RIEGL miniVUX-1UAV

- very compact & lightweight (1.55 kg / 3.4 lbs)
- 360° field-of-view
- robust aluminum housing, ready to be mounted on multi-rotor, rotary-wing, and fixed-wing UAVs
- makes use of RIEGL's unique echo signal digitization and online waveform processing
- multiple target capability up to 5 target echoes per laser shot
- scan speed up to 100 scans/sec
- measurement rate up to 100,000 measurements/sec
- mechanical and electrical interface for IMU mounting
- NEW OPTION:

RIEGL RILOC IMU/GNSS system solutions available

- exceptionally well suited to measure in snowy and icy terrains
- user-friendly, application- and installation-oriented solutions for integration

The *RIEGL* miniVUX-1UAV is an extremely lightweight airborne laser scanner, designed specifically for integration with UAS/UAV/RPAS.

The small and sophisticated design of the stable aluminum housing offers various integration possibilities with platforms that offer restricted space or payload capabilities. The 360° field of view allows complete acquisition of the environment.

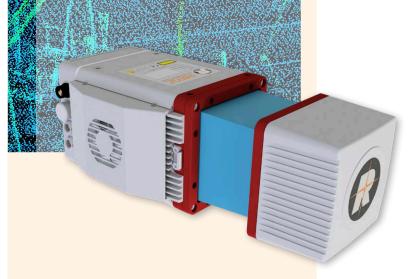
An easy-to-remove SD card for data storage, and/or the option for streaming the scan data via LAN-TCP/IP interface, in combination with the modest power consumption of the scanner, enable straight-forward integration with most UAS/UAV/RPAS types.

The *RIEGL* miniVUX-1UAV 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. As a further special feature, the wavelength is optimized for the measurement of snowy and icy terrain.

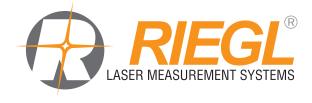
In addition to the stand-alone version of the miniVUX-1UAV, *RIEGL* also offers fully-integrated system solutions with integrated camera and IMU/GNSS systems, e.g. with *RIEGL* RiLOC-E²⁵ or RiLOC-F.

Typical applications include

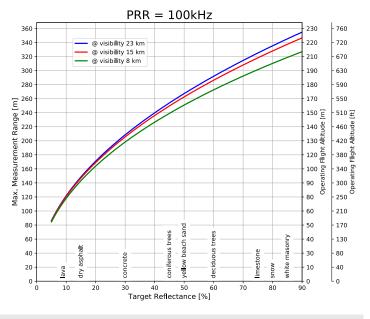
- Agriculture & Forestry
- Glacier and Snowfield Mapping
- Archeology and Cultural Heritage Documentation
- Construction-Site Monitoring
- Landslide Monitoring

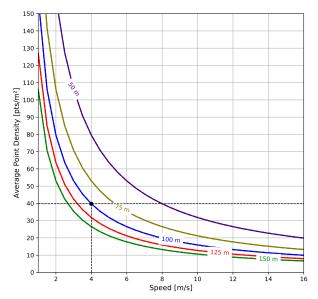


visit our website www.riegl.com



Maximum Measurement Range vs. Target Reflectance RIEGL miniVUX®-1UAV

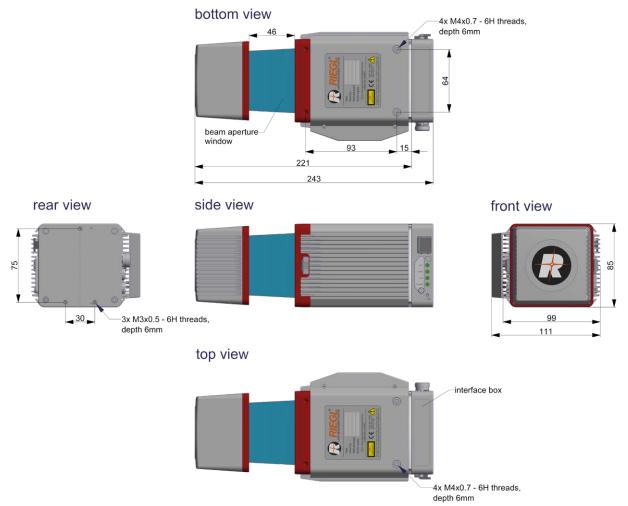




Operating Flight Altitude AGL given for the following conditions: FOV of $\pm 1/45^\circ$, target size \ge laser footprint, average ambient brightness

Example: miniVUX-1UAV at 100,000 pulses/second, speed = 4 m/s, range to target = 100 m, resulting point density \sim 40 pts/m²

Dimensional Drawings RIEGL miniVUX®-1UAV Stand-Alone



all dimensions in mm

Besides of the stand-alone miniVUX-1UAV LiDAR engine, RIEGL offers also system solutions, combining the miniVUX-1UAV with IMU/GNSS systems of different performance and of different form factors as well as optional RGB camera systems.

Below you can find the most common configurations offered for RIEGL miniVUX-SYS systems based on the RIEGL miniVUX-1UAV LiDAR sensor.

For more detailed information and further possible RIEGL miniVUX-SYS configurations, lease contact sales@riegl.com

RIEGL miniVUX-SYS IMU/GNSS Integration Options

RIEGL miniVUX-3UAV with RiLOC®-E25 / RiLOC®-F



- RIEGL's IMU/GNSS solution fully integrated with LiDAR engine
- total weight approx. 1.84 kg
- interfaces for up to 2 cameras
- suited for integration into multi-rotor UAVs

RIEGL miniVUX-1UAV with APX-15 UAV1)



- IMU/GNSS unit integrated with LiDAR engine
- total weight approx. 2 kg
- interfaces for up to 2 cameras
- suited for integration into fixed-wing UAVs

1) See technical details in the corresponding Applanix datasheet

RIEGL RILOC-E ^{25 1)}	RIEGL RILOC-F 1)	Applanix APX-15 UAV 2)
0.010°	0.005°	0.025°
0.025°	0.020°	0.080°
up to 700 Hz	up to 700 Hz	200 Hz
0.02 - 0.04 m	0.02 - 0.03 m	0.05 - 0.1 m
1.84 kg	1.84 kg	2.0 kg
	0.010° 0.025° up to 700 Hz 0.02 - 0.04 m	0.010° 0.005° 0.025° 0.020° up to 700 Hz up to 700 Hz 0.02 - 0.04 m 0.02 - 0.03 m

²⁾ See technical details at the according Applanix datasheet

RIEGL Integration Kit 400 / 350

A special add-on to the RIEGL miniVUX-SYS allows for straight forward integration with your multi-rotor UAV, e.g. a DJI Matrice M400 / M350 RTK. Please contact sales@riegl.com to get more detailed information.



- RIEGL miniVUX-1UAV on RIEGL Integration Kit 400
- RIEGL miniVUX-1UAV on RIEGL Integration Kit 350
- add-on to the miniVUX-SYS coming with shock-absorbing mounting-kit, power supply module and cabling
- total weight approx. 0.22 kg / 0.35 kg (without sensor and camera)
- suited for integration into multi-rotor UAVs

RIEGL miniVUX-1UAV LiDAR Sensor equipped with RiLOC®-E²⁵ / RiLOC®-F



with RGB camera 2)

RIEGL miniVUX-1UAV LiDAR Sensor equipped with APX-15 UAV1)





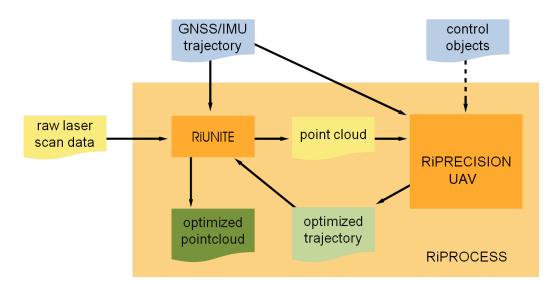
with two Sony Alpha 6100 cameras (oblique mount)

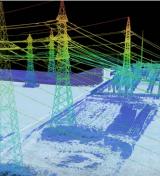
with nadir-looking RGB camera 2)

- 1) See technical details in the corresponding Applanix data sheet.
 2) Versatile camera options (e.g. Sony Alpha 6100, Sony A7R III, Sony A7R IV, Sony ILX-LR1).

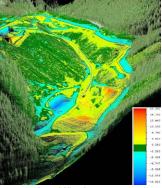
RIEGL miniVUX®-SYS - Processing Workflow and Scan Data Examples

Using RIEGL's software suites (RIPROCESS, RIUNITE) and dedicated processing workflows with specialized alignment tools like RiPRECISION conducting the whole procedure of scan data alignment fully automatically, processing time can be reduced to a minimum. RiPROCESS can interface the optimized, georeferenced point cloud in further post-processing tools via LAS or other data exchanges in various user-defined coordinate systems.





power line surveying



cut and fill volume comparison of disposal site

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.



Range Measurement Performance

Measuring Principle

time of flight measurement, echo signal digitization, online waveform processing

Laser Pulse Repetition Rate PRR 1)	100 kHz
Max. Measuring Range ²⁾ natural targets $\rho \geq 20$ % natural targets $\rho \geq 60$ % natural targets $\rho \geq 80$ %	170 m 290 m 330 m
Typ. Operating Flight Altitude AGL $^{1)(3)}$ natural targets $\rho \geq 20$ % natural targets $\rho \geq 60$ %	100 m (330 ft) 160 m (525 ft)
Max. Number of Targets per Pulse 4)	5

1) Rounded values.

 $3 \, \mathrm{m}$ 15 mm 10 mm

Minimum Range
Accuracy 5) 7)
Precision 6) 7)
Laser Pulse Repetition Rate 1)
Max. Effective Measurement Rate 1)
Echo Signal Intensity
Laser Wavelength
Laser Beam Divergence 8)
Laser Beam Footprint

100 000 meas./sec. (@ 100 kHz PRR & 360° FOV) for each echo signal, high-resolution 16 bit intensity information is provided near infrared

1.6 x 0.5 mrad 160 mm x 50 mm @ 100 m

Scanner Performance

Scanning Mechanism Field of View (selectable) Scan Speed (selectable)

Angular Step Width $\Delta \Phi$ (selectable) between consecutive laser shots Angle Measurement Resolution

rotating mirror up to 360°

10 - 100 revolutions per second, equivalent to 10 - 100 scans/sec $0.036^{\circ} \leq \Delta \ \phi \leq 0.36^{\circ}$

0.001°

Interfaces

Configuration, Scan Data Output & Communication with External Devices

GNSS Interface 9)

General IO & Control 10) Camera Interface

Memory Card Slot

2 x LAN 10/100/1000 Mbit/sec WLAN IEEE 802.11 a/b/a/n

Serial RS-232 interface for data string with GNSS-time information, TTL input for 1PPS synchronization pulse.

2 x TTL input/output, 1 x Remote on/off

2 x GNSS RS-232 Tx & PPS, Power, Trigger, Exposure

for SDHC/SDXC memory card 32 GByte (can be upgraded to 64 GByte)

9) internally available (not available with standard interface box)

10) 1x externally available with standard interface box

General Technical Data

Power Supply Input Voltage / Consumption Main Dimensions (L x W x H) / Weight with Cooling Fan

without Cooling Fan **Humidity**

Protection Class Temperature Range 11) 11 - 34 V DC / typ. 18 W @ 100 scans/sec

243 x 111 x 85 mm / approx. 1.6 kg 243 x 99 x 85 mm / approx. 1.55 kg max. 80 % non condensing @ 31°C IP64, dust and splash-proof

-10°C up to +40°C (operation) / -20°C up to +50°C (storage)

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

⁴⁾ If more than one target is hit, the total laser transmitter power is split and, accordingly, the achieveable range is reduced.

⁵⁾ Accuracy is the degree of conformity of a measured quantity

to its actual (frue) value.

6) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.

One sigma @ 50 m range under *RIEGL* test conditions.

Measured at 50% peak intensity, 1.6 mrad corresponds to an increase of 160 mm of beam diameter per 100 m distance.

Continuous operation at ambient temperature of $\geq 30^{\circ} C~(\geq 86^{\circ} F)$ requires a minimum amount of air flow at approx. 3 m/s. For applications where a 3 m/s air flow along the cooling fins cannot be guaranteed, the cooling fan has to be used.



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

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