High-Performance LiDAR Sensor for KINEMATIC Laser Scanning

RIEGL VUX®-3HA

- *very high scan speed up to 400 scans/sec*
- *RIEGL proprietary RiLOC IMU/GNSS system available*

- *very high measurement rate up to 3,000,000 meas./sec*
- *survey-grade performance:*
  3 mm accuracy
  2 mm precision
- *360° field of view for unrestricted data acquisition*
- *regular point pattern, perfectly parallel scan lines*
- *cutting edge RIEGL technology:*
  - echo signal digitization
  - online waveform processing
  - multiple-time-around processing
  - multi-target capability
  - calibrated amplitude
  - range independent reflectance
- *compact (212x209x125 mm), lightweight (3.2 kg), and rugged*
- *userfriendly mounting*
- *mechanical and electrical interface for external IMU sensor*
- *electrical interfaces for GNSS data string and sync pulse (1PPS)*
- *LAN-TCP/IP interface*
- *internal solid state drive (SSD) for data storage*

The *RIEGL* VUX-3HA high-precision laser scanner offers a 360° coverage of extremely dense point cloud data. A pulse repetition rate of up to 3 MHz combined with an increased line speed of up to 400 scans/second enables the detection of minute details in close-range applications such as scanning road surfaces and the detection of even thin structures such as steel cable constructions, power lines, and vegetation details at longer distances. Even at higher platform speeds, the point density requirements of projects are easily met, increasing efficiency in a wide variety of mapping tasks.

High performance pulsed laser ranging, based on *RIEGL's* well-proven echo signal digitization technology with subsequent online waveform processing results in superior measurement capabilities even under adverse atmospheric conditions and in excellent multiple target echo discrimination. Scan data is provided with additional point attributes, e.g. range-independent reflectance and calibrated amplitude. While calibrated amplitude values visualize the objects scanned depending on the distance, range-independent reflectance values visualize them regardless of distance but depending on surface properties. Such information can be used for classification and further AI-based processing. *RIEGL's* software package RiPROCESS and the associated software tools and apps enable full utilization of the highly informative data available with each individual measurement point.

Typical MLS applications include

ROAD:

- *Transportation Infrastructure Mapping*
- *Road Surface Measurement*
- *HD Mapping for Autonomous Vehicles*
- *City Modeling*
- *GIS Mapping and Asset Management*
- *As-Built Surveying*

RAIL:

- *Rapid and Safe Data Capture with Minimal Disruption to Network Schedules*
- *Track and Infrastructure Monitoring*
- *Clash Detection Simulation and Clearance Analysis*

visit our website
www.riegl.com

RIEGL®
LASER MEASUREMENT SYSTEMS

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, multiple-time-around-capability

Laser Pulse Repetition Rate PRR [1) 2)]	*300 kHz*	*1000 kHz*	*1800 kHz*	*3000 kHz*
Max. Measuring Range [3) 4)]				
natural targets ρ ≥ 10 %	180 m	100 m	90 m	70 m
natural targets ρ ≥ 80 %	500 m	280 m	250 m	200 m
Max. Number of Targets per Pulse [5)]	31	15	8	5

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

Minimum Range	1 m
Accuracy [6) 8)]	3 mm
Precision [7) 8)]	2 mm
Laser Pulse Repetition Rate [1) 9)]	300 kHz to 3000 kHz
Max. Effective Measurement Rate [1)]	up to 3 000 000 meas./sec. (@ 3000 kHz PRR & 360° FOV)
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	near infrared
Laser Beam Divergence	typ. 0.35 mrad @ 1/e [10)], typ. 0.5 mrad @ 1/e² [11)]
Laser Beam Footprint (Gaussian Beam Definition)	4.5 mm @ exit, 5 mm @ 5 m, 6.6 mm @ 10 m, 13 mm @ 25 m, 25 mm @ 50 m, 50 mm @ 100 m

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) One sigma @ 16 m range under *RIEGL* test conditions.
9) User selectable, setting of intermediate PRR values possible.
10) Measured at the 1/e points. 0.35 mrad corresponds to an increase of 35 mm of beam diameter per 100 m distance.
11) Measured at the 1/e² points. 0.50 mrad corresponds to an increase of 50 mm of beam diameter per 100 m distance.

Scanner Performance

Scanning Mechanism [12)]	rotating mirror
Field of View (selectable)	360° „full circle"
Scan Speed (selectable) [12)]	10 - 400 revolutions per second, equivalent to 10 - 400 scans/sec
Angular Step Width Δ ϑ (selectable) between consecutive laser shots	0.0012° ≤ Δ ϑ ≤ 0.48°
Angle Measurement Resolution	0.001°
Internal Sync Timer	for real-time synchronized time stamping of scan data
Scan Sync (optional)	scanner rotation synchronization

12) The rotation noise may vary from device to device and depends strongly on the rotation speed. A louder rotation noise in a device compared to other devices is usually no indication of a malfunction, does not qualify for a rectification, nor does it constitute a warranty case. The max. noise is less than 70 dB(A) at 1 m distance.

Data Interfaces

Configuration	LAN 10/100/1000 Mbit/sec
Scan Data Output	LAN 10/100/1000 Mbit/sec
GNSS Interface	Serial RS-232 interface for data string with GNSS-time information, TTL input for 1PPS synchronization pulse
Internal Data Storage	2 TByte SSD
External Camera (1x)	TTL input/output

General Technical Data

Power Supply Input Voltage	11 - 34 V DC
Power Consumption [13)]	typ. 48 W @ 25 °C typ. 65 W @ low temperatures
Main Dimensions [13)]	212 x 209 x 125 mm
Weight [13)]	approx. 3.2 kg
Humidity	max. 80 % non condensing @ 31 °C
Protection Class	IP66[14)], IP67[15)]
Temperature Range	-20 °C [16)] up to +40 °C (operation) / -20 °C up to +50 °C (storage)

13) without external IMU/GNSS
14) dust-tight, protected against powerful waterjets
15) dust-tight, protected against temporary immersion in water
16) Requires that the scanner is powered up at or above -10 °C ambient temperature and held in continuous scanning operation. Insulating the scanner with appropriate material will enable operation at even lower temperatures.

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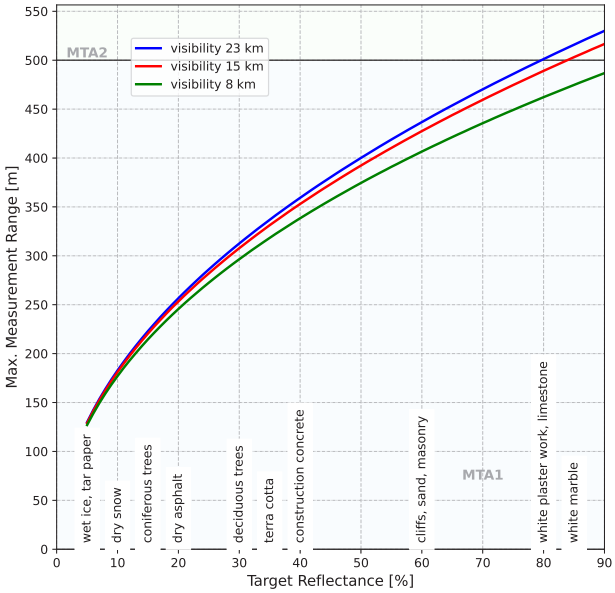
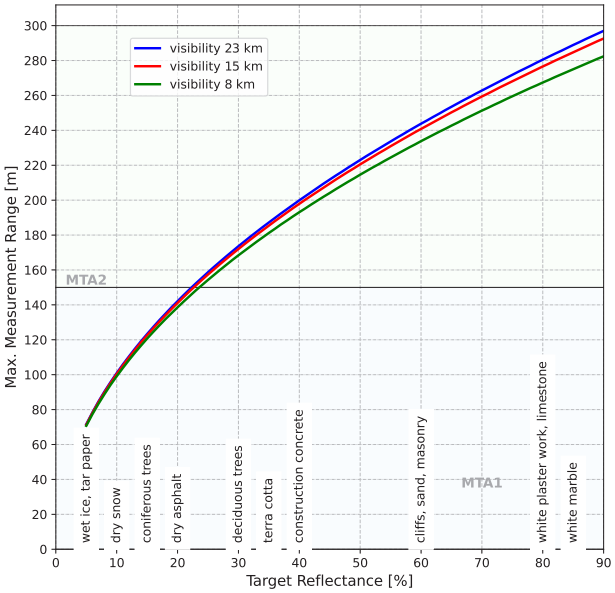
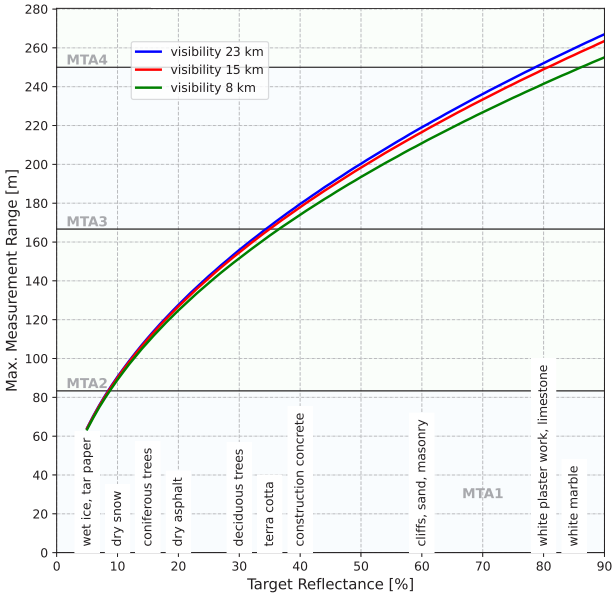
Laser PRR = 300 kHz



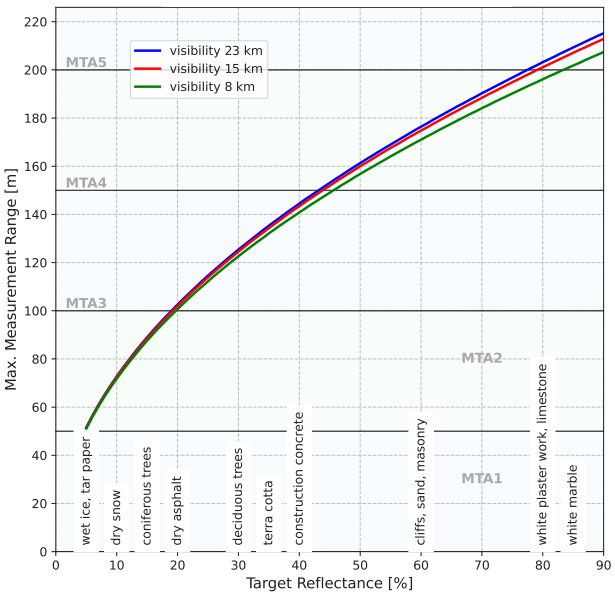
Laser PRR = 1000 kHz



Laser PRR = 1800 kHz



Laser PRR = 3000 kHz



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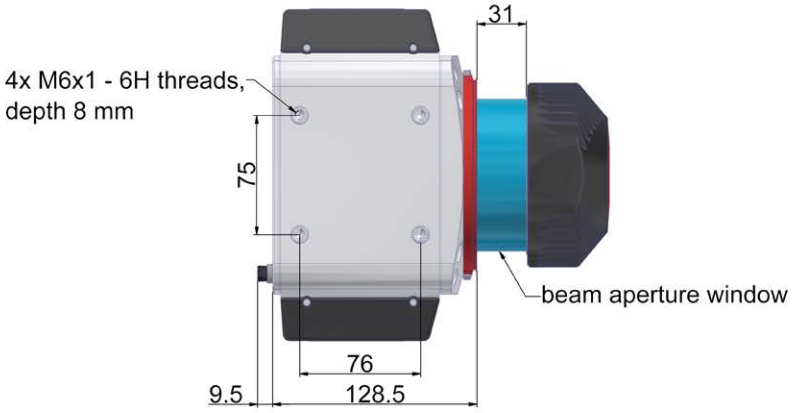
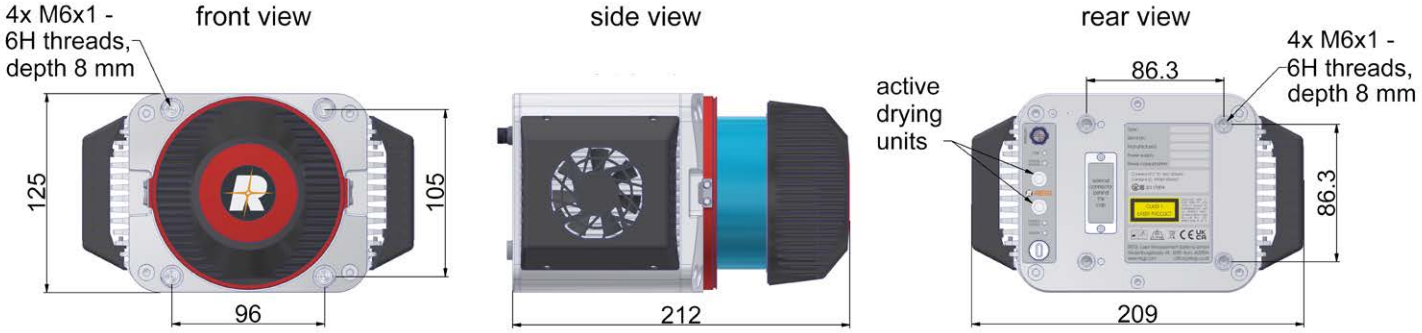
bottom view

all dimensions in mm



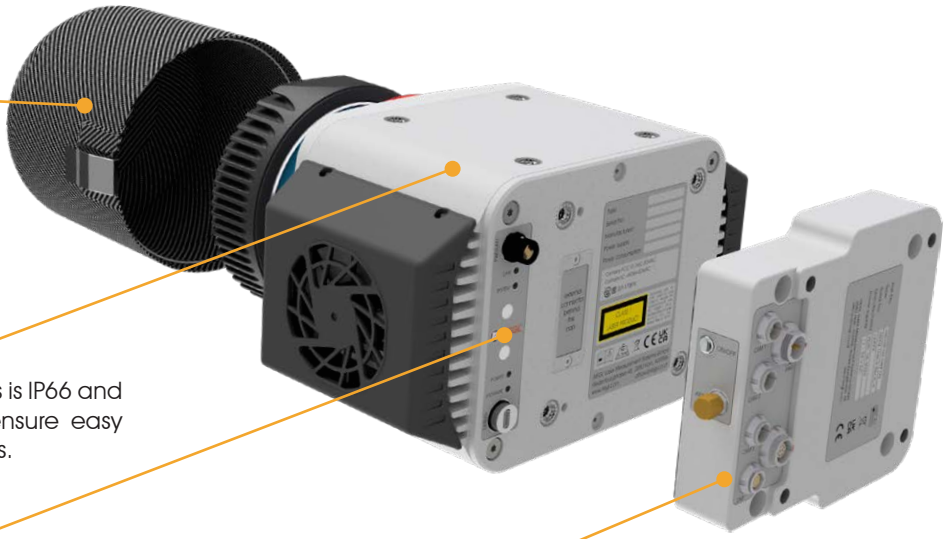


Options for *RIEGL* VUX-3HA Integration

RIEGL offers user-friendly hardware and software interfaces for straight forward integration of the *RIEGL* VUX-3HA LiDAR sensor into kinematic systems.

Protective Cap

To shield the glass tube of the *RIEGL* VUX-3HA from mechanical damage and soiling, a protective cap is provided to cover the upper part of the instrument during transport and storage.



Compact, Rugged Housing

The housing with its industrial-grade fans is IP66 and IP67 rated. Several mounting points ensure easy installation in various mounting positions.

Active Dehumidification

The integrated active drying units ensure reliable air dehumidification inside the *RIEGL* VUX-3HA during operation.

VUX-3-RiLOC-F (optional)

The VUX-3-RiLOC-F, *RIEGL's* proprietary IMU/GNSS unit, provides accurate location and orientation data in addition to the acquired LiDAR measurements.

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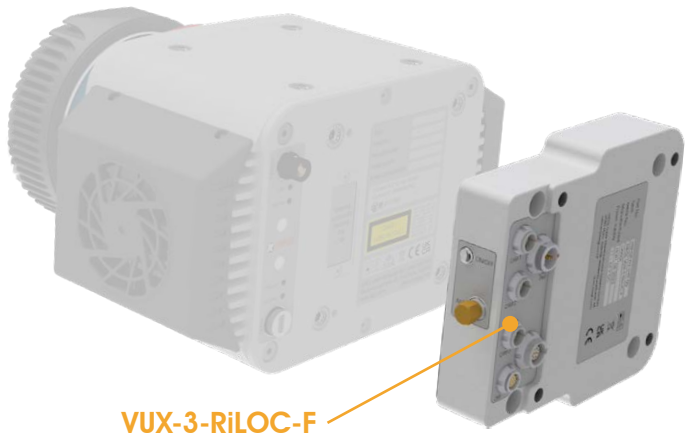
RIEGL VUX®-3HA with optional RiLOC-F



RIEGL VUX-3-RiLOC-F IMU/GNSS Unit

The high-performance ultra-fast mobile laser scanner *RIEGL* VUX-3HA is now available as fully integrated system solution. The **VUX-3-RiLOC-F, *RIEGL's* proprietary IMU/GNSS unit,** provides accurate location and orientation data in addition to the acquired LiDAR measurements. IMU/GNSS information is seamlessly integrated with the *RIEGL* acquisition and post-processing workflows. The rigorous GNSS/IMU/LiDAR adjustment enables superior point cloud alignment resulting in 3D point cloud precision close to the laser ranging accuracy.

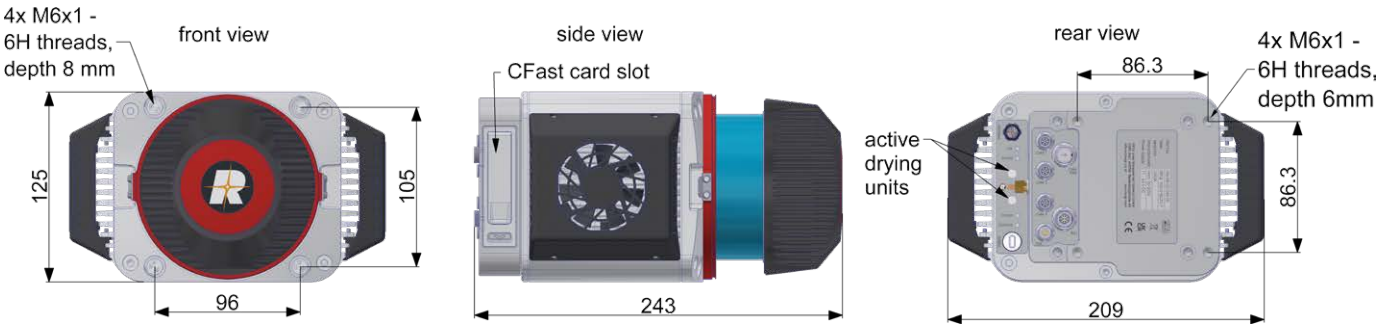
Technical Data *RIEGL* VUX®-3HA with optional RiLOC-F

Note:
Only the data that changes as a result of the integration of RiLOC-F is listed here. You can find the basic data in the technical specifications for the VUX-3HA.

General Technical Data	
Main Dimensions [1]	243 x 209 x 125 mm
Weight [1]	approx. 3.6 kg
Memory Card Slot	for CFast® [2] industrial memory card
RiLOC-F IMU/GNSS System	
Orientation Accuracy [3]	
Roll, Pitch	0.005°
Heading	0.020°
IMU Sampling Rate	up to 700 Hz
Position Accuracy (typ.)	0.02 - 0.03 m
VUX-3-RiLOC-F Interfaces [4]	
Camera Interfaces (3x)	power, trigger, exposure, GNSS RS-232 TX & PPS
DMI Interface	DMI input (for distance measuring indicatior; odometer)
Interface for Optional External IMU	IMU data, power

1) *RIEGL* VUX-3HA with VUX-3-RiLOC-F
2) CFast is a registered trademark of CompactFlash Association.
3) accuracy specifications for post-processed data
4) in addition to the scanner's interfaces

Dimensional Drawings *RIEGL* VUX®-3HA with optional RiLOC-F



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