RIEGL Mobile Mapping Systems
Optional Camera Systems

Much more than colorizing your scan data ...

RIEGL Mobile Mapping Systems can be used with a wide range of cameras, including *RIEGL* directional cameras with GigE vision interface as well as high resolution spherical cameras.

These camera systems are seamlessly integrated into the entire acquisition and processing workflow.

Various *RIEGL* software features are supporting the combination of point clouds with images to achieve deliverables such as colored point clouds, true ortho photos and gapless 360° panorama images.

RIEGL®

RIEGL Camera Hardware Solutions

RIEGL Mobile Mapping Systems are ready to work with *RIEGL* cameras, spherical cameras and DSLR cameras - depending on the user-specific applications and requirements.
For an overview, see table on page 3.

RIEGL Cameras

RIEGL offers high-sensitive ball-joint directional cameras with leading edge CMOS technology for high resolution images, high frame rates, and minimized lens distortion. The camera's CMOS global shutter sensor provides a high dynamic range, hardly any smearing effects caused by sunlight, great details in shadows and highlights, and low temporal dark noise. These cameras offer precise leveling and project-specific alignment in landscape and portrait orientation.

The *RIEGL* cameras are provided in two designs: „ball-shaped" cameras and „tube-shaped" cameras. Depending on the type of mobile mapping system and camera, different mounting options are available. Horizontal camera alignment allows landscape picture acquisition. A specific *RIEGL* pavement mount enables nadir and tilted camera orientation to capture high-resolution images of the road surface.

***RIEGL* Camera Options** [1) 2)]	tube- | ball-shaped	max. frames [3)] per second	resolution [px (H) x px (V)]	pixel size [µm]	lens focal length [mm]	Field of View (FOV) [4)]
5 MP RAW	✓ | ✓	20	2464 x 2056	3.45	5	80.7° x 70.7°
5 MP JPEG [5)]	✓ | ✗	30	2465 x 2056	3.45	5	80.7° x 70.7°
12 MP RAW	✓ | ✓	8	4112 x 3008	3.45	8 / 16	83.1° x 65.9° / 47.8° x 35.9°
12 MP JPEG [5)]	✓ | ✗	17	4112 x 3008	3.45	8 / 16	83.1° x 65.9° / 47.8° x 35.9°
24 MP RAW	✓ | ✓	4.5	5328 x 4608	2.74	8.5	81.3° x 73.1°
24 MP JPEG [5)]	✓ | ✗	9	5328 x 4608	2.74	8.5	81.3° x 73.1°

1) A user defined „region of interest" can be definied during data acquisition, resulting in a reduction of the FOV and resolution. This may help to reduce image file sizes on the one hand and to further increase frame rates on the other hand.
2) The *RIEGL* cameras require the usage of the VM-IU Interface Unit respectively of the VMX-CU.
3) Maximum frame rate of a single camera operated with 8-bit color depth. The use of multiple cameras may reduce the maximum frame rates.
4) Nominal values (actual values may be slightly different due to manufacturing tolerances)
5) @ 90% image compression.

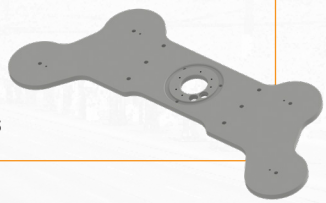
RIEGL camera types

ball-shaped cameras

- for application in harsh environments (e.g. rail applications)
- desiccant cartridge and nitrogen purging valve integrated on the rear side
- directly mounted to the camera mounting plate
- IP65 rated
- two types of connectors on the rear side
- camera heads can be turned 45° in any direction

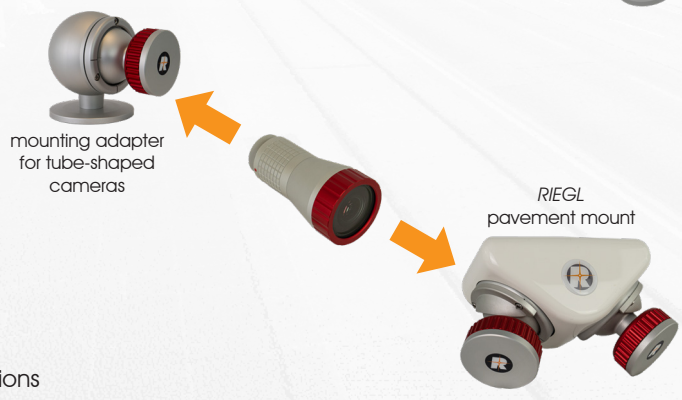
RIEGL camera mounting plate

- for 2 *RIEGL* cameras at different mounting positions
- support of ball-shaped as well as tube-shaped cameras (using the appropriate mounting adapter)
- mounting for 1 spherical camera
- primarily designed for VMQ- and VMY-series



tube-shaped cameras

- support real-time JPEG compression
  - to increase max. frame rates
  - for less storage requirements in data acquisition and post processing
- IP64 rated
- camera heads can be turned 50° in any direction



RIEGL tube-shaped camera mounting

- mounting adapter for smooth integration available
- special pavement imaging system (2 tube-shaped cameras and pavement mount)
- plug-and-play swap between different mounting options

RIEGL Mobile Mapping Systems

Overview with possible

Camera Types

RIEGL VMY-1 | *RIEGL* VMY-2 | *RIEGL* VMQ-1HA, *RIEGL* VMQ-3HA | *RIEGL* VMX-2HA, *RIEGL* VMX-3HA | *RIEGL* VMX-RAIL

RIEGL cameras tube-shaped 	max. 2	max. 2	max. 2	max. 9	–
	or	or	or	or	
RIEGL cameras ball-shaped 	max. 2	max. 2	max. 2	max. 9	max. 6
RIEGL pavement mount 	✓ [1]	✓	✓	✓	–
spherical camera 	✓	✓	✓	✓	✓
DSLR camera 	4	4	4	–	–
max. number of cameras	4	4	4	9	6

1) -15° and +15° swivel position not possible with the use of a pavement camera system.

The combination of different camera types is possible. Please note, this list is intended as an overview.

RIEGL Integration Examples

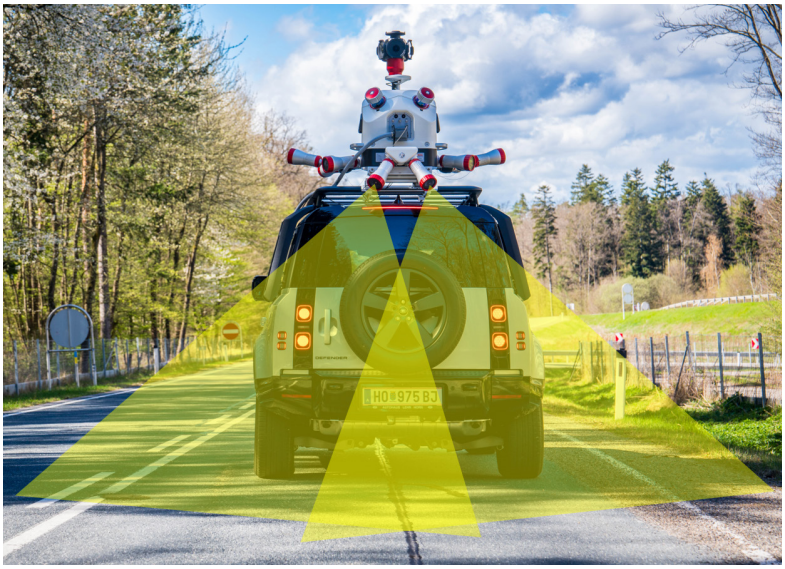
RIEGL VMQ-1HA
with Ladybug 6 and Pavement Mount for two *RIEGL* tube-shaped cameras; two special mounting adapters at the front are ready to also carry these cameras for landscape data acquisition

RIEGL VMY-2
with Mosaic X

RIEGL VMX-2HA
with 6 horizontally aligned *RIEGL* cameras (6 x 24 MP), the *RIEGL* pavement camera system (2 x 12 MP) as well as a 72 MP Ladybug 6 spherical camera system

RIEGL Pavement Mount

Using the *RIEGL* pavement mount two *RIEGL* tube-shaped cameras are mounted close to nadir orientation to enable detailed capturing of the road surface. Depending on the selected orientation of the two cameras, the user can focus on a single lane width with a minimal ground sampling distance (GSD) or on multiple lane acquisition with larger GSD.



close to nadir camera orientation

***RIEGL* pavement camera system advantages:**

- detailed capturing of the road surface
- high-resolution images for pavement analysis and crack indexing
- generation of true-orthophotos with a GSD within millimeter range
- complements blind spots in spherical imaging systems to achieve 360° gapless panoramas

Spherical Cameras

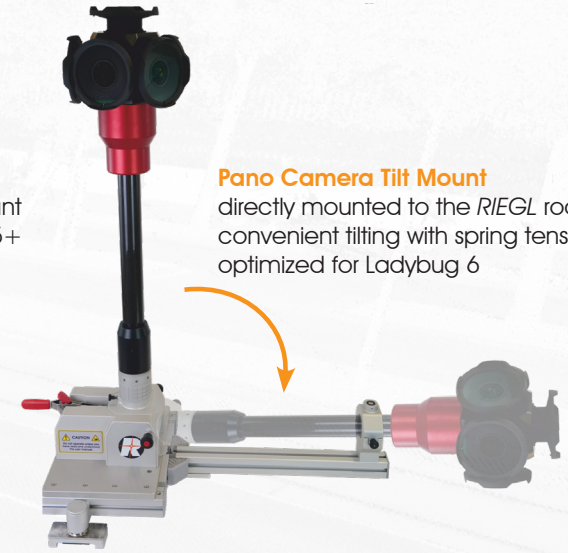
Spherical camera systems with global shutter sensors are essential in mobile mapping to generate high quality panorama images. For specific cameras, *RIEGL* provides appropriate integration kits including mechanical mounting and cabling. Level of integration with *RIEGL* acquisition and post-processing software is depending on the specific type of camera – details on request.

Camera Types	Ladybug 5+	Ladybug 6	MOSAIC X
Resolution	30 MPx	72 MPx	72 MPx
Frame Rate	17 fps	12 fps	7 fps
Data Management	VM-IU / VMX-CU acquisition laptop via USB		USB drive data storage inside camera

RIEGL VMX-2HA with directional cameras, and Ladybug 6

Pano Camera Fix mount

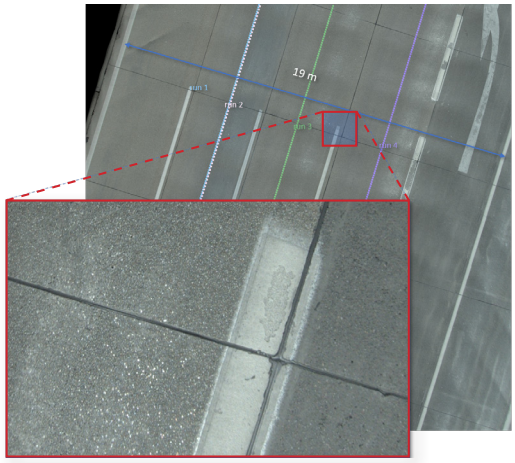
directly mounted to the *RIEGL* Roof Mount compatible with Ladybug 6 / Ladybug 5+ and MOSAIC X



Pano Camera Tilt Mount

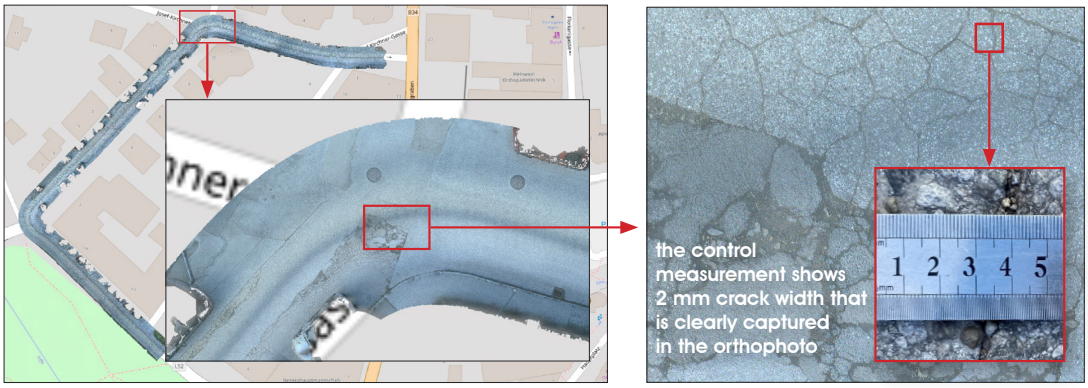
directly mounted to the *RIEGL* roof mount, convenient tilting with spring tension optimized for Ladybug 6

RIEGL Software Features



Orthophoto

Highly accurate and precise point clouds combined with high-resolution pavement images enable high quality ortho photo production within the *RIEGL* post processing workflow. Depending on the camera hardware used, ortho photos with smooth and homogeneous color transitions can be exported with a ground resolution in the millimeter range.
Ortho photos from different acquisition runs can be generated for arbitrary road geometries including ramps, steep curves, crossings as well as multi lane roads resulting in georeferenced disjunctive tiles.



application example of pavement data acquisition with subsequent generation of true ortho photos (RiPROCESS)

Gap Fill Panos

A *RIEGL* post-processing software feature enables to close gaps in panorama images acquired in typical road environment. Blind spots beneath the car as well as parts of the acquisition platform and the mobile mapping system can be masked out in the source panorama to be replaced by images taken from a different perspective. For gap filling, images from adjacent frame epochs of the spherical camera system or high-resolution pavement imagery can be used. The best possible ground sampling distance for gap filling can be achieved by supplementing the spherical camera with a *RIEGL* pavement camera system.
The use case shows an up to 134 MP[1)] Ladybug 6 panorama image generated by FLIR's camera SDK (left image), further enhanced in *RIEGL* post-processing by gap-filling with high-resolution pavement imagery (right image).

Ladybug 6 panorama image with up to 134 MP[1)] with user-defined masks of areas to be gap-filled

RIEGL gapless high-resolution 360° panorama

1) Please refer to Ladybug 6 technical notes regarding supported panorama image resolutions beyond 72 MP sensor resolution.

Colored Point Cloud

RGB color information for the point cloud is extracted of the precisely geo-referenced images. All supported camera types provide precise time stamping and lens calibration as a pre-requisite for high quality point cloud coloring.

Contact us

www.riegl.com