The RIEGL VUX-1UAV is a very lightweight and compact laser scanner, meeting the challenges of emerging survey solutions by UAS/UAV/RPAS both in measurement performance as in system integration. With regard to the specific constraints and flight characteristics of UAS, the RIEGL VUX-1UAV 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 240 GByte SSD and/or provided as real-time line scan data via the integrated LAN-TCP/IP interface.

The RIEGL VUX-1UAV 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
Technical Data RIEGL VUX-1UAV

Laser Product Classification

Class 1 Laser Product according to IEC60825-1:2007
The following clause applies for instruments delivered into the United States:
Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

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]

<table>
<thead>
<tr>
<th>Frequency (kHz)</th>
<th>50 kHz</th>
<th>100 kHz</th>
<th>200 kHz</th>
<th>300 kHz</th>
<th>380 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Measuring Range [2][4]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>natural targets p ≥ 20 %</td>
<td>550 m</td>
<td>920 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>natural targets p ≥ 60 %</td>
<td>400 m</td>
<td>660 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Operating Flight Altitude AGL [1][5]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>350 m (1150 ft)</td>
<td>250 m (820 ft)</td>
<td>180 m (590 ft)</td>
<td>150 m (490 ft)</td>
<td>130 m (430 ft)</td>
<td>110 m (360 ft)</td>
</tr>
</tbody>
</table>

Min. Number of Targets per Pulse 3 m 10 mm 5 mm up to 550 kHz up to 500 000 meas./sec. (@ 550 kHz PRR & 330° FOV) for each echo signal, high-resolution 16 bit intensity information is provided near infrared 0.5 mrad (10) 50 mm @ 100 m, 250 mm @ 500 m, 500 mm @ 1000 m

Scanner Performance

Scanning Mechanism
rotating mirror up to 330° (full range measurement performance) 10 - 200 revolutions per second, equivalent to 10 - 200 scans/sec 0.006° ≤ Δ θ ≤ 1.5°

Precision:
8) One sigma @ 150 m range under RIEGL test conditions.
9) User selectable.
10) Measured at the 1/e2 points. 0.50 mrad corresponds to an increase of 50 mm of beam diameter per 100 m distance.

Data Interfaces

LAN 10/100/1000 Mbit/sec LAN 10/100/1000 Mbit/sec or USB 2.0 Serial RS232 interface for data string with GNSS-time information, TTL input for 1PPS synchronization pulse 240 GByte SSD TTL input/output SMA connector

General Technical Data

11 - 32 V DC / typ. 60 W

Main Dimensions [11]
VUX-1UAV without / with Cooling Fan Device
VUX-1UAV without / with Cooling Fan Device Weight [11]
227 x 180 x 125 mm / 227 x 209 x 129 mm approx. 3.5 kg / approx. 3.75 kg
Humidity max. 80 % non condensing @ 31°C Protection Class IP64, dust and splash-proof

Temperature Range [12]
0°C up to +40°C (operation) / -20°C up to +50°C (storage)

Optional Components (integrated)

Embedded GNSS-Inertial System high performance multi-channel, multi-band GNSS receiver, solid-state MEMS IMU

1) Rounded values.
2) Laser power optimized (reduced) for measurements of short ranges with high pulse repetition rate.
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 RiMTA ALS software.
5) Reflectivity p ≥ 20%, flat terrain assumed, scan angle ±45° FOV
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) Meaning of the 1/e2 points. 0.50 mrad corresponds to an increase of 50 mm of beam diameter per 100 m distance.
9) without external IMU/GNSS, cooling fan device not in operation
10) The instrument requires air convection with a minimum flow rate of 6 m/s for continuous operation at +15 °C and above. If the necessary flow rate cannot be provided by the moving platform, the cooling fan device (included in the scope of delivery) has to be used.
Maximum Measurement Range & Point Density RIEGL VUX-1UAV

The following conditions are assumed for the Operating Flight Altitude AGL:
- ambiguity resolved by multiple-time-around (MTA) processing & flight planning
- target size ≥ laser footprint
- average ambient brightness
- operating flight altitude given at a FOV of ±45°

### Maximum Measurement Range [m]

<table>
<thead>
<tr>
<th>PRR</th>
<th>50 kHz</th>
<th>100 kHz</th>
<th>200 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range to Target</td>
<td>250 m</td>
<td>180 m</td>
<td>400 m</td>
</tr>
<tr>
<td>Speed [kn]</td>
<td>8 kn</td>
<td>10 kn</td>
<td>6 kn</td>
</tr>
<tr>
<td>Resulting Point Density</td>
<td>~15.5 pts/m²</td>
<td>~34 pts/m²</td>
<td>~6.5 pts/m²</td>
</tr>
</tbody>
</table>

### Example
- **PRR = 100 kHz**
  - Range to target = 180 m, speed = 10 kn
  - Resulting Point Density ~ 34 pts/m²

### Target Reflectivity [%]
- dry snow, coniferous trees, dry asphalt, deciduous trees, terra cotta, construction concrete, cliffs, sand, masonry, white plaster work, limestone, white marble, wet ice, black tar paper.
**RIEGL VUX®-1UAV**

**Maximum Measurement Range & Point Density**

**PRR = 300 kHz**

- MTA1: no ambiguity / one transmitted pulse “in the air”
- Visibility: 23 km
- Point Density: 72 pts/m²

**Example:** VUX-1UAV at 300,000 pulses/second
- Range to target = 160 m, Speed = 8 kn
- Resulting Point Density ~ 72 pts/m²

**PRR = 380 kHz**

- MTA1: no ambiguity / one transmitted pulse “in the air”
- MTA2: two transmitted pulses “in the air”
- Visibility: 15 km, 8 km
- Point Density: 95 pts/m²

**Example:** VUX-1UAV at 380,000 pulses/second
- Range to target = 120 m, Speed = 10 kn
- Resulting Point Density ~ 95 pts/m²

**PRR = 550 kHz**

- MTA1: no ambiguity / one transmitted pulse “in the air”
- MTA2: two transmitted pulses “in the air”
- Visibility: 23 km, 15 km, 8 km
- Point Density: 210 pts/m²

**Example:** VUX-1UAV at 550,000 pulses/second
- Range to target = 100 m, Speed = 8 kn
- Resulting Point Density ~ 210 pts/m²

---

**The following conditions are assumed for the Operating Flight Altitude AGL**

- Ambiguity resolved by multiple-time-around (MTA) processing & flight planning
- Target size ≥ laser footprint
- Average ambient brightness
- Operating flight altitude given at a FOV of +/-45°
Maximum Measurement Range & Point Density **RIEGL VUX-1UAV**

**PRR = 550 kHz reduced power**

- **Example:** VUX-1UAV at 550,000 pulses/second reduced power range to target = 50 m, speed = 6 kn
  - Resulting Point Density ~ 570 pts/m²

**Dimensional Drawings RIEGL VUX®-1UAV**

*all dimensions in mm*

**RIEGL VUX®-1UAV with Cooling Fan Device**
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-1UAV 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 RiMTA provides algorithms for multiple-time-around processing, which automatically assign definite range results to the correct MTA zones without any further user interaction required.

Additional Equipment for RIEGL VUX-1UAV

Cooling Fan Device
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-1UAV. The cooling fan device can be mounted either on the top side or on the bottom side of the RIEGL VUX-1UAV and is included in the scanner’s scope of delivery.

The cooling fan device is to be mounted whenever the environmental conditions/temperatures require (see “temperature range” on page 2 of this datasheet).

Protective Cap
To shield the glass tube of the RIEGL VUX-1UAV 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-1UAV Integration
RIEGL provides user-friendly, application- and installation-oriented solutions for integration of the VUX-1UAV LiDAR sensor:

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

- **RICOPTER**
  Ready to fly remotely piloted airborne laser scanning 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.