"Downward-Looking" LiDAR Sensor for Unmanned Laser Scanning

RIEGL miniVUX®-1DL

- *very compact & lightweight: 2.4 kg / 5.3 lbs*
- *46° FOV, ± 23° off nadir*
- *robust aluminum housing, ready to be mounted on any suitable type of UAV*
- *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 150 scans/sec*
- *measurement rate up to 100,000 measurements/sec*
- *user-friendly, application- and installation-oriented solutions for integration*

The *RIEGL* miniVUX-1DL is a sister device to the miniature UAV laser scanner *RIEGL* miniVUX–1UAV.
The added indicator "DL" means "downward looking" and refers to its special design tailored to meet the needs of corridor mapping tasks (downward looking, optimized field of view, small size).

Thus, the *RIEGL* miniVUX-1DL is perfectly suited for tasks such as powerline and pipeline surveillance, or for infrastructure inspection as in highway or railway monitoring.

The specific wedge prism scanner construction produces a FOV (Field of View) of ± 23°, and the circular scan pattern provides a very high point density and good point distribution.

The *RIEGL* miniVUX-1DL 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.

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 – allows straightforward integration into various types of UAVs.

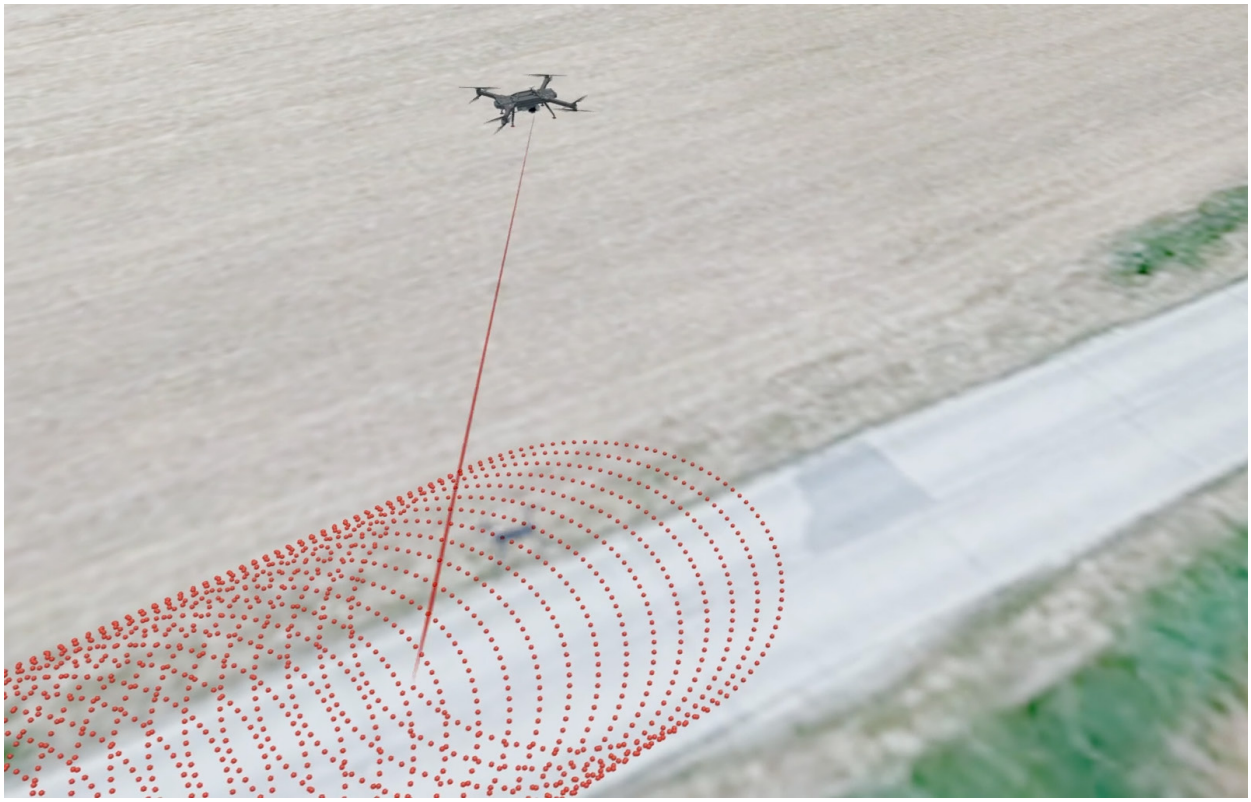
In addition to the stand-alone version of the miniVUX-1DL, *RIEGL* also offers fully-integrated system solutions.

Typical applications include

- ***Pipeline and Power Line Monitoring***
- ***Highway and Railtrack Inspection***
- ***Further Applications in Corridor Mapping***

visit our website
www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS



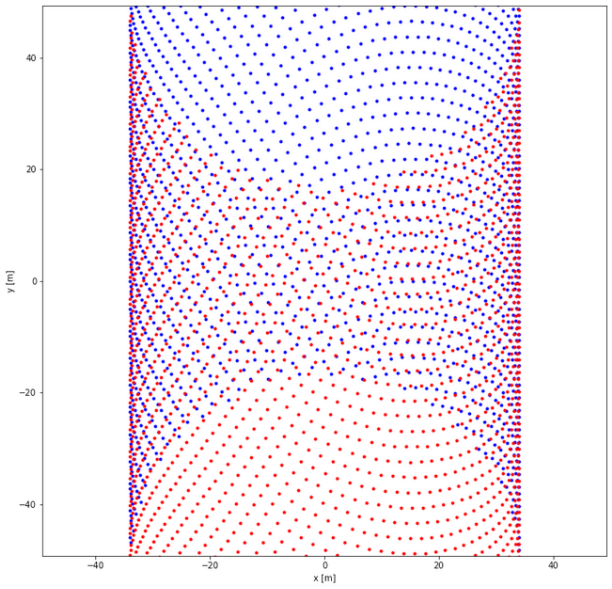
The rotating wedge prism generates a circular scan pattern with 23° off-nadir scan angle. The figures below show the point distribution on ground for the following parameters:

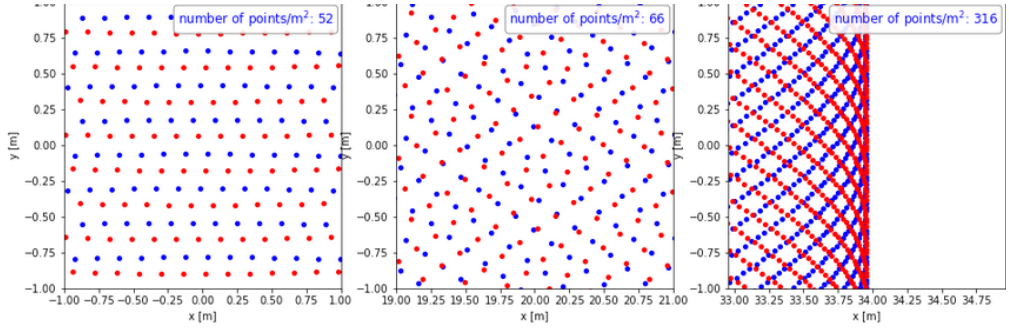
- Ground speed of aircraft: 35 kts (18 m/s)
- Height above ground: 80 m (260 ft)
- Scan rate: 75 revolutions per second
- Laser pulse repetition rate: 100 000 shots per second

Red dots = circular arc behind the scan origin

Blue dots = circular arc in front of the scan origin

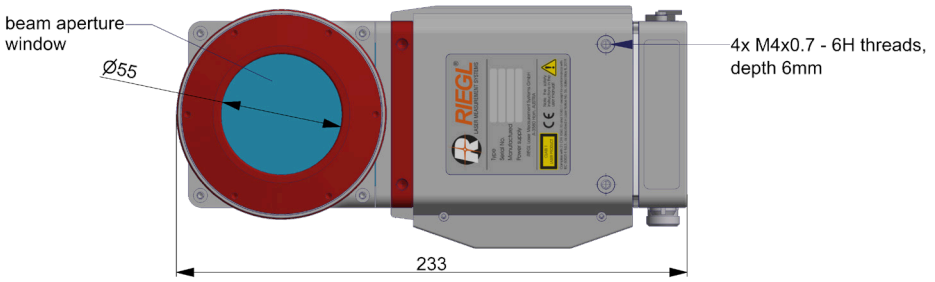
For reasons of better clarity every hundred-fiftieth measurement point is plotted.



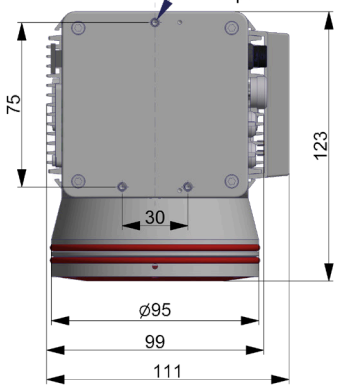


Detailed views (2 m x 2 m) of point distribution from left to right: nadir, x=20 m off-nadir and x=40 m off-nadir

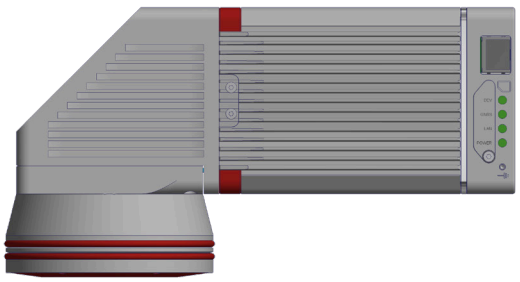
bottom view



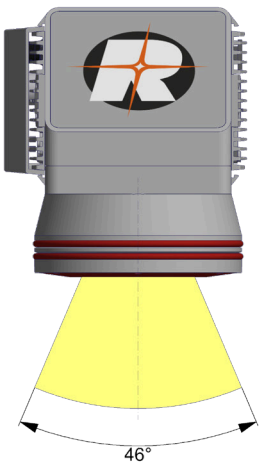
rear view



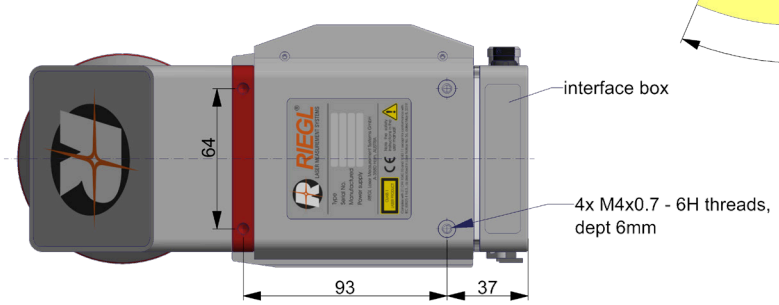
side view



front view



top view



all dimensions in mm

RIEGL miniVUX-SYS System Integration Options

Besides of the stand-alone miniVUX-1DL LiDAR engine, *RIEGL* offers also system solutions, combining the miniVUX-1DL with IMU/GNSS systems of different performance and of different form factors as well as optional RGB camera systems. With regards to the IMU/GNSS system, three options are available, depending on customer's requirements and the integration environment:

RIEGL miniVUX-SYS with APX-15 UAV[1)]

- IMU/GNSS unit integrated with LiDAR engine *RIEGL* miniVUX-1DL
- total weight approx. 2.8 kg
- interfaces for up to 2 cameras
- suited for integration into fixed-wing UAVs

with nadir-looking camera e.g. Sony Alpha 6000 camera or Sony Alpha 7R III

RIEGL miniVUX-SYS with APX-20 UAV[1)]

- higher-grade IMU/GNSS unit integrated with LiDAR engine *RIEGL* miniVUX-1DL
- total weight approx. 3.3 kg
- interfaces for up to 2 cameras
- suited for integration into all types of UAVs

with nadir-looking camera e.g. Sony Alpha 6000 camera or Sony Alpha 7R III

Please contact sales@riegl.com to get more detailed information.

1) See technical details in the corresponding Applanix datasheet

Technical Data *RIEGL* miniVUX®-1DL

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 ρ ≥ 20 %	140 m
natural targets ρ ≥ 60 %	240 m
natural targets ρ ≥ 80 %	260 m
Typ. Operating Flight Altitude AGL [1] [3]	
natural targets ρ ≥ 20 %	100 m (330 ft)
natural targets ρ ≥ 60 %	160 m (525 ft)
Max. Number of Targets per Pulse [4]	5

1) Rounded values.
2) 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 ±23° FOV, additional roll angle ± 5°
4) If more than one target is hit, the total laser transmitter power is split and, accordingly, the achieveable range is reduced.

Minimum Range	3 m
Accuracy [5] [7]	15 mm
Precision [6] [7]	10 mm
Max. Effective Measurement Rate [1]	100 000 meas./sec
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	near infrared
Laser Beam Divergence [8]	1.6 x 0.5 mrad
Laser Beam Footprint	160 mm x 50 mm @ 100 m

5) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.
6) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.
7) One sigma @ 50 m range under *RIEGL* test conditions.
8) Measured at 50% peak intensity, 1.6 mrad corresponds to an increase of 160 mm of beam diameter per 100 m distance.

Scanner Performance

Scanning Mechanism	rotating wedge prism
Field of View	± 23° = 46° (circular scan pattern)
Scan Speed (selectable)	10 - 75 revolutions/second equivalent to 20 - 150 scans/sec
Angular Step Width Δ ϑ (selectable) between consecutive laser shots	0.036° ≤ Δ ϑ ≤ 0.27°
Angle Measurement Resolution	0.001° (3.6 arcsec)

Interfaces

Configuration, Scan Data Output & Communication with External Devices	2 x LAN 10/100/1000 Mbit/sec WLAN IEEE 802.11 a/b/g/n
GNSS Interface [9]	Serial RS-232 interface for data string with GNSS-time information, TTL input for 1PPS synchronization pulse. Power Output 10 V DC, max 4.5 W
General IO & Control [10]	2 x TTL input/output, 1 x Remote on/off
Camera Interface	2 x GNSS RS-232 Tx & PPS, Power (USB 2.0), Trigger, Exposure
Memory Card Slot	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 / Power Consumption	11 - 34 V DC / typ. 43 W @ 75 revolutions/sec
Main Dimensions (L x W x H)	
without Cooling Fan / with Cooling Fan	232 x 99 x 123 mm / 232 x 111 x 123 mm
Weight	
miniVUX-1DL / Cooling Fan / Protective Cap	approx. 2.4 kg / approx. 0.04 kg / approx. 0.05 kg
Humidity	max. 80 % non condensing @ 31°C
Protection Class	IP64, dust-proof and splash-proof
Temperature Range [11]	0°C up to +40°C (operation)[12] / -20°C up to +50°C (storage)

11) Continuous operation at ambient temperature of ≥ 30°C (≥ 86°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.
12) Valid for the initial start-up. After a warm-up phase, operation down to -10°C is also possible.

RIEGL LASER MEASUREMENT SYSTEMS

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