High Speed, High Performance Dual Scanner Mobile Mapping System

Typical Applications
- Transportation Infrastructure Mapping
- Road Surface Measurement
- HD mapping for autonomous vehicles
- City Modeling
- Rapid Capture of Construction Sites and Bulk Material
- Open-Pit Mine Surveying
- GIS Mapping and Asset Management
- As-Built Surveying
RIEGL VMX-2HA at a glance

RIEGL VMX-2HA Key Features

Proven System
The RIEGL VMX-2HA is the consistent further development of the compact RIEGL VMX Mobile Mapping System. The alignment and placement of the two VUX-1HA (High Accuracy) scanners keeps within the proven VMX tradition with a simultaneous forward/backward looking to reduce scan shadows.
A compact dual scanner platform carries both, LiDAR sensors and a high-grade IMU/GNSS subsystem and provides an accurate and long-term stable system calibration.

VMX-2HA Scan Pattern

<table>
<thead>
<tr>
<th>1 MHz program</th>
<th>line spacing of a single scanner (mm)</th>
<th>point spacing within a scan-line of a single scanner (mm)</th>
<th>point spacing within a scan-line of a single scanner (mm)</th>
<th>point spacing within a scan-line of a single scanner (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>platform speed</td>
<td>pattern @ 3m distance</td>
<td>VMX-2HA point density</td>
<td>VMX-2HA point density</td>
<td>VMX-2HA point density</td>
</tr>
<tr>
<td>platform speed 50km/h</td>
<td>56</td>
<td>4.7</td>
<td>7640</td>
<td>15.7</td>
</tr>
<tr>
<td>platform speed 80km/h</td>
<td>89</td>
<td>4.7</td>
<td>4774</td>
<td>15.7</td>
</tr>
<tr>
<td>platform speed 120km/h</td>
<td>133</td>
<td>4.7</td>
<td>3184</td>
<td>15.7</td>
</tr>
</tbody>
</table>

New Camera System and Features
The VMX-2HA impresses with an extremely enhanced camera performance and a number of new features. Camera interface and SYNC of up to 9 external devices are included in the basic system configuration. Multiple high-resolution RIEGL cameras allow for unique capture angles and a high degree of details in the images. The interface between the VMX-MH (Measuring Head) with scanners and cameras and the VMX-CU (Control Unit) was completely re-designed.

The VMX-CU (equipped with a high performance 7th generation Intel Core i7 processor) precisely controls management of power, data acquisition, and operation of the laser scanners, INS/GNSS sensors and the optional cameras. A 10 GigE network and a set of SSD storage media with a total of 6 TB disk space enable big data handling for uninterrupted data recording of comprehensive missions.

The modular design of the system provides unique flexibility to meet a diversity of project requirements. Ready to be mounted on road and off-road vehicles, as well as on trains and boats, it provides the user with the technology and tools to ensure full data capturing for transportation infrastructure, facades, overhead structures, power lines, bridges, tunnels etc.

Seamless RIEGL Workflow
A handy touch-screen and the RIEGL data acquisition software facilitate the operator’s task in the field by providing real-time visualization of acquired scan data and imagery. The RIEGL software packages also offer comprehensive features in data processing. This covers enhanced scan data adjustment to merge overlapping mobile scan data. Furthermore it enables the scan data to be fitted to specific control objects which results in a consistent point cloud of enhanced precision and increased geo-referenced accuracy. Finally, the precise geo-referenced scan data and high resolution (panorama) images can be exported to well-known file formats, or interfaced directly with third-party software.

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**RIEGL VMX-2HA Components and Setup**

- **RIEGL VUX-1HA laser scanners**
- **GNSS antenna**
- **IMU**
- **Interfaces to optional external devices**
- **Harting® connector for RIEGL VMX-MC Main Cable**
- **trigger & time stamping unit**
- **protective cover**
- **camera extension mounting pole**
- **up to 7 RIEGL cameras**
- **RIEGL VMX-RM Roof Mount**
**RIEGL VMX-2HA Camera Options**

**Camera System**

The VMX-2HA Mobile Mapping System provides interface and SYNC for up to 9 external devices and allows flexible combination of different camera configurations.

- high-sensitivity 5MP and 12MP RIEGL cameras
- spherical camera FLIR Ladybug® 5+
- DSLR camera such as Nikon D850 or Sony Alpha

The modular setup of the system allows to change or upgrade the camera configuration any time. The provided camera ports enable unique flexibility to select an optimal position and orientation of the cameras to meet the specific project requirements. Each single camera can be mounted and dismounted smoothly with accurate reproducibility of camera position and orientation.

The new integration of the spherical Ladybug 5+ camera improves time stamping and enables fully integrated operation within the RIEGL system operating software.

Multiple 5MP or 12MP RIEGL cameras can be used to enable full capture of the surrounding. The rear port is optimized to carry a close to NADIR downward looking camera for detailed capturing of the road surface to improve pavement analysis and crack indexing.

As high-resolution cameras such as the 12 MP RIEGL camera triggered with 8 fps require up to 1GigE bandwidth the data transfer to the VMX-2HA Control Unit is realized by a 10GigE interface.

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### Camera Options

<table>
<thead>
<tr>
<th>Camera Options 1)</th>
<th>max. numbers of cameras</th>
<th>max. frames2) per second</th>
<th>resolution [px (H) x px (V)]</th>
<th>pixel size [µm]</th>
<th>lens focal length [mm]</th>
<th>Field of View (FOV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 MP CMOS 3)</td>
<td>9</td>
<td>20</td>
<td>2464 x 2056</td>
<td>3.45</td>
<td>5</td>
<td>80.7° x 70.7°</td>
</tr>
<tr>
<td>12 MP CMOS 3)</td>
<td>9</td>
<td>8</td>
<td>4112 x 3008</td>
<td>3.45</td>
<td>8 / 16</td>
<td>83.1° x 65.9° / 47.8° x 35.9°</td>
</tr>
<tr>
<td>FLIR Ladybug® 5+</td>
<td>1 unit / 6 lens</td>
<td>19</td>
<td>6 x [2048x2448]</td>
<td>3.45</td>
<td>4.4</td>
<td>90% of full sphere</td>
</tr>
<tr>
<td>Nikon® D850</td>
<td>9</td>
<td>1</td>
<td>8256 x 5504</td>
<td>4.34</td>
<td>14 / 20</td>
<td>104° x 81° / 83° x 61°</td>
</tr>
</tbody>
</table>

1) The combination of different cameras is possible.
2) Maximum frame rate of a single camera operated in 8-bit mode. The use of multiple cameras may reduce maximum frame rates.
3) A user defined “Region of Interest” can be defined during data acquisition, resulting in a reduction of the FOV and the resolution. This may help to reduce image file sizes on the one hand and to further increase frame rates on the other hand.
Specifications RIEGL Cameras

RIEGL offers special high-sensitive 5MP and 12MP cameras with leading edge CMOS technology for high resolution images, high frame rates, and minimized lens distortion.

The camera’s CMOS global shutter sensor is responsible for a higher dynamic range, less smearing effects caused by sunlight, greater details in shadows and highlights, low temporal dark noise for more signal gain up to 40dB.

The system provides 6 side-facing and one backward facing camera mounting options.

Up to 6 Side-Facing Cameras

These cameras are optimized for capturing traffic signs, overhead structures, building structures, and facades.

Camera Key Features:
- cantilever-mounted cameras reducing the occurrence of car shadows
- forward/backward facing positions enabling different view angles on objects
- ball-joint camera heads with ± 50deg v×h rotation for flexible adjustment of the camera positions

Backward Facing Camera

The rear port is optimized to carry a close to nadir downward looking camera offering

- detailed capturing of the road surface
- reliable data for pavement analysis and crack indexing
- little distortion of projected image on road surface

Camera Key Features:
- up to 20 fps1) per camera @ 5MP
- 1.1 m distance @ 80 km/h
- small pixel footprint of 1.4 mm @ 2 m
- very short exposure time (0.1ms) to avoid motion blur 1.6 pixel blur @ 80 km/h

1) A user defined “Region of Interest” can be defined during data acquisition, resulting in a reduction of the FOV and the resolution. This may help to reduce image file sizes on the one hand and to further increase frame rates on the other hand.
RIEGL VMX-2HA System Block Diagram

RIEGL VMX-2HA System Components:
- RIEGL VMX-MH Measuring Head
- RIEGL VMX-CU Control Unit
- VMX-DMI Distance Measurement Indicator
- up to 9 cameras (optional)
- sustainable power supply with back-up battery
- single VMX-MC Main Cable with Harting® connectors

RIEGL VMX-2HA Dimensions and Weight

<table>
<thead>
<tr>
<th>Weight and Dimensions</th>
<th>Weight (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMX-MH Measuring Head (without cameras)</td>
<td>39 kg</td>
</tr>
<tr>
<td>VMX-RM Roof Mount</td>
<td>12.5 kg</td>
</tr>
<tr>
<td>VMX-RM Mounting Kit (Thule wing bars with Thule mountings)</td>
<td>4.8 kg</td>
</tr>
<tr>
<td>VMX-MC Main Cable (5m length)</td>
<td>5 kg</td>
</tr>
<tr>
<td>VMX-CU Control Unit</td>
<td>25 kg</td>
</tr>
<tr>
<td><strong>RIEGL cameras</strong></td>
<td></td>
</tr>
<tr>
<td>12 MP camera</td>
<td>1.65 kg</td>
</tr>
<tr>
<td>5 MP camera</td>
<td>1.25 kg</td>
</tr>
<tr>
<td>camera extension mounting pole</td>
<td>1.2 kg</td>
</tr>
<tr>
<td>FLIR Ladybug® 5+ Kamera (with cabling and mounting)</td>
<td>9 kg</td>
</tr>
</tbody>
</table>

all dimensions in mm
### RIEGL VMX-2HA Technical Data

#### VMX-2HA Scanner Performance

<table>
<thead>
<tr>
<th>Effective Measurement Rate</th>
<th>Laser Class 1 (Class 1 Laser Product according to IEC 60825-1:2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 kHz</td>
<td>1 MHz</td>
</tr>
<tr>
<td>1 MHz</td>
<td>1.5 MHz</td>
</tr>
<tr>
<td>2 MHz</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max. Range, Target Reflectivity ≥ 80%</th>
<th>Max. Range, Target Reflectivity ≥ 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>420 m</td>
<td>150 m</td>
</tr>
<tr>
<td>330 m</td>
<td>120 m</td>
</tr>
<tr>
<td>270 m</td>
<td>100 m</td>
</tr>
<tr>
<td>235 m</td>
<td>85 m</td>
</tr>
</tbody>
</table>

Max. Number of Targets per Pulse: Practically unlimited (details on request)

Minimum Range: 1.2 m

Accuracy / Precision:
- 5 mm / 3 mm

Field of View: 360° "full circle"

Scan Speed (selectable): Up to 500 scans/sec

1) Rounded values, selectable by measurement program.
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) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.
5) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.
6) One sigma @ 30 m range under RIEGL test conditions.

### IMU/GNSS Performance

<table>
<thead>
<tr>
<th>IMU/GNSS Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position Accuracy (absolute)</td>
</tr>
<tr>
<td>Roll &amp; Pitch Accuracy</td>
</tr>
<tr>
<td>Heading Accuracy</td>
</tr>
</tbody>
</table>

7) One sigma values, no GNSS outage, with DMI option, post-processed using base station data.

### General Technical Data

<table>
<thead>
<tr>
<th>VMX-CU Power Supply Input Voltage</th>
<th>11 - 15 V DC powered by on-board source (e.g. alternator)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMX-MH Power Supply Input Voltage</td>
<td>11 - 15 V DC backup power</td>
</tr>
<tr>
<td>Typ. Power Consumption</td>
<td>24 V DC (powered via VMX-CU)</td>
</tr>
<tr>
<td>system operation without cameras</td>
<td>Typ. 250 W / max. 1020 W</td>
</tr>
<tr>
<td>additional power consumption per camera</td>
<td>Typ. 6 W / max. 34 W</td>
</tr>
</tbody>
</table>

Protection Class VMX-MH with camera system: IP64

<table>
<thead>
<tr>
<th>Temperature Range VMX-MH with camera system</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10°C up to +40°C (operation) / -20°C up to +50°C (storage)</td>
</tr>
<tr>
<td>0°C up to +40°C (operation) / -20°C up to +50°C (storage)</td>
</tr>
</tbody>
</table>

Interface VMX-CU to VMX-MH: Single main cable for power & data interface with robust Harting® connectors

Humidity: Max. 80% non condensing @ +31°C
## Data Interfaces

### VMX-MH Measuring Head

- 9 x multi-purpose ports supporting complementary camera systems and additional devices, each with
  - trigger pulse
  - precise time stamping of exposure pulse
  - NMEA data
  - PPS
  - LAN 1GigE
  - power 24V DC, max. 34 W

### VMX-CU Control Unit

- 1 x DMI input (for distance measuring indicator; odometer)
- 1 x NAV RS-232 (COM port for IMU/GNSS for RTK, SBAS)
- 1 x AUX +12V DC
- 1 x touch screen incl. USB (for system operation)
- 1 x HDMI (additional video output)
- 1 x Display Port (additional video output)
- 2 x LAN, 1000 Mbit/sec (e.g. connect additional computer)
- 4 x USB 3.0
- 2 x USB 3.0 specific configuration for FLIR Ladybug® 5+
- 4 x removable double SSD drive carrier with a of total 6TB swappable disc space
- wireless communication via Bluetooth, WLAN and LTE

### VMX-MC Main Cable (single cable connection between VMX-MH and VMX-CU) with 10 GigE Link

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**Further Information**

Watch our videos!

youtube.com/rieglidar