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

Preliminary Data Sheet
VZ®-400i Optional Equipment and Software

- **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
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
VZ®-400i Highly Informative Scan Data

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](image1)

![point cloud before filter application](image2)

![automatically cleaned-up point cloud](image3)

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), an 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](image4)

![move scanner to next scan position](image5)

![to start the next scan just press the START-button](image6)

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.
RiSOLVE enables a fully automatic registration and colorization of scan data. This streamlined 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.

**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.**

### Workflow: 5 easy steps

**Scan**  
- 20+ million measurements  
- 5 high-resolution images  
- Precise inclination data  
- GNSS position  
- Compass bearing  

**Import**  
- Download project  
- Import from USB flash drive  
- Create project structure  

**Register**  
**Automatic Registration:**  
1. Position estimation via:  
   - Inclination, GPS & compass  
2. Course registration  
3. Fine adjustment  

**Color**  
**One-Click Color:**  
- Utilizes calibrated images  
- Automatically adjusts frame  
- Colorizes point cloud  

**Plot**  
- Automatically selects region  
- Exportable to PDF  
- Plot to image  

*With the new VZ-400i*:  
75 seconds per position  

*Download project*  
1 minute per position  

*Course registration*  
less than 1 minute per position  

*Fine adjustment*  
less than 1 minute per position  

*One-Click Color*  
less than 1 minute per position  

*Plot*  
less than 1 minute per position  

*Scan resolution = 0.05 deg*
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.

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.
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.
Operating Elements and Connectors RIEGL VZ®-400i

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)

All dimensions in mm.
## 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**

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

<table>
<thead>
<tr>
<th>Laser Pulse Repetition Rate PRR (peak)</th>
<th>100 kHz</th>
<th>300 kHz</th>
<th>600 kHz</th>
<th>1200 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Measurement Rate (meas./sec)</td>
<td>42,000</td>
<td>125,000</td>
<td>250,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Max. Measurement Range</td>
<td>800 m</td>
<td>480 m</td>
<td>350 m</td>
<td>250 m</td>
</tr>
<tr>
<td>natural targets ( \geq 90 % )</td>
<td>400 m</td>
<td>230 m</td>
<td>160 m</td>
<td>120 m</td>
</tr>
<tr>
<td>natural targets ( \geq 20 % )</td>
<td>1.5 m</td>
<td>1.2 m</td>
<td>0.5 m</td>
<td>0.5 m</td>
</tr>
<tr>
<td>Minimum Range</td>
<td>15</td>
<td>15</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Max. Number of Targets per Pulse</td>
<td>5 mm</td>
<td>3 mm</td>
<td>near infrared</td>
<td>0.35 mrad</td>
</tr>
</tbody>
</table>

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.

**Scanner Performance**

Scan Angle Range
- Vertical (Line) Scan
- Horizontal (Frame) Scan

Scan Speed
- Scan Angle Range
- Scan Mechanism
- Scan Speed

Angular Step Width
- \( \Delta \vartheta \) (vertical), \( \Delta \varphi \) (horizontal)

Angle Measurement Resolution

Orientation Sensors (MEMS)
- GNSS Receiver
- Laser Plummets
- 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
- typ. 58 W (max. 80 W)
- up to three independent external power sources can be connected for uninterrupted operation

External Power Supply
- 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
- -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.

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**Contact Information**

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

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