

RIEGL VUX[®]-1UAV²²

- 10 mm survey-grade accuracy
- scan speed up to 200 scans / second
- PRR values freely selectable
- measurement rate up to 1,200,000 meas./sec (@ 1200 kHz PRR & 360° FOV)
- operating flight altitude more than 2,640 ft
- field of view up to 360° for practically unrestricted data acquisition
- regular point pattern, perfectly parallel scan lines
- cutting edge RIEGL technology providing:
 - echo signal digitization
 - online waveform processing
 - multiple-time-around processing
- multiple target capability - up to 15 target echoes
- compact (227x180x125 mm), lightweight (3.5 kg), and rugged
- easily mountable to professional UAS / UAV / RPAS
- mechanical and electrical interface for IMU mounting
- electrical interfaces for GPS data string and Sync Pulse (1PPS)
- LAN-TCP/IP interface
- internal data storage on Solid State Disc SSD, 1 TByte

The *RIEGL VUX-1UAV²²* is a very lightweight and compact laser scanner, meeting the challenges of emerging survey solutions by UAS/UAV/RPAS both in measurement performance as well as in system integration.

With regard to the specific constraints and flight characteristics of the UAS, the *RIEGL VUX-1UAV²²* is designed to be mounted in any orientation and even under limited weight and space conditions. Modest in power consumption, the instrument requires only a single power supply. The entire data set of an acquisition campaign is stored onto an internal 1 TByte SSD and/or provided as real-time line scan data via the integrated LAN-TCP/IP interface.

The *RIEGL VUX-1UAV²²* provides highspeed data acquisition using a narrow infrared laser beam and a fast line scanning mechanism. High-accuracy laser ranging is based on *RIEGL's* unique echo digitization and online waveform processing, which enables achieving superior measurement results even under adverse atmospheric conditions, and the evaluation of multiple target echoes. The scanning mechanism is based on an extremely fast rotating mirror, which provides fully linear, unidirectional and parallel scan lines, resulting in excellent regular point pattern.

Typical applications include

- Agriculture & Forestry
- Archaeology and Cultural Heritage Documentation
- Corridor Mapping: Power Line, Railway Track, and Pipeline Inspection
- Topography in Open-Cast Mining
- Construction-Site Monitoring
- Surveying of Urban Environments
- Resources Management



visit our website
www.riegl.com



Laser Product Classification

Class 1 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.

CLASS 1
LASER PRODUCT

Range Measurement Performance

Measuring Principle

time of flight measurement, echo signal digitization,
online waveform processing, multiple-time-around-processing

Laser Pulse Repetition Rate PRR ^{1) 2)}	50 kHz	100 kHz	200 kHz	400 kHz	600 kHz	800 kHz	1200 kHz
Max. Measuring Range ^{3) 4)}							
natural targets $\rho \geq 20\%$	755 m	545 m	390 m	280 m	230 m	200 m	160 m
natural targets $\rho \geq 60\%$	1250 m	910 m	660 m	480 m	390 m	340 m	280 m
natural targets $\rho \geq 80\%$	1415 m	1040 m	755 m	550 m	450 m	390 m	320 m
Max. Operating Flight Altitude AGL ^{1) 5)}							
@ $\rho \geq 20\%$	490 m (1590 ft)	350 m (1150 ft)	250 m (820 ft)	180 m (590 ft)	150 m (490 ft)	130 m (420 ft)	100 m (340 ft)
@ $\rho \geq 60\%$	800 m (2640 ft)	580 m (1920 ft)	420 m (1390 ft)	310 m (1010 ft)	250 m (820 ft)	220 m (720 ft)	180 m (590 ft)
Max. Number of Targets per Pulse up to ⁶⁾	15	15	15	15	15	11	7

1) Rounded values.

2) Setting of intermediate PRR values possible.

3) Typical values for average conditions. 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. In bright sunlight, the max. range is shorter than under overcast sky.

4) Ambiguity to be resolved by post-processing with RIUNITE software.

5) Flat terrain assumed, scan angle $\pm 45^\circ$ FOV.

6) If more than one target is hit, the total laser transmitter power is split and, accordingly, the achievable range is reduced.

Minimum Range

Accuracy ^{7) 9)}

Precision ^{8) 9)}

Laser Pulse Repetition Rate ^{1) 10)}

Max. Effective Measurement Rate ¹⁾

Echo Signal Intensity

Laser Wavelength

Laser Beam Divergence

Laser Beam Footprint (Gaussian Beam Definition)

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.

3m @ PRR ≤ 500 kHz, 2m @ $500 \text{ kHz} < \text{PRR} < 1 \text{ MHz}$, 1.5m @ PRR $\geq 1 \text{ MHz}$

10 mm

5 mm

up to 1200 kHz

up to 1200 000 meas./sec. (@ 1200 kHz PRR & 360° FOV)

for each echo signal, high-resolution 16 bit intensity information is provided

near infrared

typ. 0.35 mrad @ $1/e^{11}$, typ. 0.5 mrad @ $1/e^2$ ¹²⁾

50 mm @ 100 m, 250 mm @ 500 m, 500 mm @ 1000 m

10) User selectable, setting of intermediate PRR values possible.

11) Measured at the $1/e$ points. 0.35 mrad corresponds to an increase of 35 mm of beam diameter per 100 m distance.

12) Measured at the $1/e^2$ points. 0.50 mrad corresponds to an increase of 50 mm of beam diameter per 100 m distance.

Scanner Performance

Scanning Mechanism

Field of View (selectable)

Scan Speed (selectable)

Angular Step Width $\Delta \theta$ (selectable)

between consecutive laser shots

Angle Measurement Resolution

Internal Sync Timer

Scan Sync (optional)

rotating mirror

up to 360° (full range measurement performance) ¹³⁾

10 - 200 revolutions per second, equivalent to 10 - 200 scans/sec

$0.003^\circ \leq \Delta \theta \leq 1.5^\circ$

0.001°

for real-time synchronized time stamping of scan data

scanner rotation synchronization

Data Interfaces

Configuration / Scan Data Output

GNSS Interface

Internal Data Storage

Memory Card Slot ¹⁴⁾

External Camera

External GNSS Antenna

LAN 10/100/1000 Mbit/sec / LAN 10/100/1000 Mbit/sec or USB 2.0

Serial RS-232 interface for data string with GNSS-time information,

TTL input for 1PPS synchronization pulse

1 TByte SSD

for CFAST[®] ¹⁵⁾ memory card 120 GByte (can be upgraded to 256 GByte)

TTL input/output

SMA connector

General Technical Data

Power Supply Input Voltage / Consumption ¹⁶⁾

Main Dimensions ¹⁷⁾

VUX-1UAV without / with Cooling Fan

Weight ¹⁷⁾

VUX-1UAV without / with Cooling Fan

Humidity

Protection Class

Max. Flight Altitude (operating / not operating)

Temperature Range ¹⁸⁾

11 - 34 V DC / typ. 60 W

227 x 180 x 125 mm / 227 x 209 x 129 mm

approx. 3.5 kg / approx. 3.75 kg

max. 80 % non condensing @ 31°C

IP64, dust and splash-proof

16 500 ft (5 000 m) above MSL / 18 000 ft (5 500 m) above MSL

-20°C ¹⁹⁾ up to $+40^\circ\text{C}$ (operation) / -20°C up to $+50^\circ\text{C}$ (storage)

Optional Components (integrated)

Embedded GNSS-Inertial System

high performance multi-channel GNSS receiver,

low-grade, solid-state MEMS IMU

13) slightly degraded ranging performance around $0^\circ/360^\circ$

14) applies to IMU APX-20 UAV only

15) CFAST is a registered trademark of CompactFlash Association

16) without external IMU/GNSS, cooling fan not in operation

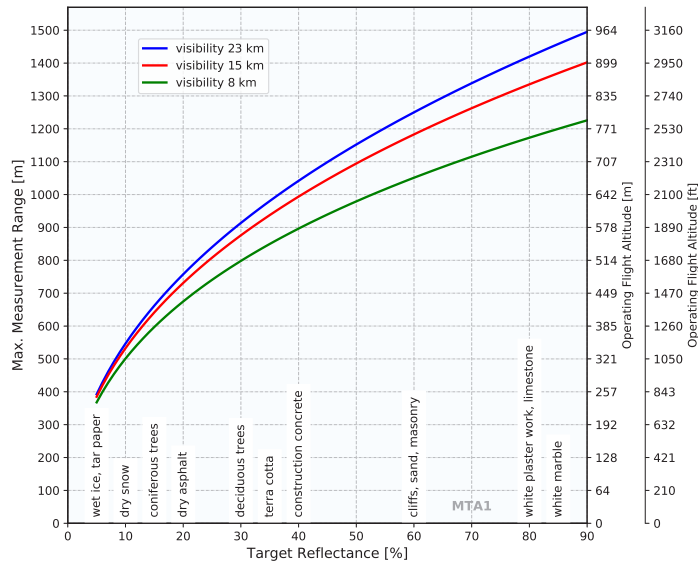
17) without external IMU/GNSS

18) The instrument requires air convection with a minimum flow rate of 5 m/s for continuous operation at $+15^\circ\text{C}$ and above. If the necessary flow rate cannot be provided by the moving platform, the cooling fan (included in the scope of delivery) has to be used.

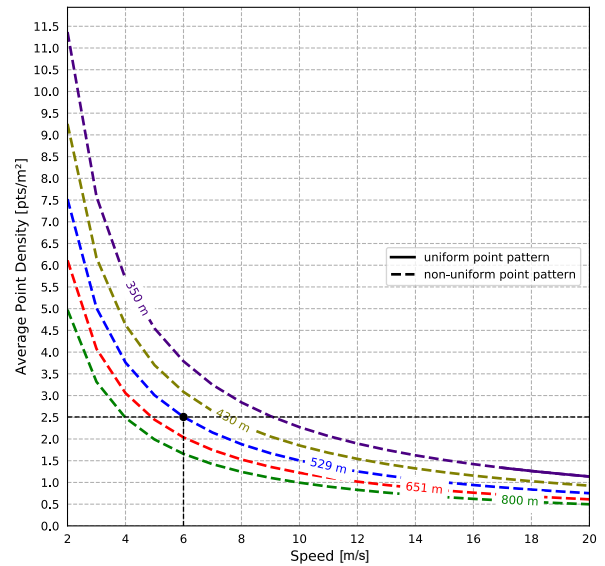
19) Continuous scanning operation if instrument is powered on while internal temperature is at or above 0°C and still air. Insulating the scanner with appropriate material will enable operation at even lower temperatures.

Maximum Measurement Range & Point Density *RIEGL VUX®-1 UAV²²*

PRR = 50 kHz

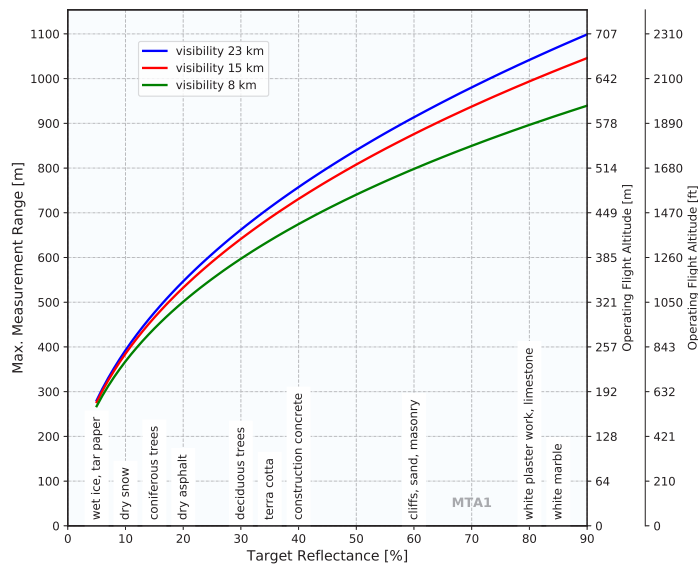


Operating flight altitude AGL given for the following conditions:
FOV +/- 45°, target size ≥ laser footprint

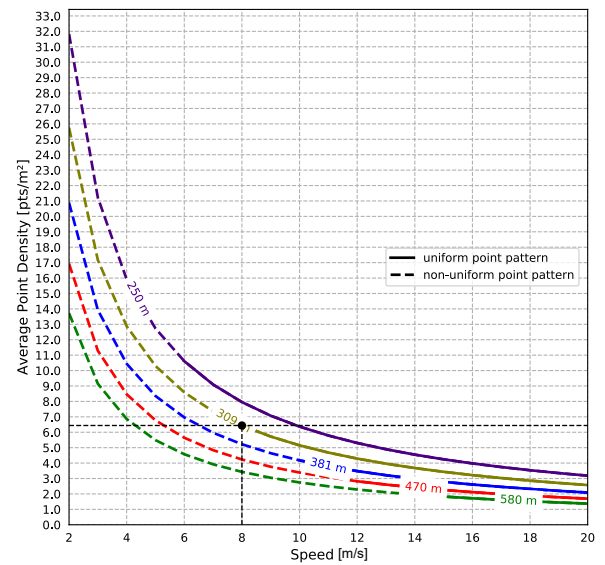


Example: VUX-1UAV²² at 50,000 pulses/second, speed = 6 m/s,
range to target = 529 m, resulting point density ~ 2.5 pts/m²

PRR = 100 kHz

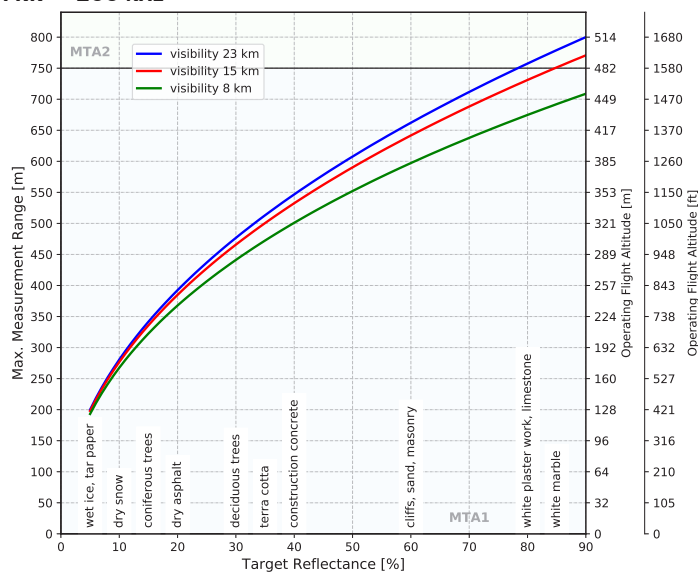


Operating flight altitude AGL given for the following conditions:
FOV +/- 45°, target size ≥ laser footprint

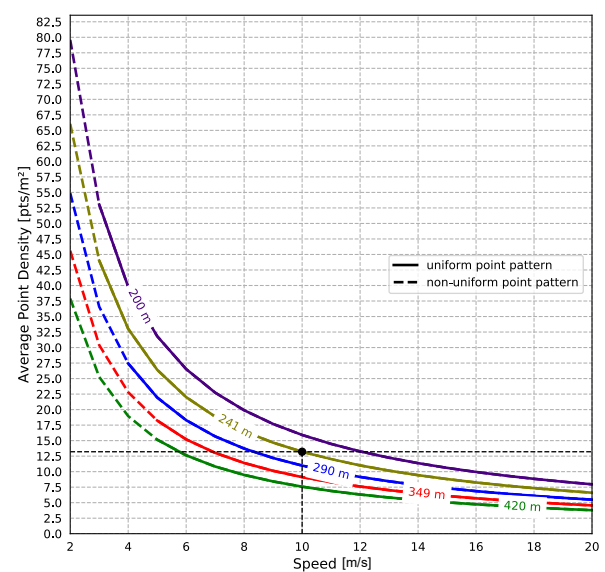


Example: VUX-1UAV²² at 100,000 pulses/second, speed = 8 m/s,
range to target = 309 m, resulting point density ~ 6.5 pts/m²

PRR = 200 kHz



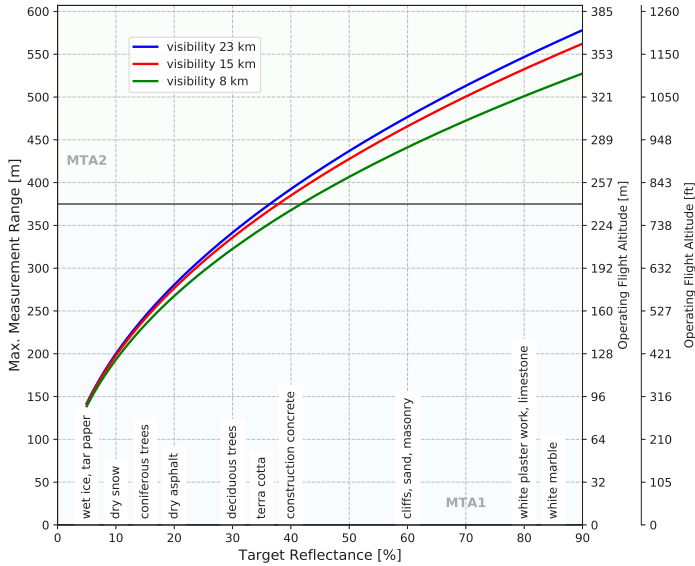
Operating flight altitude AGL given for the following conditions:
FOV +/- 45°, target size ≥ laser footprint



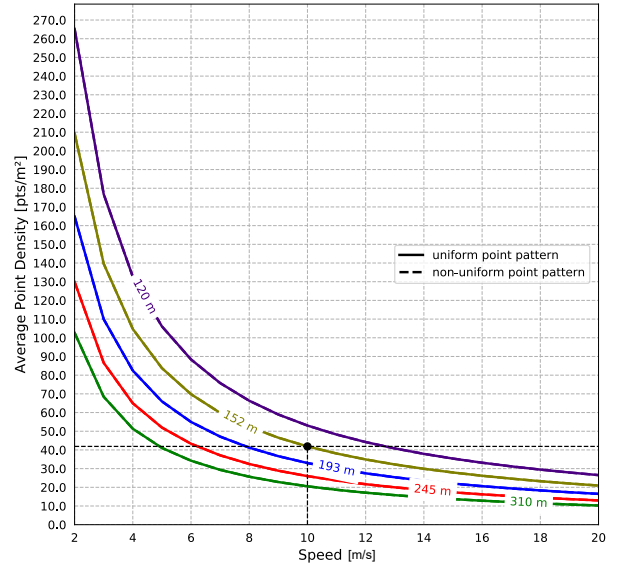
Example: VUX-1UAV²² at 200,000 pulses/second, speed = 10 m/s,
range to target = 241 m, resulting point density ~ 13 pts/m²

Maximum Measurement Range & Point Density *RIEGL VUX[®]-1UAV²²*

PRR = 400 kHz

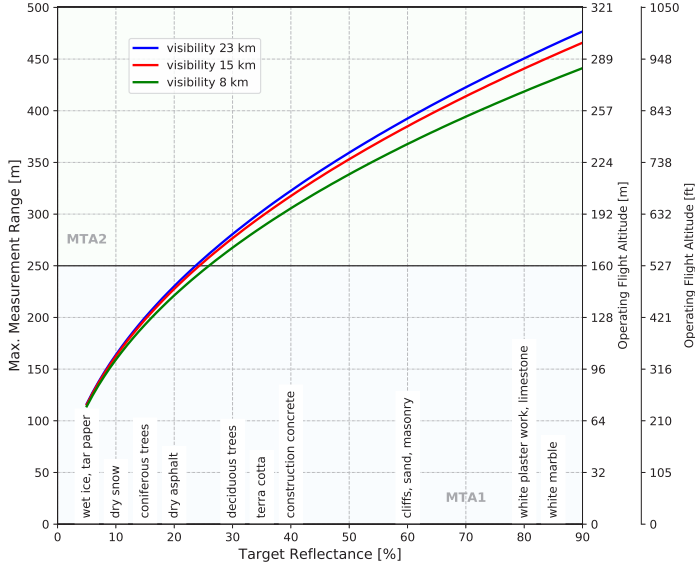


Operating flight altitude AGL given for the following conditions:
FOV +/- 45°, target size ≥ laser footprint

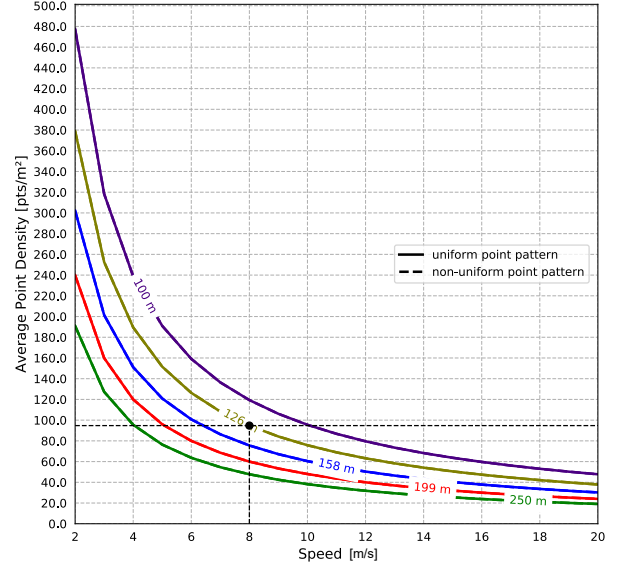


Example: VUX-1UAV²² at 400,000 pulses/second, speed = 10 m/s,
range to target = 152 m, resulting point density ~ 42 pts/m²

PRR = 600 kHz

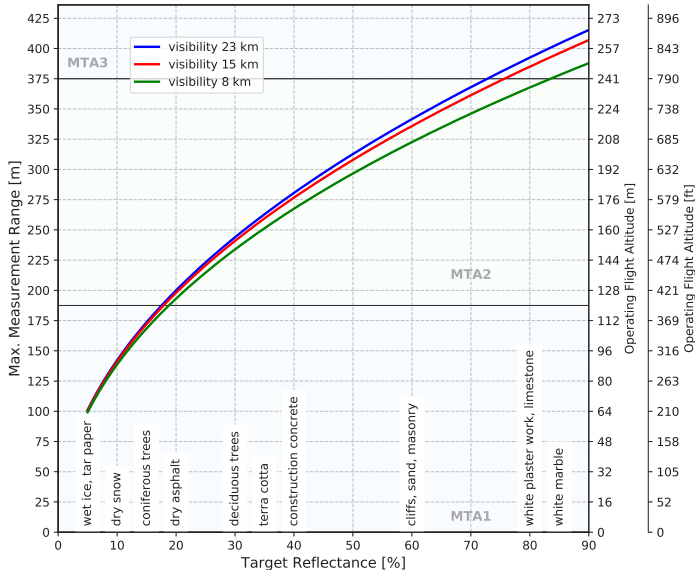


Operating flight altitude AGL given for the following conditions:
FOV +/- 45°, target size ≥ laser footprint

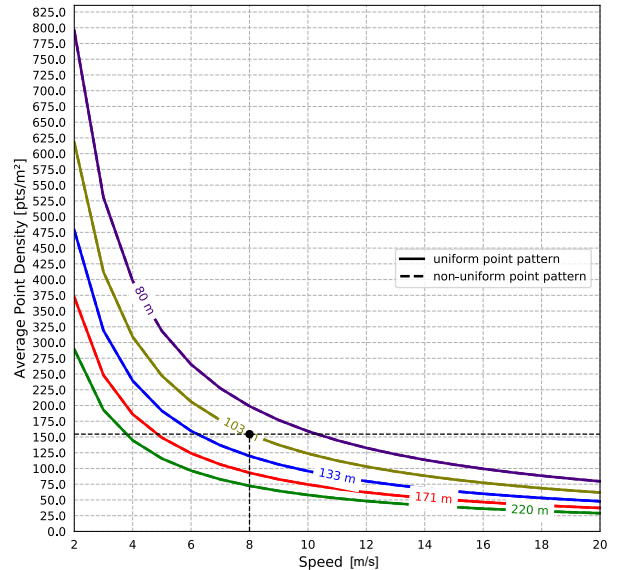


Example: VUX-1UAV²² at 600,000 pulses/second, speed = 8 m/s,
range to target = 126 m, resulting point density ~ 95 pts/m²

PRR = 800 kHz



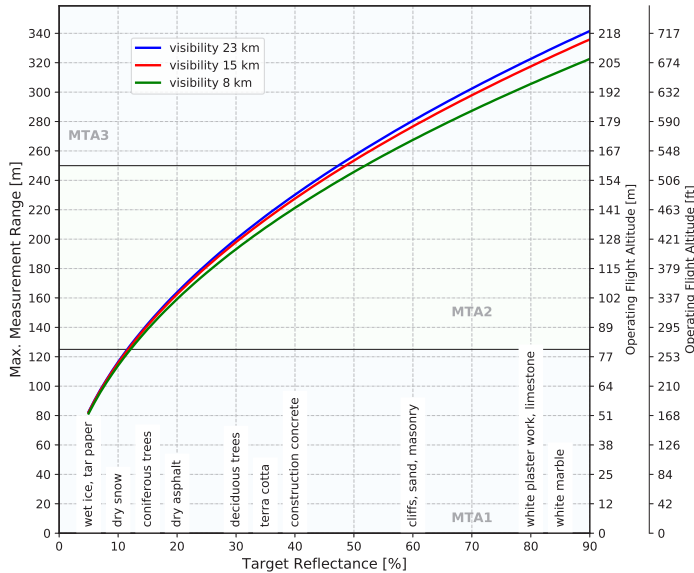
Operating flight altitude AGL given for the following conditions:
FOV +/- 45°, target size ≥ laser footprint



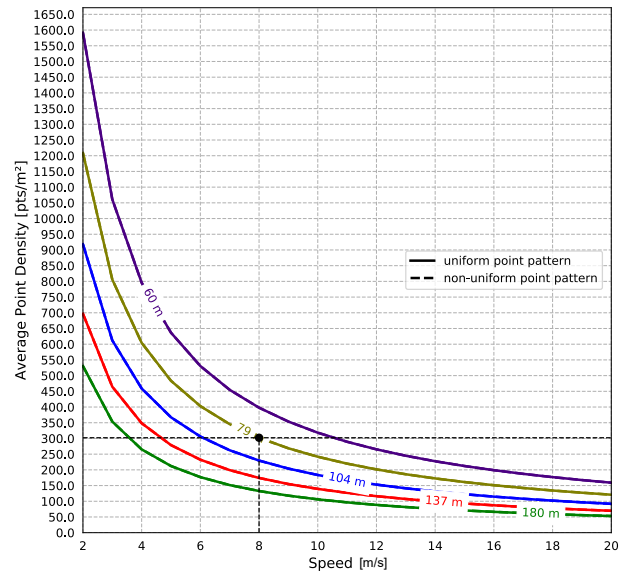
Example: VUX-1UAV²² at 800,000 pulses/second, speed = 8 m/s,
range to target = 103 m, resulting point density ~ 155 pts/m²

Maximum Measurement Range & Point Density *RIEGL VUX®-1 UAV²²*

PRR = 1200 kHz



Operating flight altitude AGL given for the following conditions:
FOV +/- 45°, target size ≥ laser footprint

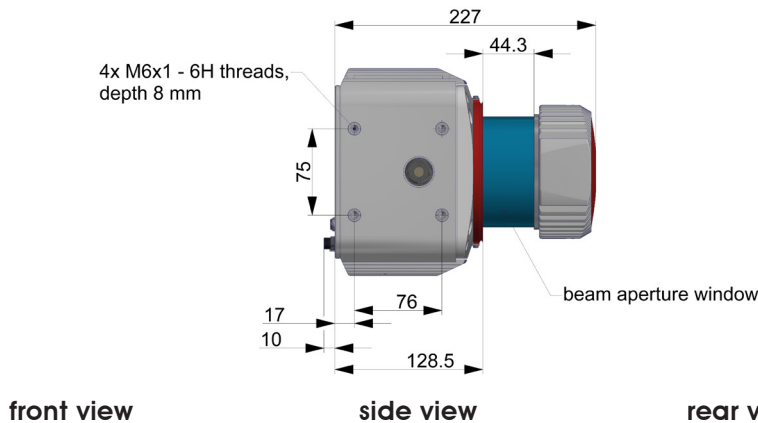


Example: VUX-1 UAV²² at 1,200,000 pulses/second, speed = 8 m/s,
range to target = 79 m, resulting point density ~ 302 pts/m²

Dimensional Drawings *RIEGL VUX®-1 UAV²²*

bottom view

all dimensions in mm

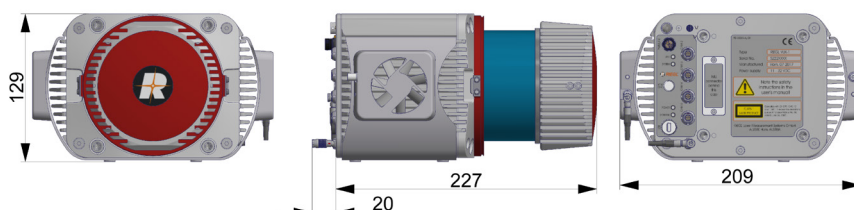


RIEGL VUX®-1 UAV²² with Cooling Fan Device

front view

side view

rear view



RIEGL VUX®-1UAV²² Additional Equipment and Integration



Cooling Fan



RIEGL VUX-1UAV²² with Protective Cap



RIEGL VUX-1UAV²² with external IMU-Sensor
(RIEGL VUX-SYS)

Additional Equipment for RIEGL VUX-1UAV²²

Cooling Fan

Lightweight structure with two axial fans providing forced air convection for applications where sufficient natural air flow cannot be guaranteed. Power supply is provided via a connector on the rear side of the RIEGL VUX-1UAV²². The cooling fan can be mounted either on the top side or on the bottom side of the RIEGL VUX-1UAV²² and is included in the scanner's scope of delivery.

The cooling fan has to be mounted whenever the environmental conditions/temperatures require (see "temperature range" on page 2 of this data sheet).

Protective Cap

To shield the glass tube of the RIEGL VUX-1UAV²² from mechanical damage and soiling, a protective cap is provided to cover the upper part of the instrument during transport and storage.

Options for RIEGL VUX-1UAV²² Integration

RIEGL provides user-friendly, application- and installation-oriented solutions for integration of the VUX-1UAV²² LiDAR sensor:

- **RIEGL VUX-SYS**

Complete airborne laser scanning system for flexible use in UAS/UAV/RPAS, helicopter, gyrocopter and ultra-light aircraft installations comprising the RIEGL VUX-1UAV²², an IMU/GNSS unit and a dedicated control unit.

- **RiCOPTER**

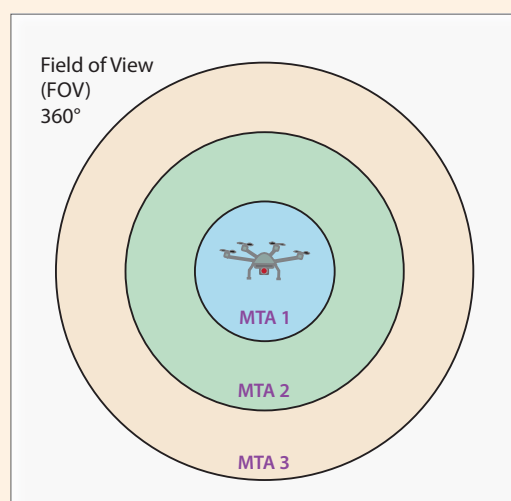
Ready to fly remotely piloted aircraft system with RIEGL VUX-SYS integrated

- **RIEGL VP-1**

Small and lightweight pod with integrated RIEGL VUX-SYS to be mounted on standard hard points and typical camera mounts of manned helicopters

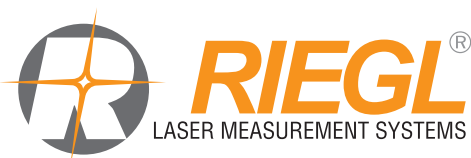
Details to be found on the relevant datasheets and infosheets.

Multiple-Time-Around Data Acquisition and Processing



In time-of-flight laser ranging a maximum unambiguous measurement range exists, which is defined by the laser pulse repetition rate and the speed of light. In case the echo signal of an emitted laser pulse arrives later than the emission of the subsequently emitted laser pulse, the range result becomes ambiguous - an effect known as „Multiple-Time-Around“ (MTA).

The RIEGL VUX-1UAV²² allows ranging beyond the maximum unambiguous measurement range using a sophisticated modulation scheme applied to the train of emitted laser pulses. The dedicated post-processing software module RiUNITE provides algorithms for multiple-time-around processing, which automatically assign definite range results to the correct MTA zones without any further user interaction required.



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