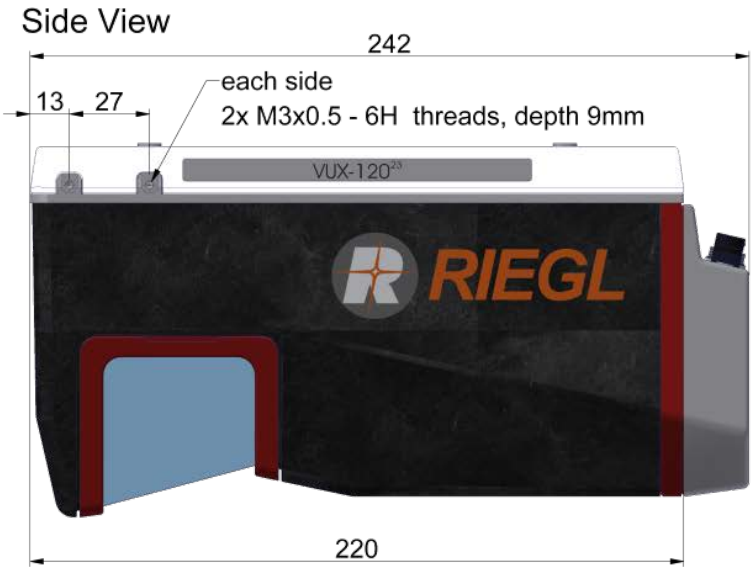


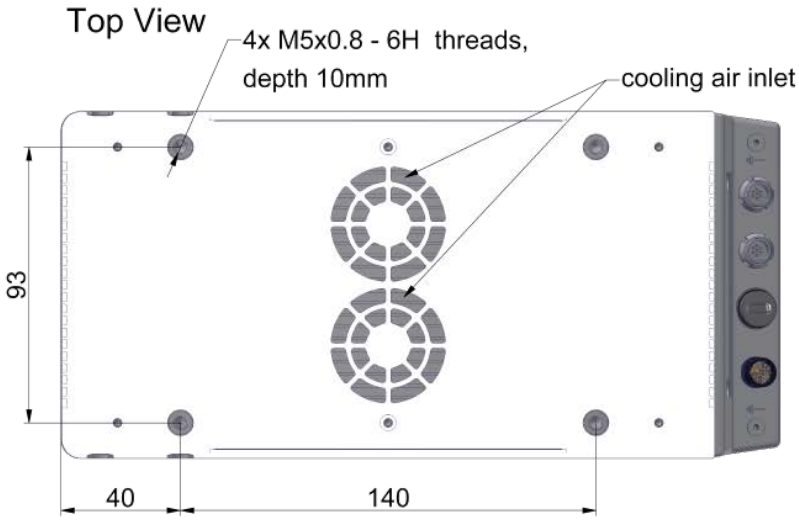
Example: VUX-120[23] at 2,400,000 pulses/sec, laser power level 100%
Altitude = 400 ft AGL, Speed 30 kn, resulting point density ~ 450 pts/m²

RIEGL VUX-120[23] UAV LiDAR Sensor with Connection Box



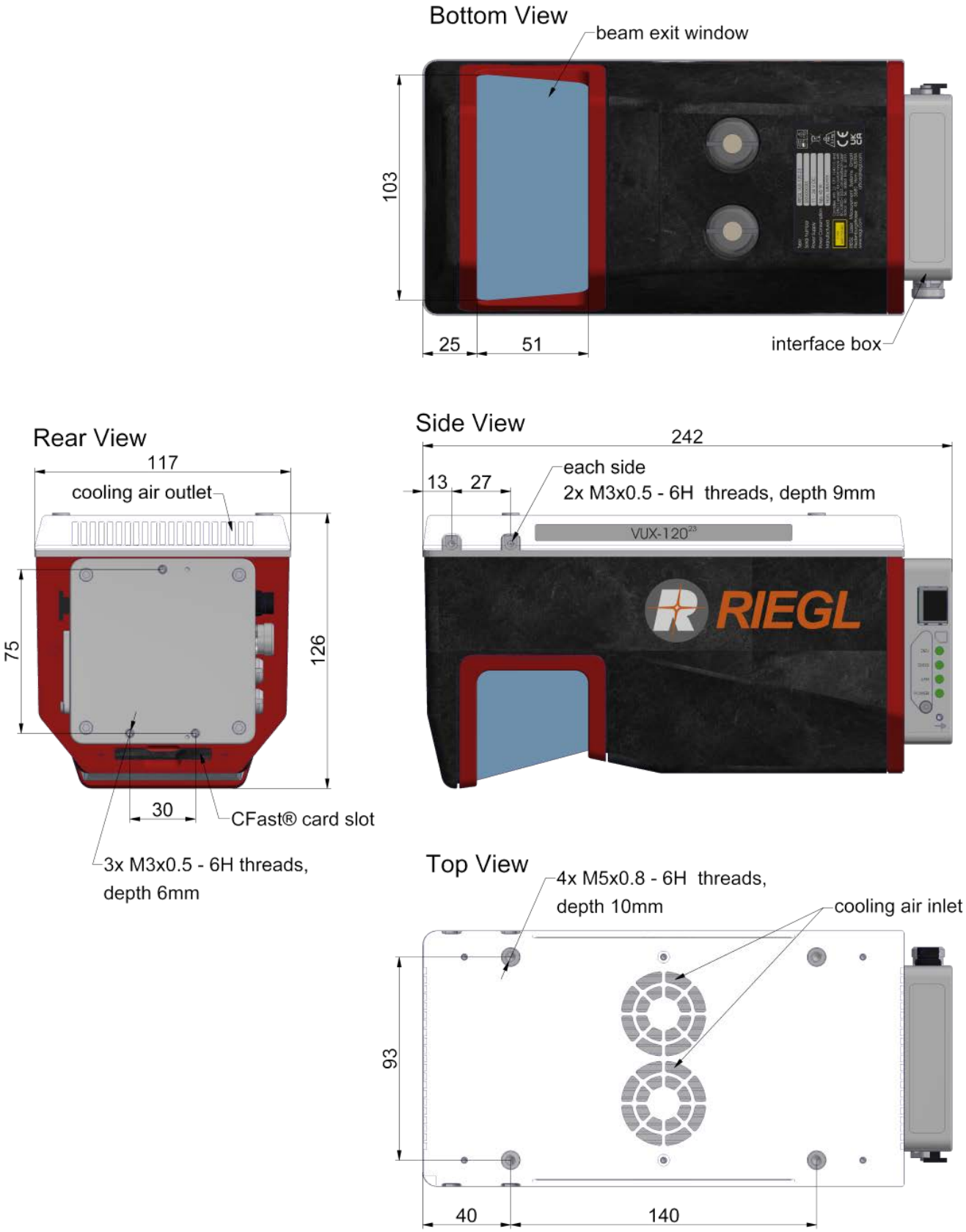






all dimensions in mm

RIEGL VUX-120[23] UAV LiDAR Sensor with Interface Box



all dimensions in mm

Laser Product Classification

Class 1 Laser Product according to IEC60825-1:2014
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.

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 [1]	*150 kHz*	*300 kHz*	*600 kHz*	*1200 kHz*	*1800 kHz*	*2400 kHz*
Max. Measuring Range [2] [3]						
natural targets ρ ≥ 20 %	760 m	550 m	400 m	280 m	230 m	200 m
natural targets ρ ≥ 60 %	1260 m	920 m	670 m	480 m	400 m	350 m
natural targets ρ ≥ 80 %	1430 m	1050 m	760 m	550 m	450 m	400 m
Max. Operating Flight Altitude AGL [2] [4]						
@ ρ ≥ 20 %	440 m (1450 ft)	320 m (1050 ft)	230 m (750 ft)	160 m (550 ft)	130 m (450 ft)	110 m (360 ft)
@ ρ ≥ 60 %	720 m (2350 ft)	530 m (1750 ft)	380 m (1250 ft)	280 m (900 ft)	230 m (750 ft)	200 m (650 ft)
Max. Number of Targets per Pulse [5]	32	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) Considering max. effective FOV 100°, additional roll angle ± 5°.
5) 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 [6] [8]	10 mm
Precision [7] [8]	5 mm
Laser Pulse Repetition Rate [1] [9]	up to 2400 kHz
Max. Effective Measurement Rate [1]	up to 2,000,000 meas./sec. (@ 2400 kHz PRR & 100° 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 [10]
Laser Beam Footprint (Gaussian Beam Definition)	40 mm @ 100 m, 200 mm @ 500 m, 400 mm @ 1000 m

6) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.
7) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.
8) One sigma @ 150 m range under *RIEGL* test conditions.
9) User selectable.
10) 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, angular directions -10°, 0°, +10° transvers to the scan direction for forward and backward view
Field of View (selectable)	± 50° = 100°
Scan Speed (selectable)	50 - 400 lines/sec
Angular Step Width Δ ϑ (selectable) between consecutive laser shots	0.0025° ≤ Δ ϑ ≤ 0.32° [11] [12]
Angle Measurement Resolution	0.001°
Scan Sync (optional)	scanner rotation synchronization

Data Interfaces

Configuration, Scan Data Output & Communication with External Devices	2x LAN 10/100/1000 MBit/sec [13] [14]
GNSS Interface	Serial RS-232 interface, TTL input for 1pps synchronisation pulse, accepts different data formats for GNSS-time information
General IO & Control [13]	1 x TTL input, 1x TTL output, 1 x Remote on/off
Camera Interfaces at connector panel	2x power (max. 1.2 A), trigger, exposure, and GNSS RS-232 Tx & PPS
Camera Interfaces via multi purpose connector [15]	1x trigger and exposure
IMU Interface (optional)	IMU data, power

General Technical Data

Power Supply Input Voltage / Consumption	11 - 34 V DC / typ. 45 W
Main Dimensions (L x W x H)	242 mm x 117 mm x 126 mm (with interface box)
Weight (without IMU/GNSS system)	approx. 2.3 kg (with interface box), approx. 2.2 kg (without interface box)
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)

11) The angular step width depends on the selected laser PRR.
12) The maximum angular step width is limited by the maximum scan rate.
13) 1x externally available via multi-purpose connector
14) 1x available directly on optional interface box
15) externally available via connection board (including 1x power camera)

Technical Data *RIEGL* VUX®-120[23] (continued)

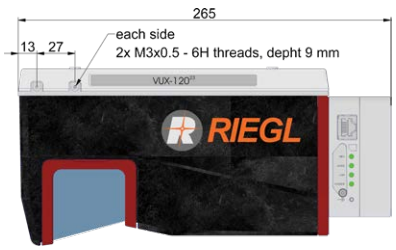
Data Storage

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

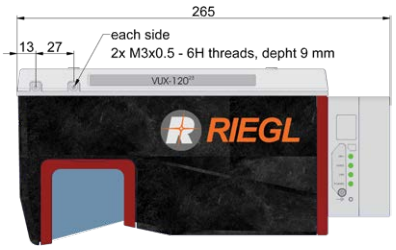
IMU & GNSS (optional)

	RIEGL RiLOC-E[25] [2]	*RIEGL* RiLOC-F [3] / *RIEGL* RiLOC-F[inside] [3]	Applanix APX-20 UAV [4]	Applanix AP+50 [4] [5]
Orientation Accuracy [6]				
Roll, Pitch	0.010°	0.005°	0.015°	0.005°
Heading	0.025°	0.020°	0.035°	0.010°
IMU Sampling Rate	up to 700 Hz	up to 700 Hz	200 Hz	200 Hz
Position Accuracy (typ.)	0.02 - 0.04 m	0.02 - 0.03 m	0.02 - 0.05 m	0.02 - 0.05 m
System Total Weight (approx.)	2.6 kg	2.6 kg / 2.5 kg	3.0 kg	3.6 kg [7]

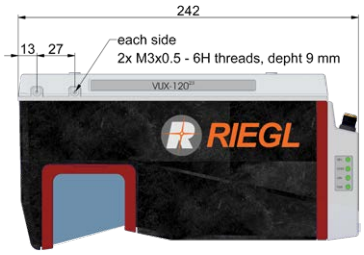
1) CFast is a registered trademark of CompactFlash Association.
2) See technical details at the RILOC-E[25] infosheet
3) See technical details at the RILOC-F/RILOC-F[inside] infosheet
4) See technical details at the according Applanix datasheet
5) Use of the RiSYS-CU-23 Control Unit is mandatory
6) Accuracy specifications for post-processed data
7) Total weight includes RiSYS-CU-23 Control Unit (0.9 kg)



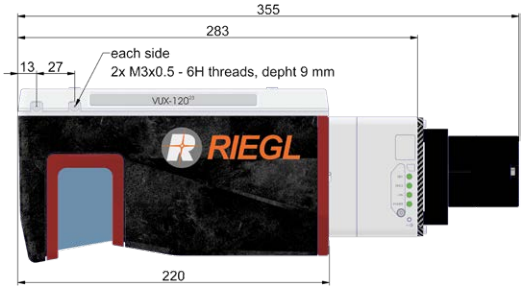
RIEGL VUX-120[23] equipped with RIEGL RiLOC-E[25]



RIEGL VUX-120[23] equipped with RIEGL RiLOC-F



RIEGL VUX-120[23] equipped with RIEGL RiLOC-F[inside]



RIEGL VUX-120[23] equipped with APX-20 UAV

RIEGL VUX-120[23] equipped with AP+50

all dimensions in mm

RIEGL VUX®-120[23] Camera Option

open platform set-up:
RIEGL VUX-120[23] LiDAR sensor with IMU/GNSS unit (RIEGL RiLOC-E[25]), and nadir RGB camera fully integrated

RIEGL® LASER MEASUREMENT SYSTEMS

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

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RIEGL China Ltd.
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