3D Very Long Range Terrestrial Laser Scanner with Online Waveform Processing

RIEGL VZ®-4000

- *very long range up to 4,000 m*
- *eye safe operation at Laser Class 1*
- *wide field of view, 60° x 360°*
- *high speed data acquisition up to 222,000 meas. / second*
- *high accuracy, high precision ranging based on echo digitization and online waveform processing*
- *multiple target capability*
- *optional waveform data output*
- *built-in calibrated digital camera*
- *on-board inclination sensors*
- *integrated L1 GPS receiver with antenna*
- *integrated compass*
- *built-in SSD drive storage*
- *compact and rugged design*
- *advanced camera options*

This 3D VZ-Line Laser Scanner offers superior and unrivaled long range measurement performance up to 4,000 m reflectorless while still maintaining completely eye safe operation (Laser Class 1).

***RIEGL´s* unique V-Line technology is based on echo digitization and online waveform processing and is the key to enabling such extreme long range measurements. The VZ-4000 operates even in poor visibility and demanding multi target situations caused by dust, haze, rain, snow, etc. which are frequently found in difficult environments such as mining sites.**

Modes of Operation:

- stand-alone operation with integrated graphical user interface via 7" touchscreen
- remote control via VNC Viewer with any standard tablet PC or mobile device via WiFi
- remote operation with RiSCAN PRO on a notebook via LAN or WiFi connection
- customized operation by third party tools / applications based on *RIEGL´s* well documented interfaces and scanner libraries (e.g., RiVLib).

Typical applications include

- ***Topography & Mining***
- ***Long Range Monitoring***
- ***Civil Engineering***
- ***Archaeology***

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RIEGL®
LASER MEASUREMENT SYSTEMS

Terrestrial Laser Scanning

VZ®-4000 Key Features and Components

Extremely Long Range Performance

The High-Speed, High-Resolution 3D Laser Scanner *RIEGL* VZ-4000 offers an extremely long range of more than 4,000 m and a wide field of view of 60° vertical and 360° horizontal. It uses an invisible laser beam for eye safe operation in Laser Class 1.

The high accuracy and reliability of range measurement performance is based on *RIEGL*´s unique V-Line technology of echo digitization and online waveform processing. Extreme long range measurements can be achieved even with poor visibility and demanding multi target situations caused by dust, haze, rain, snow, etc.

Built-in Camera

A built-in calibrated 5-Megapixel camera capturing images deflected by the laser mirror enables coverage of the entire field of view with an appropriate number of high resolution images automatically stitched together to create a high resolution panorama image. This panorama image, in combination with precise 3D measurements produced by the VZ-4000, enables the creation of photorealistic virtual models for geological and geotechnical investigations, avalanche research, geomorphology, and other geological features.

Waveform Data Output Option

The digitized echo signals, also known as waveform data, acquired by the *RIEGL* VZ-4000 are the basis for waveform analysis. This data is provided via the optionally available waveform data output and accessible with the associated *RIEGL* software library RiWAVELib for investigations and research on multi target situations based on the digital waveform data samples of the target echoes.

Compatible Software Packages

The *RIEGL* VZ-4000 is compatible with the *RIEGL* software package RiSCAN PRO for terrestrial laser scanning, *RIEGL*'s interface library RiVLib, as well as the workflow-optimizing software packages, e.g., RiMINING. The optional software plugin RiMTA TLS provides automatic assignment of the scan data to the correct MTA zone in multiple time around situations.

Supported Registration Methods

Direct Geo-Referencing

- integrated GPS receiver (L1) connected
- external high-end RTK GNSS receiver connected
- integrated compass, accuracy typically 1°
  (one sigma value, available for vertical scanner setup position)
- on-board inclination sensors (tilt range ±10°, accuracy typ. ±0.008°)

GNSS Traversing

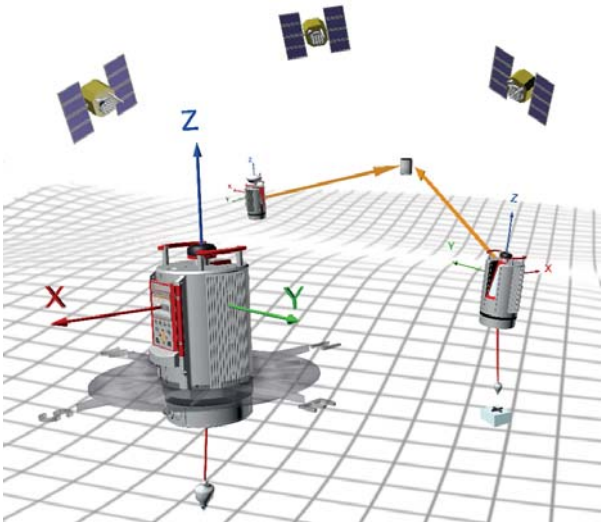
- GNSS position (RTK or autonomous)
- on-board inclination sensors
- automatic acquisition of well known remote target (reflector)

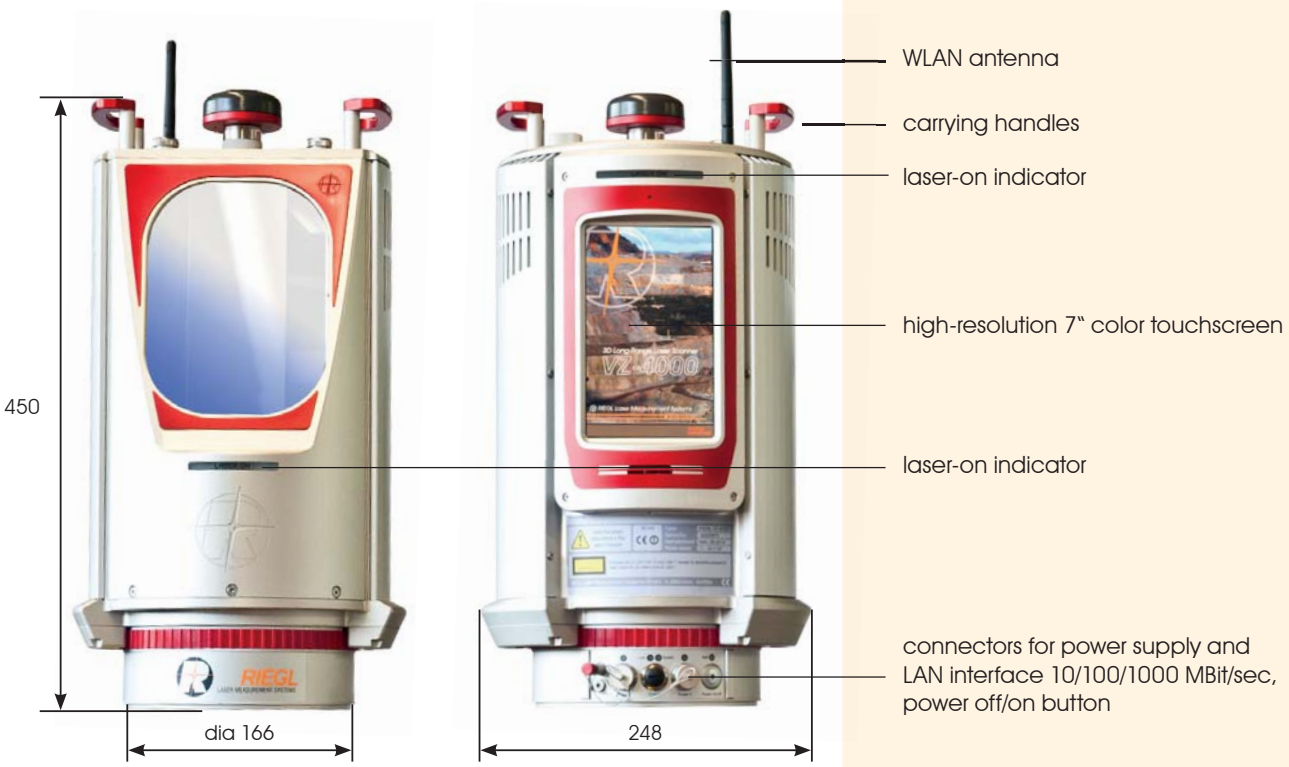
Free Stationing

- fast fine scanning of reflectors for precise determination
  of scanner position using control points

Backsighting

- setup on well known point
- on-board inclination sensors
- precise fine scanning of well known remote target (reflector)

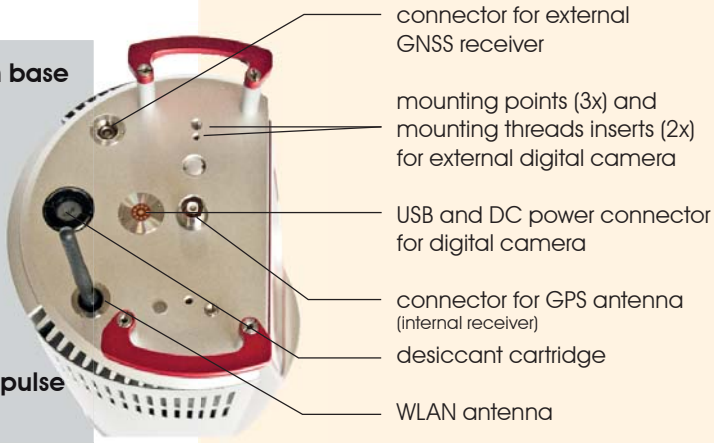




All dimensions in mm.

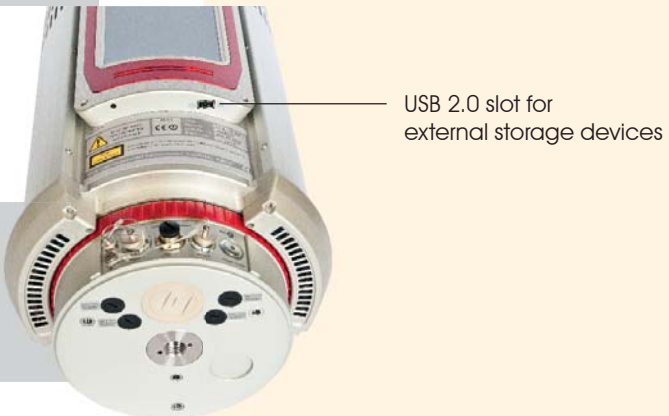
Communication and Interfaces

- **built in LAN port 10/100/1000 MBit/sec within base**
- **integrated WLAN interface with high-gain antenna**
- **USB 2.0 for connecting an external digital camera**
- **connector for GPS antenna**
- **two external power supply ports**
- **connector for external GPS synchronization pulse (1PPS)**
- **connector for external GNSS receiver**



Scan Data Storage

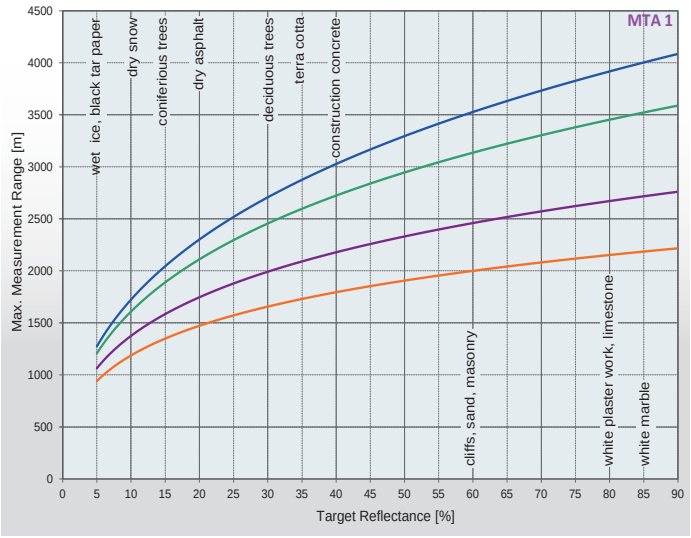
- **internal 80 GByte SSD (Solid State Disc)** (2 GByte reserved for the operating system)
- **external storage devices** (USB flash drives or external hard drives) **via USB 2.0 interface**



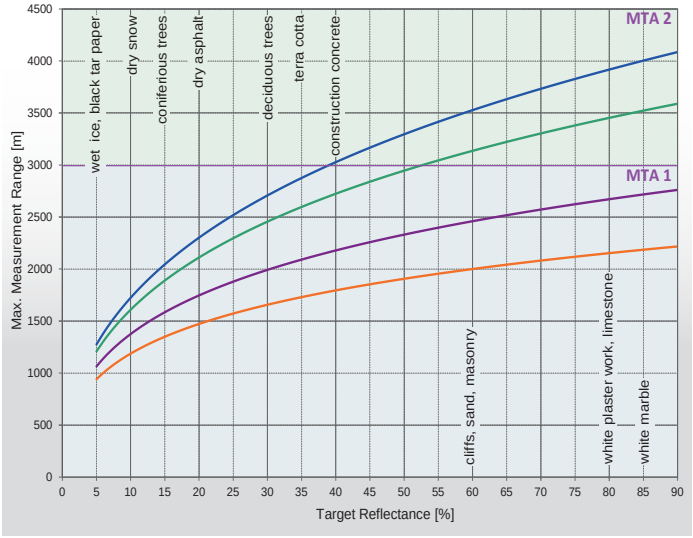
Max. Measurement Range *RIEGL* VZ®-4000

standard clear atmosphere: visibility 23 km
clear atmosphere: visibility 15 km
light haze: visibility 8 km
medium haze: visibility 5 km

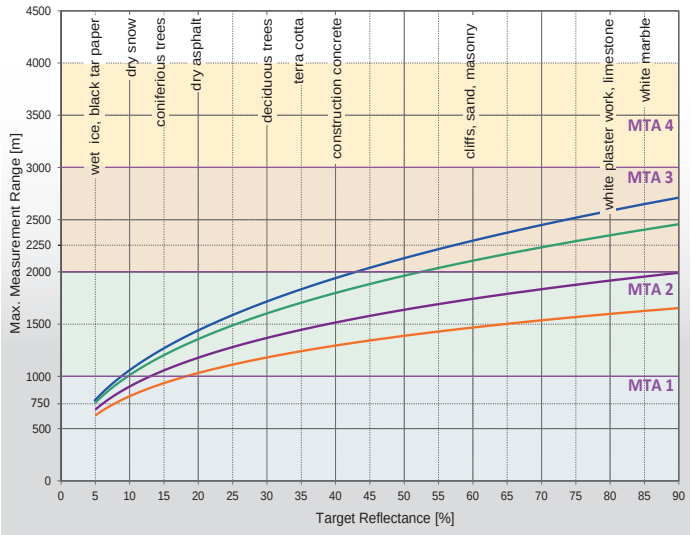
30 kHz PRR



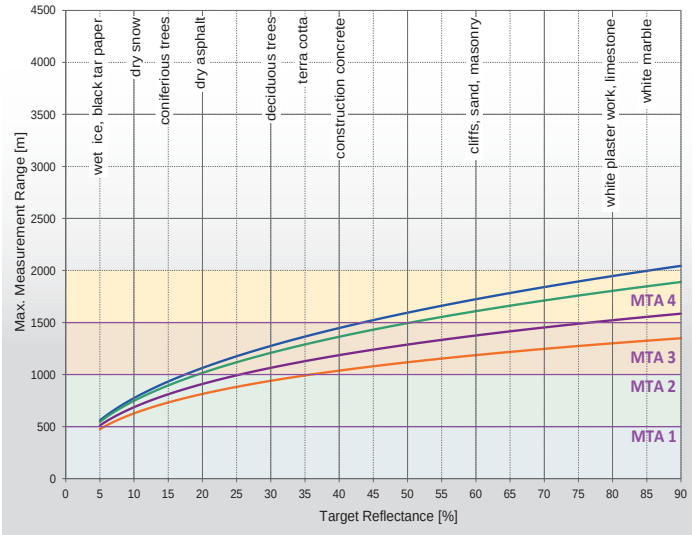
50 kHz PRR



150 kHz PRR



300 kHz PRR



The following conditions are assumed:

- flat target larger than footprint of the laser beam
- perpendicular angle of incidence
- average brightness
- ambiguity resolved by post processing with RiMTA TLS

MTA zones:

MTA 1: no ambiguity / 1 pulse „in the air"
MTA 2: 2 pulses „in the air"
MTA 3: 3 pulses „in the air"
MTA 4: 4 pulses „in the air"

User-Friendly and Efficient Operation and Acquisition Workflow

Operation is easy with the integrated graphical user interface via 7" touchscreen, or by remote control of the scanner via VNC Viewer with any tablet PC or mobile device via WiFi connection.
Highly efficient scan data acquisition and global registration is supported by on-board inclination sensors, integrated L1 GPS receiver, an interface for a high-end external GNSS receiver on top of the scanner, a digital compass and built-in SSD data storage media. With a visual project overview of acquired scan data, it is possible to ensure complete data coverage or check the progress of a project as it is acquired. The system provides a number of useful features that help to increase the overall user experience. One of these features is the ability to schedule scans to be acquired fully automatically on a regularly defined time interval which is useful for capturing 4D (3D time-lapse) datasets without direct user supervision of the system.

Power Supply

- intelligent power supply management, up to three independent external power sources can be connected simultaneously for uninterrupted operation
- reliable under- and over voltage protection
- wide external voltage supply range 11-32 V DC
- power consumption typ. 75 W (max. 90 W)
- LED indicators for power status

Camera Capabilities

Advanced Camera Support Capability

The VZ-Line of scanners has been updated with advanced camera support capability. Utilizing a specialized interface and a universal mount system, *RIEGL* is able to provide support for a wide variety of industrial cameras in standalone operation. This development enables the VZ-4000 to **directly control, operate and acquire images from RGB, Thermal, Industrial and a number of other camera systems and types** without complex cabling, connections or the need of an external laptop. With simplified mount integrations, it is now possible to acquire advanced images from state-of-the-art camera technologies simply using *RIEGL* Terrestrial Laser Scanners.

Technical Data *RIEGL* VZ®-4000

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 deviations pursuant to Laser Notice No. 50, dated June 24, 2007

Range Measurement Performance [1]

Measuring Principle	time of flight measurement, echo signal digitization, online full waveform analysis, multiple-time-around processing, full waveform export capability (optional)
Mode of operation	single pulse ranging

Laser Pulse Repetition Rate PRR (peak) [2]	30 kHz	50 kHz	150 kHz	300 kHz
Effective Measurement Rate (meas./sec) [2]	23,000	37,000	113,000	222,000
Max. Measurement Range [3]				
natural targets ρ ≥ 90 %	4,000 m	4,000 m [4]	2,700 m [4]	2,000 m [4]
natural targets ρ ≥ 20 %	2,300 m	2,300 m [4]	1,450 m [4]	1,000 m [4]
Max. Number of Targets per Pulse [5]	15	15	10	9

Accuracy [6] [8]	15 mm
Precision [7] [8]	10 mm
Minimum Range	5 m
Laser Wavelength	near infrared
Laser Beam Divergence [9]	0.15 mrad
Laser Beam Footprint (Gaussian Beam Definition)	18 mm @ exit, 75 mm @ 500 m, 150 mm @ 1000 m, 300 mm @ 2000 m

1) With online waveform processing.
2) Rounded values, selectable by measurement program.
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 TLS
5) If the laser beam hits, in part, more than one target, the laser's pulse power is split accordingly. Thus, the achievable range is reduced.
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 @ 150 m range under *RIEGL* test conditions.
9) Measured at the $1/e^2$ points. 0.15 mrad corresponds to an increase of 15 mm of beam diameter per 100 m of range.

Scanner Performance

	Vertical (Line) Scan	*Horizontal (Frame) Scan*
Scanning Mechanism	lightweight mirror rotating / oscillating	rotating head
Field of View (selectable)	total 60° (+30° / -30°)	max. 360°
Scan Speed (selectable)	100°/sec to 14 400°/sec (÷ 20 rotations/sec), full FOV	0°/sec to 60°/sec [10]
Angular Step Width Δ ϑ (vertical), Δ φ (horizontal)	0.002° ≤ Δ ϑ ≤ 0.280° [11] between consecutive laser shots	0.002° ≤ Δ φ ≤ 3° [11] between consecutive scan lines
Angle Measurement Resolution	better than 0.0005° (1.8 arcsec)	better than 0.0005° (1.8 arcsec)
Inclination Sensors	integrated, for vertical scanner setup position, details see page 2	
GPS Receiver	integrated, L1, with antenna	
Compass	integrated, for vertical scanner setup position, details see page 2	
Laser Plummet	integrated	
Internal Sync Timer	integrated, for real-time synchronized time stamping of scan data	
Scan Sync (optional)	scanner rotation synchronization	
Waveform Data Output (optional)	providing digitized echo signal information for specific target echoes	

10) Frame scan can be disabled, providing 2D scanner operation.
11) Selectable.

General Technical Data

Power Supply Input Voltage / Power Consumption	11 - 32 V DC / typ. 75 W (max. 90 W)
External Power Supply	up to 3 independent external power sources can be connected simultaneously for uninterrupted operation
Main Dimensions / Weight	248 x 226 x 450 mm (length x width x height), approx. 14.5 kg
Humidity / Protection Class	max. 80 % non condensing @ +31°C / IP64, dust-proof and splash-proof
Temperature Range	
Storage / Operation	-10°C up to +50°C / 0°C up to +40°C (standard operation)
Low Temperature Operation [12]	-20°C: continuous scanning operation if instrument is powered on while internal temperature is at or above 0°C and still air

Integrated Digital Camera

field of view 7.2°x5.5° (v x h)
resolution 2560 x 1920 pixels (5 Mpixel)

Display

7" WVGA (800 x 480) color
capacitive touchscreen, full operation control for stand alone usage

12) Insulating the scanner with appropriate material will enable operation at even lower temperatures.

RIEGL® LASER MEASUREMENT SYSTEMS

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