Lightweight Airborne Laser Scanner with Online Waveform Processing

RIEGL VUX®-1

- *survey-grade accuracy & precision typ. 25 mm*
- *scan speed up to 200 scans / second*
- *measurement rate up to 500,000 meas./sec (@ 600 kHz PRR & 300° FOV)*

- *operating flight altitude up to more than 1,000 ft*
- *field of view up to 300° 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 - practically unlimited number of target echoes*

- *compact (225x180x125 mm), lightweight (3.85 kg), and rugged*
- *easily mountable to professional UAS / UAV / RPAS*
- *mechanical and electrical interface for IMU mounting*

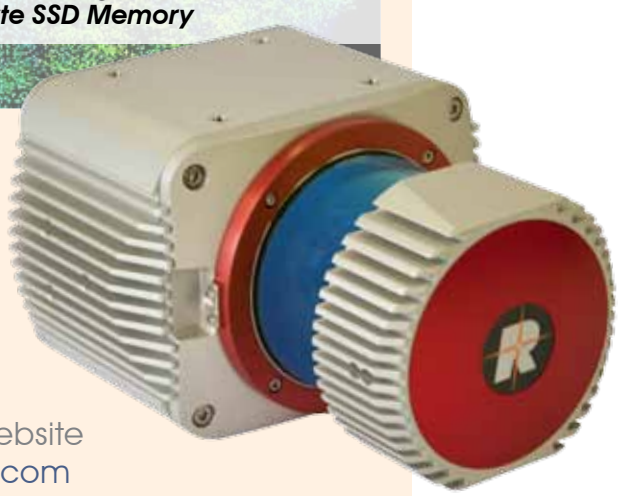
- *electrical interfaces for GPS data string and Sync Pulse (1PPS)*
- *LAN-TCP/IP interface*
- *scan data storage on internal 240 GByte SSD Memory*

The *RIEGL* VUX-1 is a very lightweight and compact laser scanner, meeting the challenges of emerging survey solutions by UAS/UAV/RPAS, gyrocopter and ultra-light aircraft, both in measurement performance as in system integration. With regard to the specific constraints and flight characteristics of UAS, the *RIEGL* VUX-1 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 Airborne Laser Scanner *RIEGL* VUX-1 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 distribution.

Typical applications include

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



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www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS

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.

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]	*50 kHz*	*100 kHz*	*200 kHZ*	*400 kHz*	*600 kHz*
Max. Measuring Range [2] [3]					
natural targets ρ ≥ 20 %	550 m	400 m	280 m	200 m	160 m
natural targets ρ ≥ 60 %	920 m	660 m	480 m	350 m	280 m
Max. Operating Flight Altitude AGL [1] [4]	350 m (1150 ft)	250 m (820 ft)	180 m (590 ft)	130 m (430 ft)	100 m (330 ft)
Max. Number of Targets per Pulse	practically unlimited (details on request)				

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) Ambiguity to be resolved by post-processing with RiMTA software.
4) Reflectivity ρ ≥ 20%, flat terrain assumed.

Minimum Range	5 m
Accuracy [5] [7]	25 mm
Precision [6] [7]	25 mm
Laser Pulse Repetition Rate [1] [8]	up to 600 kHz
Max. Effective Measurement Rate [1]	up to 500 000 meas./sec. (@ 600 kHz PRR & 300° FOV)
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	near infrared
Laser Beam Divergence [9]	0.5 mrad
Laser Beam Footprint (Gaussian Beam Definition)	50 mm @ 100 m, 250 mm @ 500 m, 500 mm @ 1000 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 @ 150 m range under *RIEGL* test conditions.
8) User selectable.
9) 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	rotating mirror
Field of View (selectable)	up to 300° (full range measurement performance)
Scan Speed (selectable)	10 - 200 revolutions per second, equivalent to 10 - 200 scans/sec
Angular Step Width $\Delta\vartheta$ (selectable) between consecutive laser shots	0.006° ≤ $\Delta\vartheta$ ≤ 1.5°
Angle Measurement Resolution	0.001°
Internal Sync Timer	for real-time synchronized time stamping of scan data
Scan Sync (optional)	scanner rotation synchronization

Data Interfaces

Configuration	LAN 10/100/1000 Mbit/sec
Scan Data Output	LAN 10/100/1000 Mbit/sec or USB 2.0
GNSS Interface	Serial RS232 interface for data string with GNSS-time information, TTL input for 1PPS synchronization pulse
Internal Memory	240 GByte SSD
External Camera	TTL input/output
External GNSS Antenna	SMA connector

General Technical Data

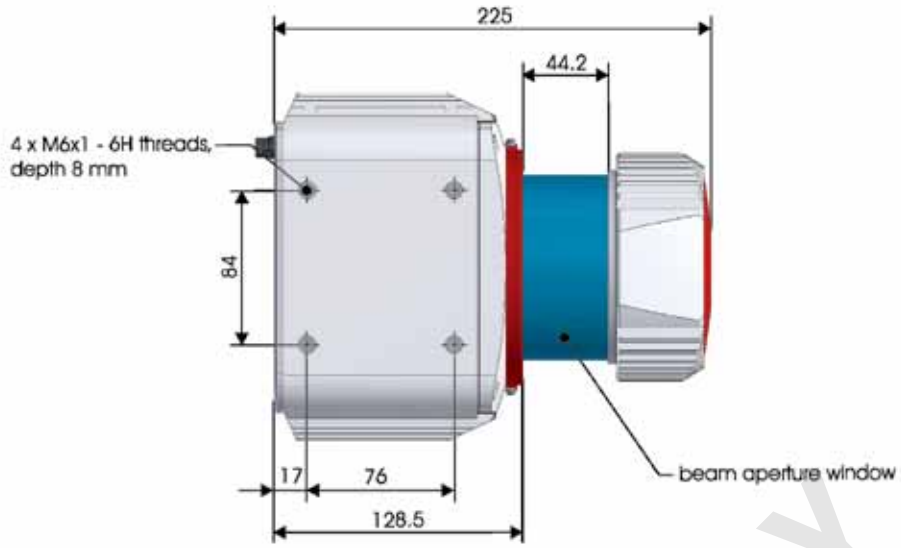
Power Supply Input Voltage	11 - 32 V DC
Power Consumption [10]	typ. 60 W
Main Dimensions [10]	225 x 180 x 125 mm
Weight [10]	approx. 3.85 kg
Humidity	non condensing
Protection Class	IP64, dust and splash-proof
Max. Flight Altitude (operating)	16 500 ft (5 000 m) above MSL
Max. Flight Altitude (not operating)	18 000 ft (5 500 m) above MSL
Temperature Range	0°C up to +40°C (operation) / -20°C up to +50°C (storage)

Optional Components [11]

IMU Sensor (integrated)	triaxial MEMs gyroscope & accelerometer
GNSS Receiver (integrated)	50 channels, GPS L1 Frequency, SMA connector for external GNSS antenna

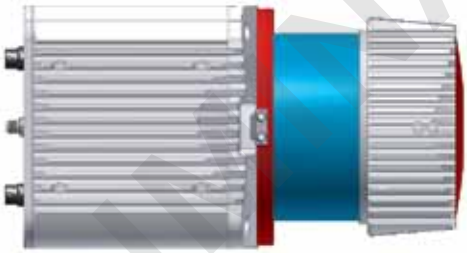
10) without external IMU/GNSS
11) external IMU sensor and GNSS receiver on request

bottom view

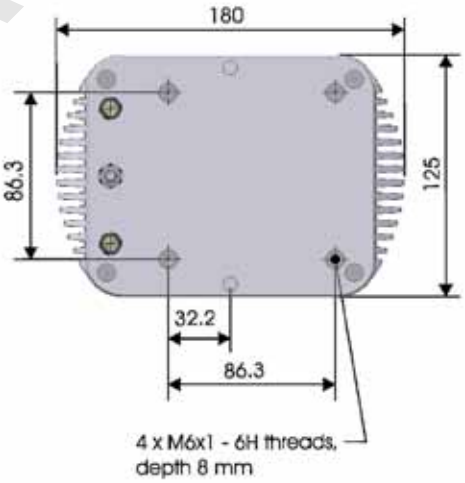


front view

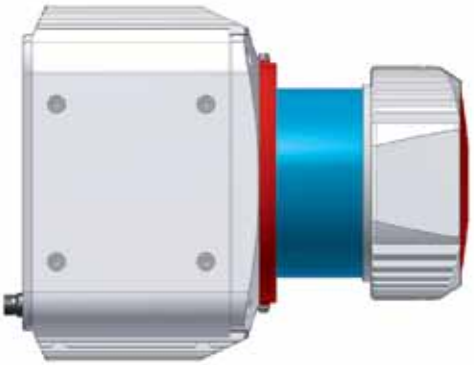
side view



rear view



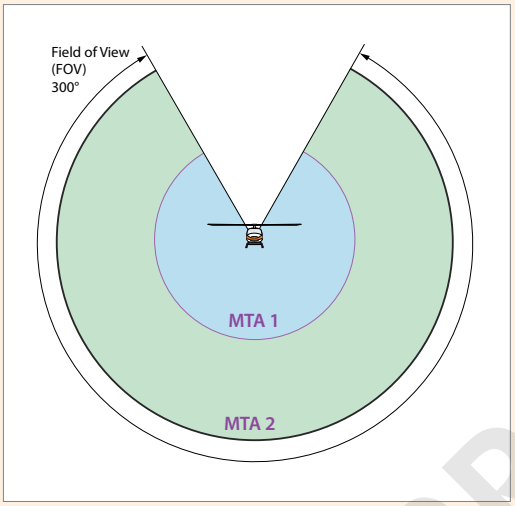
top view



all dimensions in mm

RIEGL VUX®-1 with External IMU-Sensor (Optional)

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-1 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.

RIEGL®
LASER MEASUREMENT SYSTEMS

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