

RIEGL VZ-400i

- **high laser pulse repetition rate of up to 1.2 MHz**
- **high speed data acquisition up to 500,000 measurements/sec**
- **eye safe operation at Laser Class 1**
- **wide field of view 100°x360°**
- **range up to 800 m, accuracy 5 mm**
- **high accuracy, high precision ranging based on echo digitization, online waveform processing, and multiple-time-around processing**
- **new, innovative processing architecture for data acquisition and simultaneous geo-referencing, in real-time**
- **easy to use – easy to train (user friendly touchscreen interface, single touch operation, etc.)**
- **automatic scan data registration with RiSOLVE**
- **cloud connectivity via Wi-Fi and 3G/4G LTE**
- **multiple target capability**
- **optional full waveform data output**
- **MEMS IMU for pose estimation**

The **RIEGL VZ-400i** is a cutting-edge 3D Laser Scanning System which combines a future-oriented, innovative new processing architecture and internet connectivity with **RIEGL's** latest laser scanning engine technology.

This real-time data flow is enabled through dual processing platforms: a dedicated processing system for data acquisition, waveform processing and system operations, and a second processing platform which enables real-time data registration, geo-referencing, filtering and analysis to be executed simultaneously. Real-time functionality is under development, continuous improvements will be available via online firmware updates. The VZ-400i provides an integrated 3G/4G LTE modem, Wi-Fi, and Ethernet communications hardware.

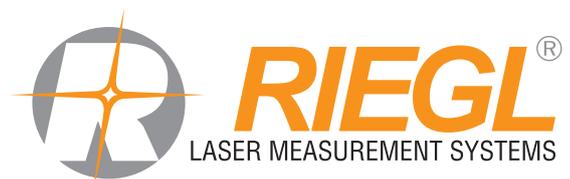
With its integrated gyroscope, accelerometer, compass, and barometer, the VZ-400i's up to 1200 kHz pulse repetition rate can be fully utilized in many environments and orientations. The system provides a high range of flexibility by supporting numerous external peripherals and accessories via its integrated USB ports and stable mounting points.



Typical applications include

- **As-Built Surveying**
- **Architecture & Facade Measurement**
- **Archeology & Cultural Heritage Documentation**
- **Building Infrastructure Management (BIM)**
- **Forensics & Crash Scene Investigation**
- **City Modeling**
- **Tunnel Surveying**
- **Civil Engineering**
- **Forestry**
- **Research**
- **Monitoring**

visit our website
www.riegl.com



Camera Option

A high-precision mount enables the **integration of an optional DSLR camera**. The camera can be easily integrated into the mount by means of two screws. Precise position and orientation of the camera is enabled by three supporting points. Power supply and a USB 3.0 interface are provided via the scanner directly. The combination of scanner, software, and camera results in photorealistic 3D data, exact identification of details, positions, and distance measurements, as well as a re-creation of any virtual point of view.

External GNSS Receiver with Bluetooth Connection

To support precise global scan data registration, the *RIEGL VZ-400i* offers an interface for a high-end external third party GNSS receiver that is to be mounted on top of the instrument. For smooth operation in the field, GNSS data is transferred to the scanner via Bluetooth transmission or cable.

Lightweight Carbon Tripod

RIEGL offers a lightweight carbon tripod to support a quick and smooth workflow in data acquisition.

Power Supply via Rechargeable Batteries

The *RIEGL VZ-400i* can be connected to the following optionally available rechargeable batteries:

- >> *RIEGL* Add-On NiMH Rechargeable Battery (97.2 Wh)
- >> NiMH Battery (235 Wh, delivered by *RIEGL*)

LiPo Batteries (type 4s, 6s or 8s) can also be used but are not offered by *RIEGL*. In case users want to use LiPo Batteries with the scanner, *RIEGL* optionally provides a special „VZ-400i LiPo connection cable“.

Waveform Data Output Option

The digitized echo signals, also known as full waveform data, acquired by the *RIEGL VZ-400i* 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.

RIEGL Software Packages for Users

- >> **RISCAN PRO** standard processing software for efficient data acquisition and registration in terrestrial laser scanning
- >> **RISOLVE** for automatic registration, colorization, and 2D-map generation
- >> **RiMINING** optimized workflow for open-pit mining

RIEGL Software Packages for Software Developers

- >> **RiVLib** library for developing customized software to acquire and process .rxp data streams
- >> **RiMTA TLS** for automated resolution of range ambiguities



RIEGL Add-On NiMH Rechargeable Battery

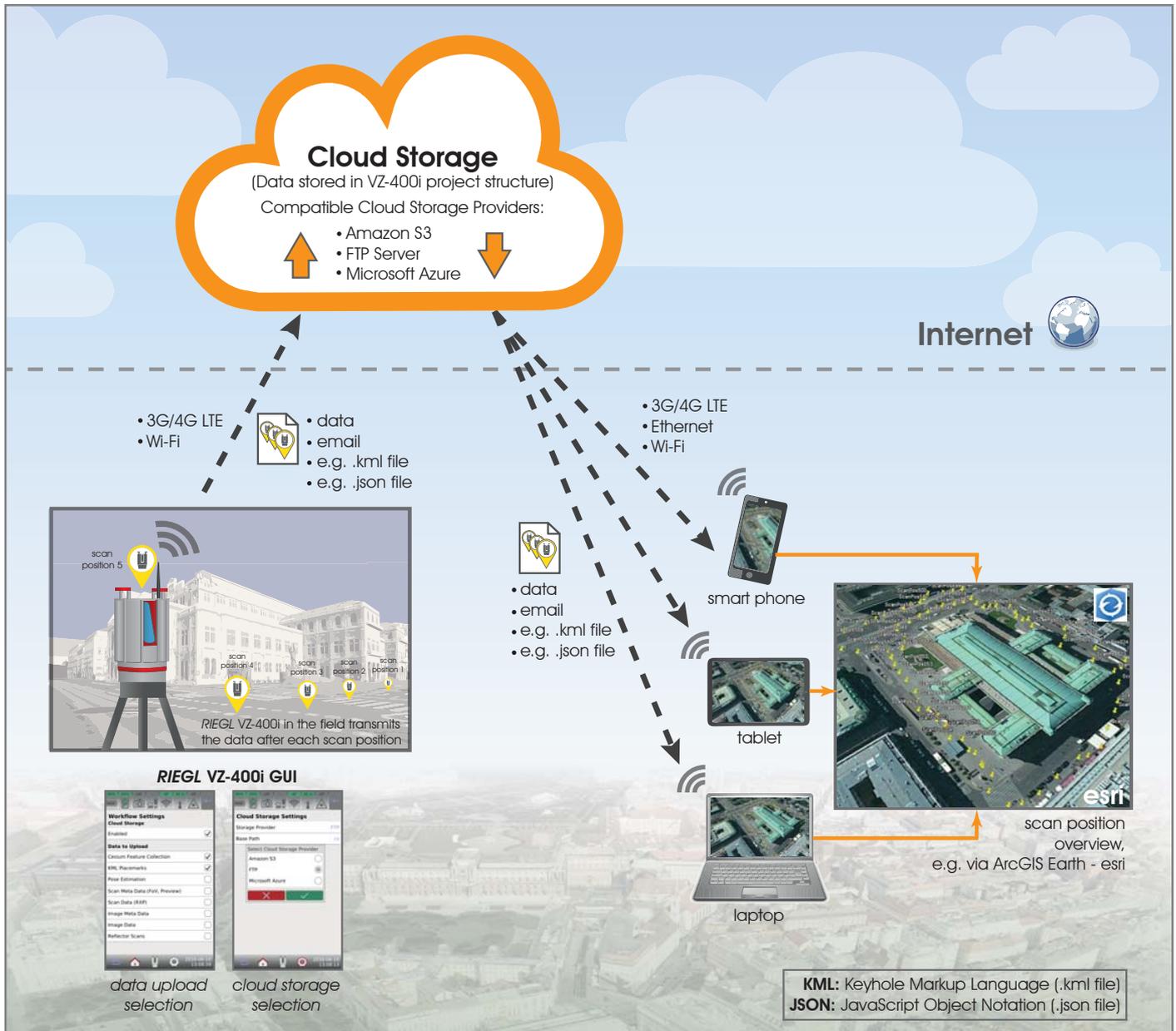
NiMH Battery



The RIEGL VZ-400i provides cloud connectivity by internet connection via either the 3G/4G LTE or Wi-Fi network.

The content to be uploaded to, stored, and downloaded from the cloud, as well as the appropriate cloud storage provider or ftp server are user definable. The defined data then is transferred to the cloud after finishing each scan position. In the cloud, data is stored in the VZ-400i's project structure.

Supported cloud storage currently includes Amazons S3 and Microsoft Azure.



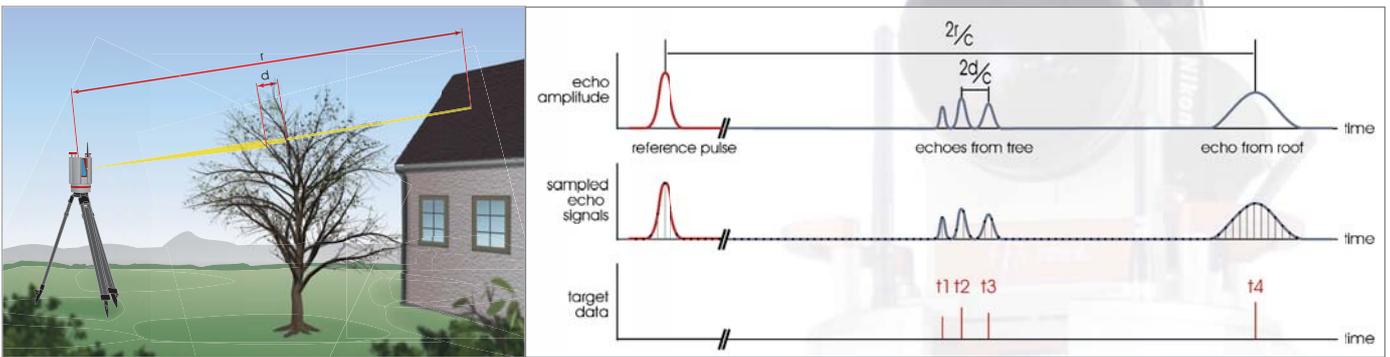
Data that can be transferred include

- >> the scanner's position in WGS84 geographic coordinates as *.kml and *.json
- >> scan data preview as *.png image
- >> thumb-nails of the images as *.jpg
- >> scan data itself as *.rxp (available transmission bandwidth has to be considered)
- >> image data itself as *.jpg
- >> error messages

RIEGL's sophisticated LiDAR technology is the basis for highly informative scan data. Every laser pulse received provides several attributes in addition to the range measurement information. By using different features and filters provided with the scanner's software, this information can be used to dramatically improve the informative content of point clouds.

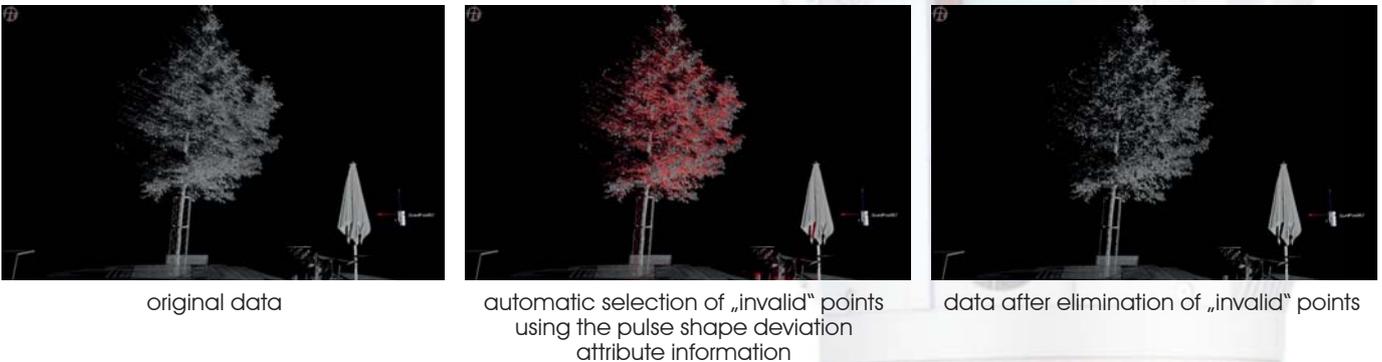
Multi Target Capability - the basis for High Penetration Capability

The ranging technique of pulsed time-of-flight ranging, as used in the VZ-400i, offers the possibility to determine the range to all targets a single laser pulse is interacting with. Depending on the measurement program used, the maximum number of targets, which can be detected, is varying.



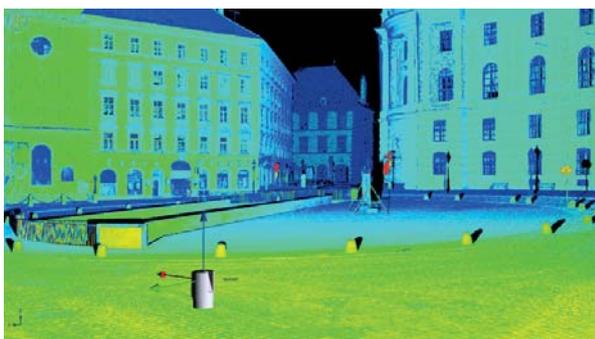
Pulse Shape Deviation Output

Even if the distance between two targets is too short to discriminate between two echoes, valuable information about the pulse shape of the return pulse is given. That allows to discriminate whether the return echo originates from a single target or from two nearby targets. A simple thresholding with respect to the pulse shape information can remove most of „invalid“ points and keep only the reliable „real“ targets.

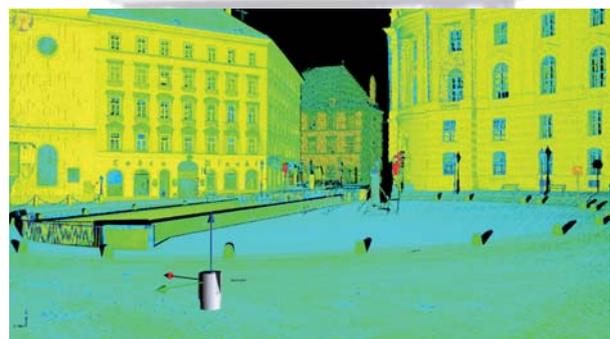


Calibrated Reflectance Output

This feature allows displaying the scan data colored by range-independent reflectance of the scanned object for better data classification.



point cloud colored by the range-depending amplitude



point cloud colored by the range-independent reflectance

Rain and Fog Penetration

Using deviation and reflectance filters, rain drops and fog can be identified and the interfering measurement points can be eliminated resulting in a clear and clean point cloud of the relevant scene.



scanning in the rain



point cloud before filter application



automatically cleaned-up point cloud

VZ-400i – a NEW Standard in User-Friendliness



The system provides a number of useful **features** that help to make the user experience better overall. Operation of the *RIEGL VZ-400i* is easy with the integrated **Graphical User Interface (GUI)** via touch-screen, or by remote control of the scanner via VNC Viewer with any tablet PC or mobile device using Wi-Fi connection.

Different degrees of scan data registration are supported by on-board **inclination sensors**, integrated **L1 GPS receiver**, an interface for a **high-end external GNSS receiver** on top of the scanner (now also via Bluetooth connection), a **digital compass**, and a built-in **SSD data storage media**.

Scanner Motion Detection

Several pre-defined data acquisition workflows (e.g. Default, Forensics, OneTouch) are available. These **pre-defined workflows** allow the operation of the scanner by pushing just one icon on the screen per scan position. After the tripod has then been re-arranged, the scan position will be automatically incremented. Modifications or creations of own workflows to meet individual user requirements are possible.



select the appropriate scanning parameters and start the first scan



move scanner to next scan position



to start the next scan just press the START-button

Apps

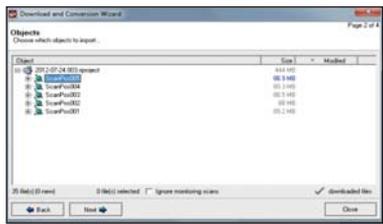
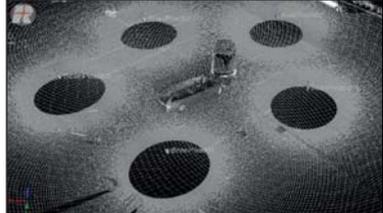
Helpful **Apps** for further improvement of processing of surveying missions are provided, self-developed Apps (written in Python software language) can be uploaded into the scanner.



Automatic Registration with RIEGL RiSOLVE

RiSOLVE enables a fully automatic registration and colorization of scan data. This stream-lined process is the fastest solution to acquire, register, and colorize outdoor 3D scan data. With additional tools for filtering, scene animation and measurements, RiSOLVE enables a rapid turnaround of critical information.

Workflow: 5 easy steps

	<p>Scan</p> <ul style="list-style-type: none"> • 20+ million measurements • 5 high-resolution images • precise inclination data • GNSS position • compass bearing 	<p>With the new VZ-400i*: 75 seconds per position</p>	
	<p>Import</p> <ul style="list-style-type: none"> • download project • import from USB flash drive • create project structure 	<p>1 minute per position</p>	
	<p>Register</p> <p>Automatic Registration:</p> <ol style="list-style-type: none"> 1) position estimation via: inclination, GPS & compass 2) course registration 3) fine adjustment 	<p>less than 1 minute per position</p>	
	<p>Color</p> <p>One-Click Color:</p> <ul style="list-style-type: none"> • utilizes calibrated images • automatically adjusts frame • colorizes point cloud 	<p>less than 1 minute per position</p>	
	<p>Plot</p> <ul style="list-style-type: none"> • automatically selects region • exportable to PDF • plot to image 		

* @ scan resolution= 0.05 deg

RiSOLVE Key Features:

- >> fully automatic registration and colorization of scan data
- >> fastest solution to acquire, register, and colorize outdoor 3D scan data
- >> rapid turnaround of critical information with additional tools for filtering, scene animation and measurements.
- >> takes the complexity out of the registration process by utilizing positioning information provided by sensors integrated into VZ-Line scanners.
- >> enables a final, fine adjustment of all scans to produce a seamless, fully registered point cloud.



Field Experience

The VZ-400i is one of the fastest terrestrial scanners on the market. Its high performance scanning technology provides high pulse repetition rates and high line scan speeds as well as user-friendliness, enabling a significant reduction of scanning time in the field.

1 operator

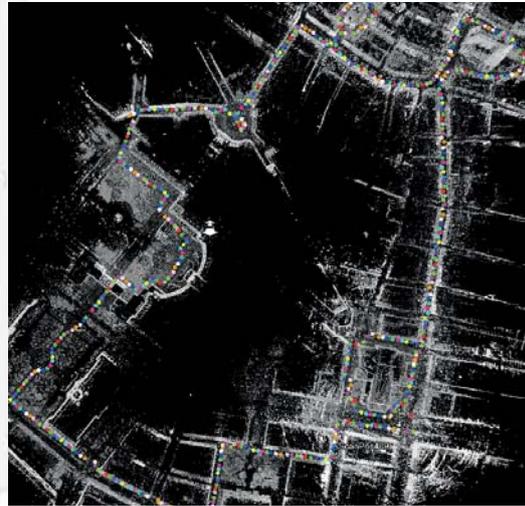
8 hours

500+ scans

With the field experience example of 3D data acquisition in the city center of Vienna the VZ-400i furnishes proof of this. More than 500 scans (50mdeg) of approx. 5 km of city center roads with adjoining buildings have been taken by just one operator within 8 hours of full acquisition time in the field. The mission was done during night, the data of the whole scene was acquired by taking individual scan positions with approx. 10 m distance in between.



RIEGL VZ-400i night scan



scan positions overview

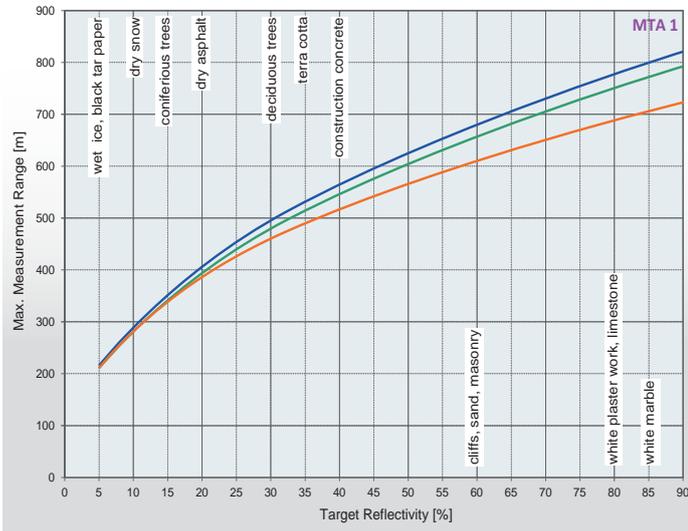


scan data detail, reflectance scaled

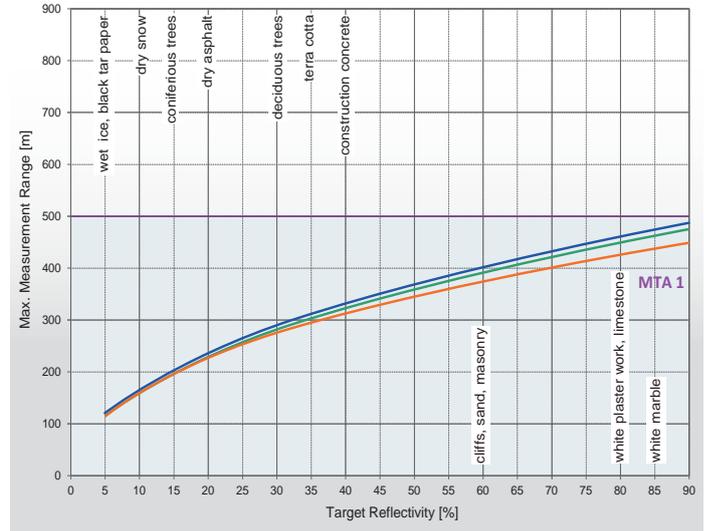


■ standard clear atmosphere: visibility 23 km
■ clear atmosphere: visibility 15 km
■ light haze: visibility 8 km

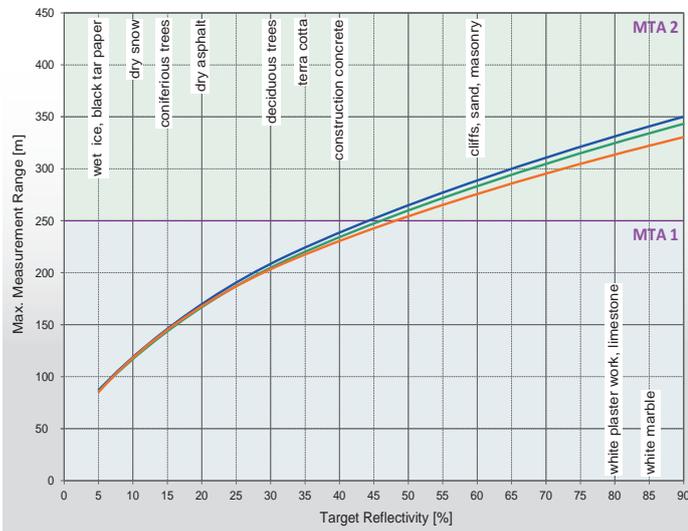
100 kHz Laser Pulse Repetition Rate



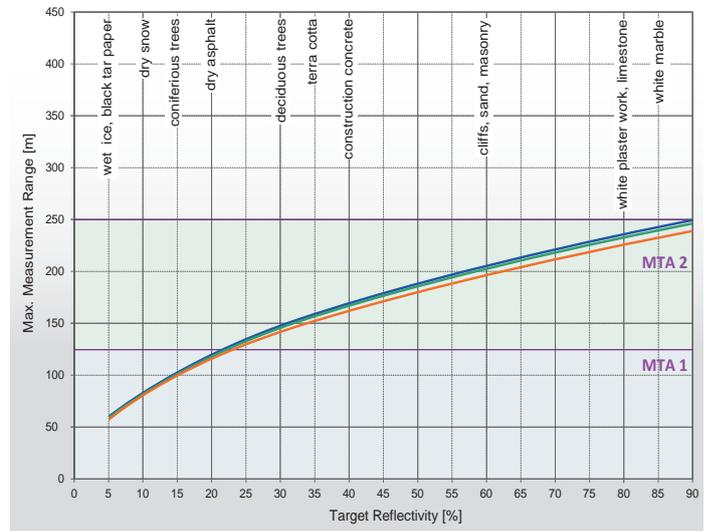
300 kHz Laser Pulse Repetition Rate



600 kHz Laser Pulse Repetition Rate ¹⁾



1200 kHz Laser Pulse Repetition Rate ¹⁾



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 within RISCAN PRO

MTA (Multiple Time Around) zones:

- MTA 1: no ambiguity / 1 pulse „in the air“
- MTA 2: 2 pulses „in the air“

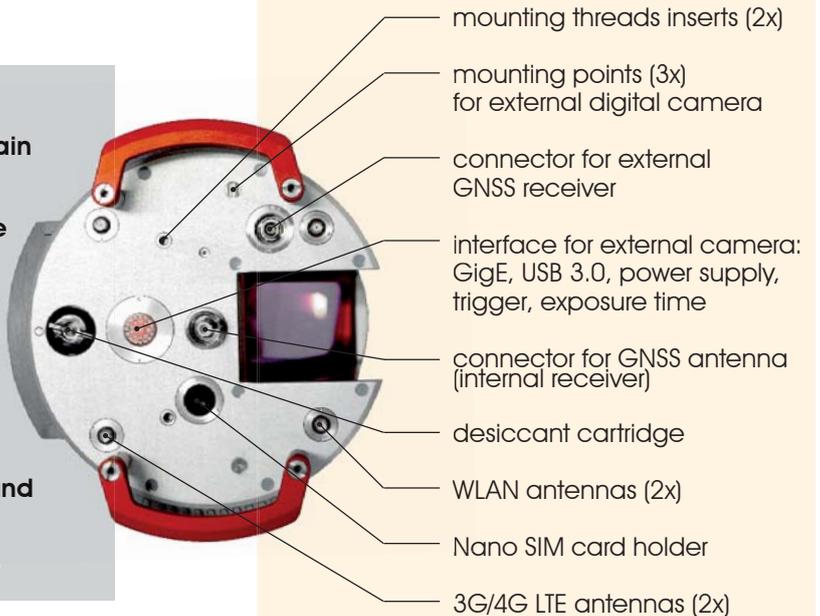
¹⁾ To avoid multiple-time-around issues, it is crucial to select a lower laser pulse repetition rate.



All dimensions in mm.

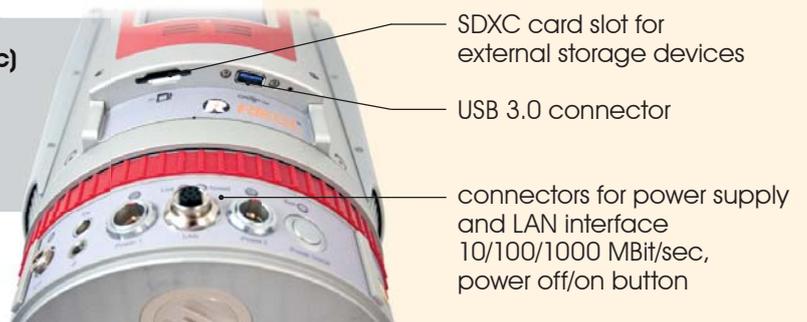
Communication and Interfaces

- LAN port 10/100/1000 MBit/sec
- integrated WLAN interface with high-gain MIMO antennas
- integrated multi-mode cellular module with MIMO 3G/4G LTE antennas
- GigE and USB 3.0 for connecting an external digital camera
- connector for GNSS antenna
- two external power supply ports
- connector for external GNSS receiver and synchronization (1PPS)
- Bluetooth connection to GNSS receiver



Scan Data Storage

- internal 256 GBytes SSD (Solid State Disc)
- external storage devices (SDXC cards up to 512 GBytes or USB 3.0 flash drives)



Technical Data *RIEGL* VZ[®]-400i

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.



Range Measurement Performance ¹⁾

Measuring Principle / Mode of Operation

time of flight measurement, echo signal digitization, online waveform processing, multiple-time-around processing, full waveform export capability (optional) / single pulse ranging

Laser Pulse Repetition Rate PRR (peak) ²⁾	100 kHz	300 kHz	600 kHz ³⁾	1200 kHz ³⁾
Effective Measurement Rate (meas./sec) ²⁾	42,000	125,000	250,000	500,000
Max. Measurement Range ⁴⁾				
natural targets $\rho \geq 90\%$	800 m	480 m	350 m	250 m
natural targets $\rho \geq 20\%$	400 m	230 m	160 m	120 m
Minimum Range	1.5 m	1.2 m	0.5 m ⁵⁾	0.5 m ⁵⁾
Max. Number of Targets per Pulse	15	15	8	4

Accuracy ^{6) 8)}

5 mm

Precision ^{7) 8)}

3 mm

Laser Wavelength

near infrared

Laser Beam Divergence

0.35 mrad ⁹⁾

1) With online waveform processing.

2) Rounded values.

3) To avoid multiple-time-around issues, it is crucial to select a lower laser pulse repetition rate.

4) 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.

5) Minimum range specified for vertical zenith angles from 30 deg to 120 deg, resp. 90° vertical field of view.

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 @ 100 m range under *RIEGL* test conditions.

9) Measured at the 1/e² points. 0.35 mrad corresponds to an increase of 35 mm of beam diameter per 100 m distance.

Scanner Performance

Scan Angle Range

Vertical (Line) Scan

total 100° (+60° / -40°)

Horizontal (Frame) Scan

max. 360°

Scanning Mechanism

rotating multi-facet mirror

rotating head

Scan Speed

3 lines/sec to 240 lines/sec

0°/sec to 150°/sec ¹¹⁾

Angular Step Width ¹⁰⁾ $\Delta \theta$ (vertical), $\Delta \phi$ (horizontal)

$0.0007^\circ \leq \Delta \theta \leq 0.6^\circ$

between consecutive laser shots

$0.0015^\circ \leq \Delta \phi \leq 0.62^\circ$

between consecutive scan lines

Angle Measurement Resolution

better 0.0007° (2.5 arcsec)

better 0.0005° (1.8 arcsec)

Orientation Sensors (MEMS)

integrated 3-axis accelerometer, 3-axis gyroscope,

3-axis magnetometer (compass), barometer

integrated L1, concurrent reception of GPS, GLONASS, Beidou

integrated

integrated, for real-time synchronized time stamping of scan data

scanner rotation synchronization

providing digitized echo signal information for specific target echoes

Amazon S3, FTP-Server, Microsoft Azure

available approx. end of 2016

GNSS Receiver

Laser Plummet

Internal Sync Timer

Scan Sync (optional)

Waveform Data Output (optional)

Cloud Storage

Real-time registration

10) Selectable.

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

General Technical Data

Power Supply Input Voltage

11 - 34 V DC

Power Consumption

typ. 58 W (max. 80 W)

External Power Supply

up to three independent external power sources can be connected

for uninterrupted operation

206 mm x 308 mm (width x height)

approx. 9.7 kg (with antennas)

max. 80 % non condensing @ +31°C

IP64, dust- and splash-proof

Main Dimensions

Weight

Humidity

Protection Class

Temperature Range

Storage

Operation

Low Temperature Operation ¹²⁾

-10°C up to +50°C

0°C up to +40°C: standard operation

-20°C: continuous scanning operation if instrument is powered on while internal temperature is at or above 0°C and still air

-40°C: scanning operation for about 20 minutes if instrument is powered on while internal temperature is at or above 15°C and still air

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



RIEGL Laser Measurement Systems GmbH
Riedenburgstraße 48
3580 Horn, Austria
Phone: +43 2982 4211 | Fax: +43 2982 4210
office@riegl.co.at
www.riegl.com

RIEGL USA Inc.
Orlando, Florida | info@rieglusa.com | www.rieglusa.com

RIEGL Japan Ltd.
Tokyo, Japan | info@riegl-japan.co.jp | www.riegl-japan.co.jp

RIEGL China Ltd.
Beijing, China | info@riegl.cn | www.riegl.cn

www.riegl.com