AIRBORNE LASER SCANNER

LMS-Q560

FOR FULL WAVEFORM ANALYSIS

The *RIEGL* LMS-Q560 is a revolutionary 2D laser scanner using the latest state-of-the-art digital signal processing, which meets the most challenging requirements in airborne laser scanning.

The *RIEGL* LMS-Q560 gives access to the detailed target parameters by digitizing the echo signal online during data acquisition, and subsequent off-line waveform analysis. This method is especially valuable when dealing with difficult tasks, such as canopy height investigation or target classification.

The operational parameters of the *RIEGL* LMS-Q560 can be configured to cover a wide field of applications. Comprehensive interface features support smooth integration of the instrument into complete airborne scanning systems.

The instrument makes use of the time-of-flight distance measurement principle of nanosecond infrared pulses. Fast opto-mechanical beam scanning provides absolutely linear, unidirectional and parallel scan lines. The instrument is extremely rugged, therefore ideally suited for the installation on aircraft. Also, it is compact and lightweight enough to be installed in small twin- or single-engine planes, helicopters or UAVs. The instrument needs only a single voltage power supply and GPS timing signals to provide online monitoring data while logging the precisely time-stamped and digitized echo signal data to the rugged *RIEGL* Data Recorder.

- ***waveform analysis for unlimited number of target echoes***
- ***high laser pulse repetition rate up to 240 kHz***
- ***high mean measurement rate up to 160 kHz***
- ***high ranging accuracy up to 20 mm***
- ***interface for smooth integration of GPS***
- ***eye safe for operation at any altitude***
- ***parallel scan lines***
- ***compact and rugged design, single power supply***
- ***wide operating temperature range***

Echo Digitization of the *RIEGL* LMS-Q560

The digitization feature of the *RIEGL* LMS-Q560 enables the user to extract most comprehensive information from the echo signals. Figure 1 illustrates a measurement situation where 3 laser measurements are taken on different types of targets. The red pulses symbolize the laser signals travelling towards the target with the speed of light. When the signal interacts with the diffusely reflecting target surface, a fraction of the transmitted signal is reflected towards the laser instrument, indicated by the blue signals.

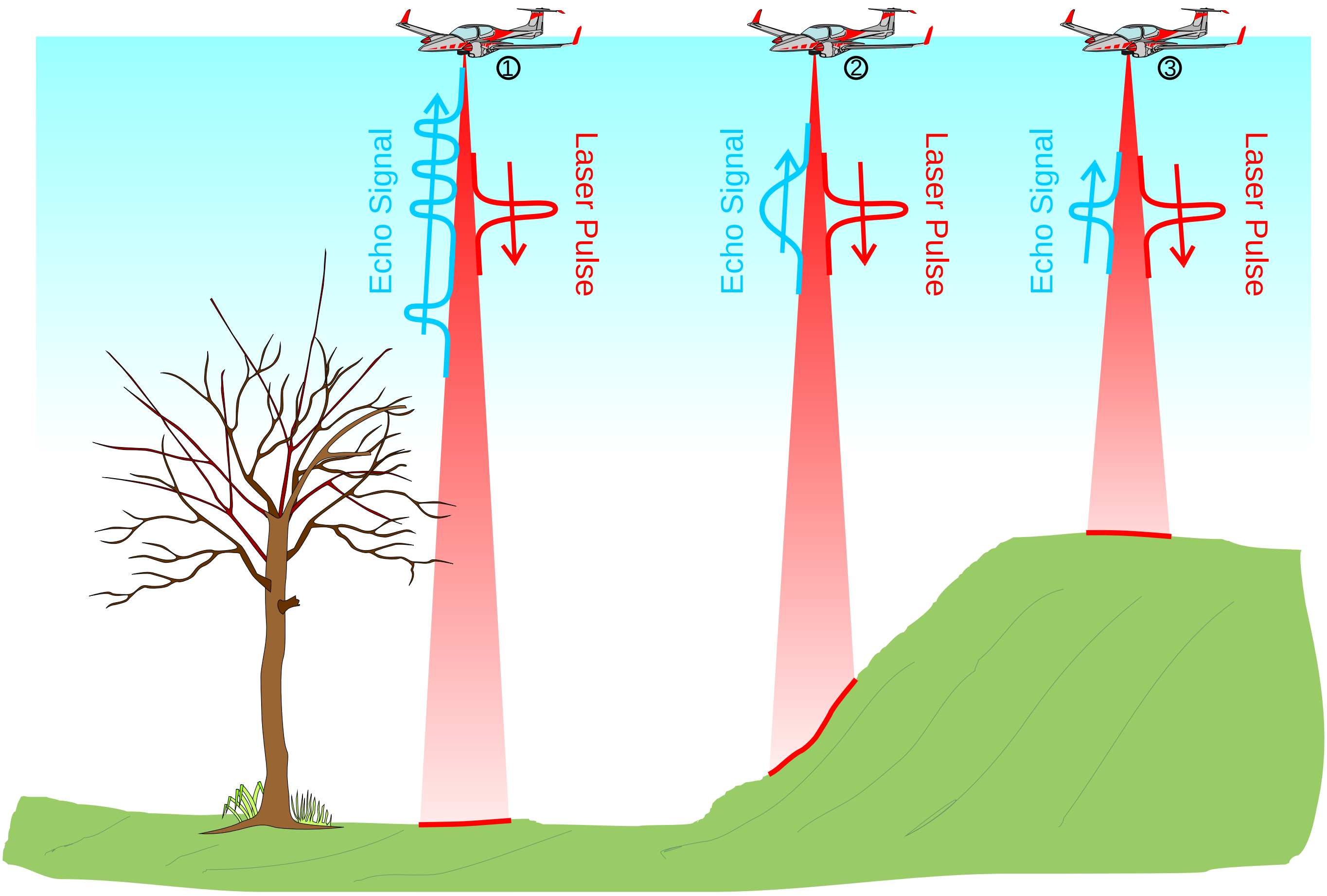


Fig. 1 Echo signals resulting from different types of targets

In situation 1, the laser pulse hits the canopy first and causes three distinct echo pulses. A fraction of the laser pulse also hits the ground giving rise to another echo pulse. In situation 2, the laser beam is reflected from a flat surface at a small angle of incidence yielding an extended echo pulse width. In situation 3, the pulse is simply reflected by a flat surface at normal incidence resulting in one single echo pulse with a shape identical to the transmitted laser pulse.

Echo Digitization of the *RIEGL* LMS-Q560

The upper line of the acquisition diagram shows the analog signals: the first (red) pulse relates to a fraction of the laser transmitter pulse, and the next 3 (blue) pulses correspond to the reflections by the branches of the tree; the last pulse corresponds to the ground reflection.
This analog echo signal is sampled at constant time intervals (middle line) and is, in the following, analog to digital converted, resulting in a digital data stream (bottom line of the acquisition section). This data stream is stored in the *RIEGL* Data Recorder for subsequent off-line post processing, as indicated in the post-processing section of the diagram.

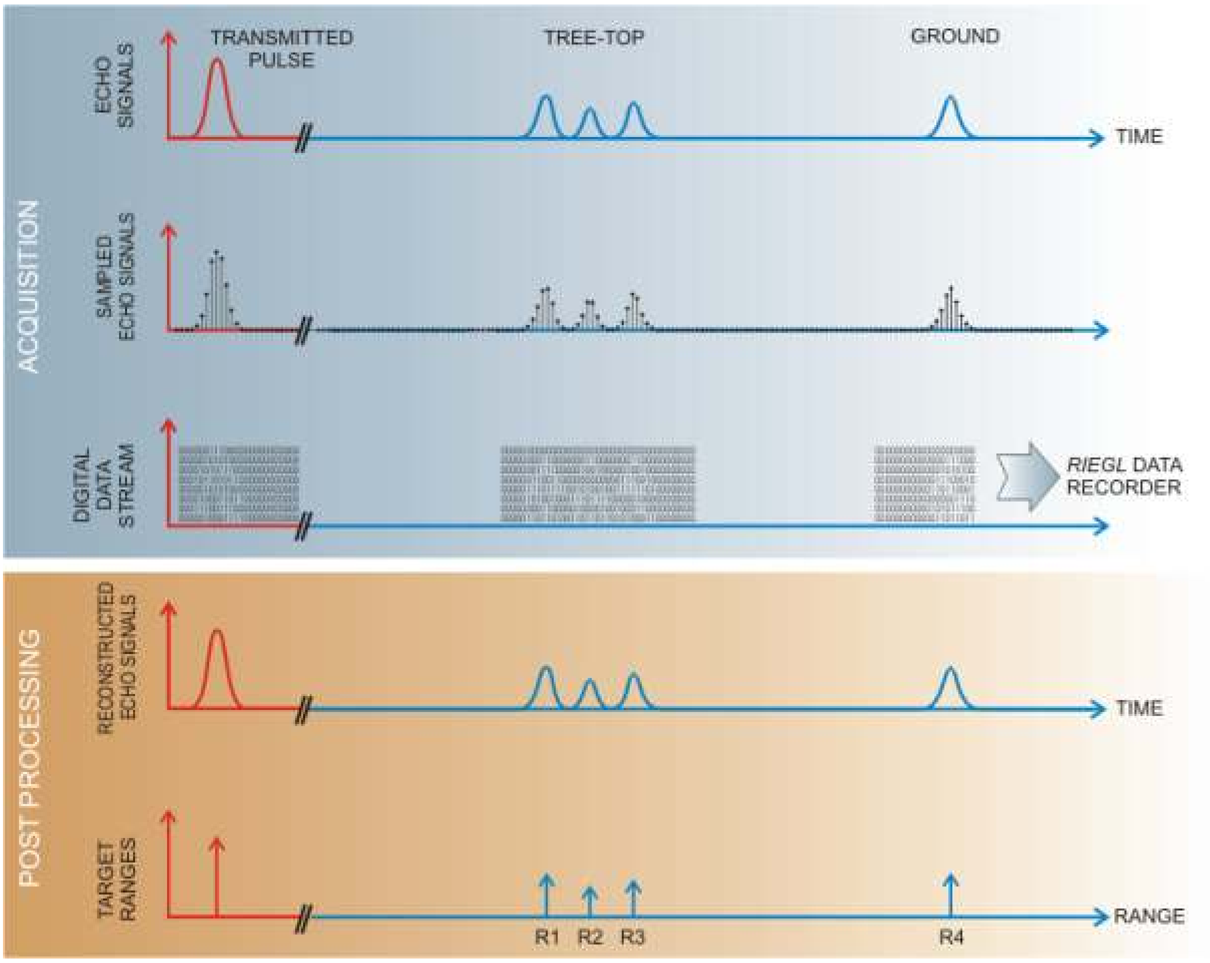


Fig. 2 Data acquisition and post processing

Based upon *RIEGL's* long-standing expertise and experience in designing, manufacturing and marketing digitizing laser rangefinders for challenging industrial and surveying applications, and due to the careful design of the analog and digital front-end electronics, the LMS-Q560 records the complete information of the echo signal over a wide dynamic range. Thus, in post-processing the signal can be perfectly reconstructed and analyzed in detail to derive target distance, target type, and other parameters precisely.

Technical Data of *RIEGL* LMS-Q560

Range Measurement Performance

as a function of PRR and target reflectivity

Laser Pulse Repetition Rate	*50 kHz*	*100 kHz*	*180 kHz*	*200 kHz*	*240 kHz*
max. Unambiguous Measurement Range[1]					
natural target r ³ *20 %*	1200 m	1000 m	780 m	700 m	580 m
natural target r ³ *60 %*	1800 m	1200 m	800 m	700 m	580 m
typ. Operating Flight Altitude AGL[2]	1000 m 3280 ft	800 m 2630 ft	600 m 1970 ft	550 m 1800 ft	450 m 1480 ft

1) The following conditions are assumed: • target is larger than the footprint of the laser beam • normal angle of incidence • visibility 23 km • average ambient brightness

2) Reflectivity r ³ 20 %, max. scan angle 60 deg, additional roll angle +/- 5 deg

Minimum Range	30 m
Accuracy[3) 4)]	20 mm
Precision[3) 5)]	10 mm
Laser Pulse Repetition Rate[6)]	up to 240 000 Hz
Effective Measurement Rate	up to 120 kHz @ 45 deg scan angle up to 160 kHz @ 60 deg scan angle
Laser Wavelength	near infrared
Laser Beam Divergence[7)]	≤ 0.5 mrad
Number of Targets per Pulse	digitized waveform processing: unlimited[8)] online monitoring data output: first pulse or last pulse
Eye Safety Class	CLASS 1 LASER PRODUCT according to IEC60825-1:1993+A1:1997+A2:2001 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 July 26, 2001.

Scanner Performance

Scanning Mechanism	rotating polygon mirror
Scan Pattern	parallel scanning lines
Scan Angle Range	± 22.5 deg = 45 deg total (± 30 deg = 60 deg total[9)])
Scan Speed	10 - 160 scans/sec
Angle Step Width D J[6)] between consecutive laser shots	D J ³ 0.004 deg (for PRR in excess of 100 000 Hz[10)])
Angle Readout Resolution	0.001 deg

3) Standard deviation one sigma @ 250 m range under *RIEGL* test conditions.
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) User selectable
7) 0.5 mrad corresponds to 50 cm increase of beam width per 1000 m distance
8) Practically limited only by the maximum data rate allowed for the *RIEGL* Data Recorder
9) Up to 60 deg with 90% of maximum measurement range
10) Minimum angle step width increasing linearly to 0.008 deg @ 50000 Hz laser pulse repetition rate

Intensity Measurement

For each echo signal, high-resolution 16-bit intensity information is provided which can be used for target discrimination and/or identification/classification.

Data Interfaces

Configuration	TCP/IP Ethernet (10/100 MBit), RS232 (19.2 kBd)
Monitoring data output	TCP/IP Ethernet (10/100 MBit)
Digitized data output	High speed serial data link to *RIEGL* Data Recorder
GPS-System	Serial RS232 interface, TTL input for 1pps synchronization pulse, accepts different data formats for GPS-time information

General Technical Data

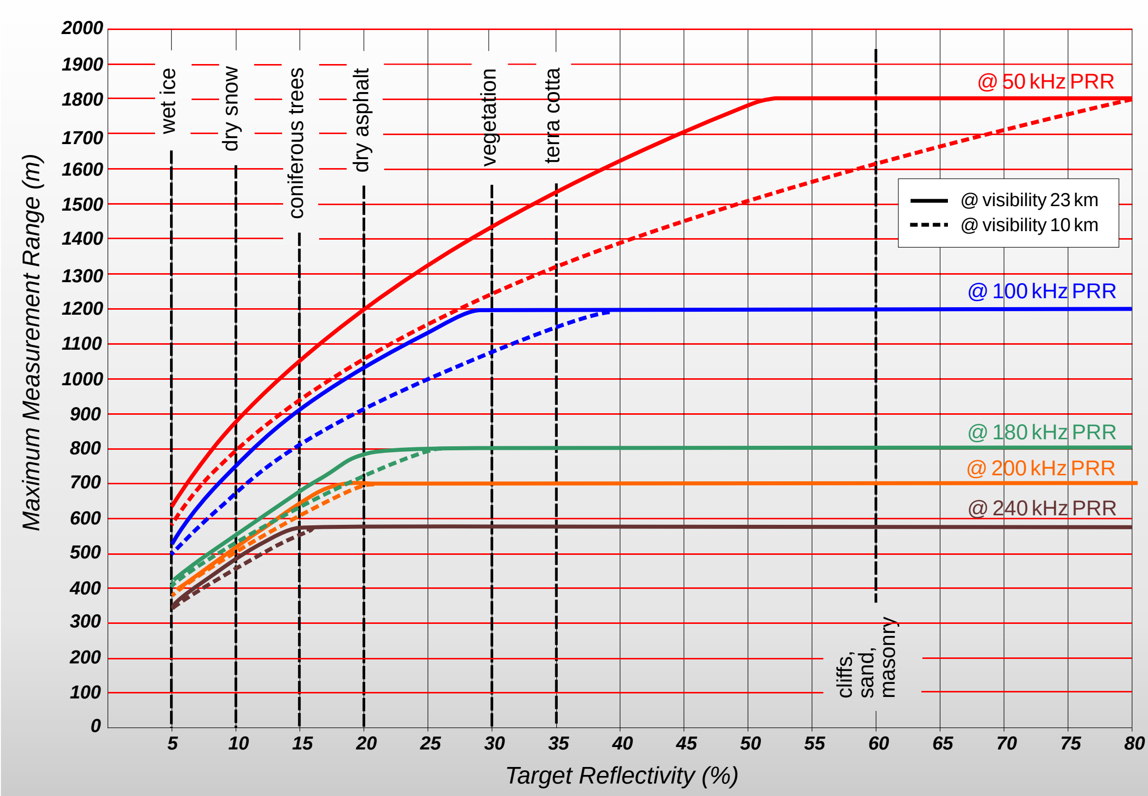
Power Supply	18 - 32 VDC
Current Consumption	approx. 5 A @ 24 VDC
Main Dimensions (L x W x H)	420 x 212 x 228 mm
Weight	16 kg
Protection Class	IP54
Temperature Range	0°C up to +40°C (operation) / -10°C up to +50°C (storage)
Mounting of IMU-Sensor	Steel thread inserts on the top of the laser scanner, rigidly connected to the inner structure of the scanning mechanism

Data sheet-01, LMS-Q560, 15/01/2008

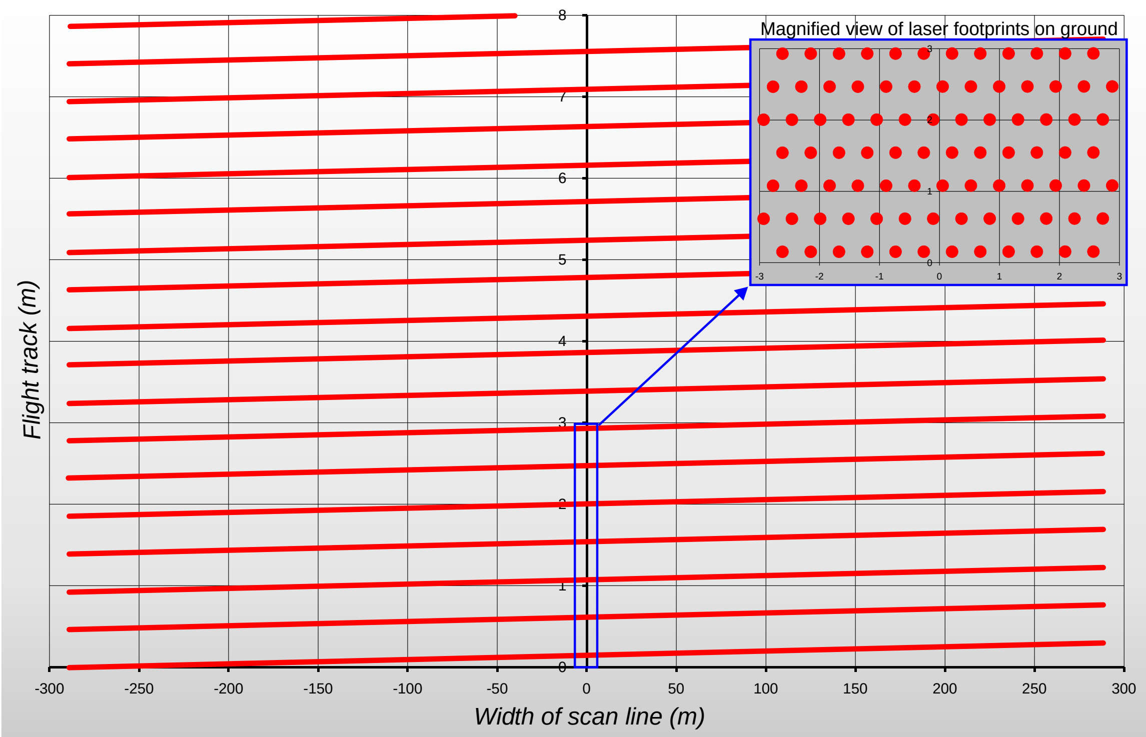
RIEGL
LASER MEASUREMENT SYSTEMS
www.riegl.com

RIEGL Laser Measurement Systems GmbH, A-3580 Horn, Austria
Tel.: +43-2982-4211, Fax: +43-2982-4210, E-mail: office@riegl.co.at
RIEGL USA Inc., Orlando, Florida 32819, USA
Tel.: +1-407-248-9927, Fax: +1-407-248-2636, E-mail: info@rieglusa.com
RIEGL Japan Ltd., Tokyo 1640013, Japan
Tel.: +81-3-3382-7340, Fax: +81-3-3382-5843, E-mail: info@riegl-japan.co.jp

RIEGL LMS-Q560 Maximum Measurement Range and Scan Pattern

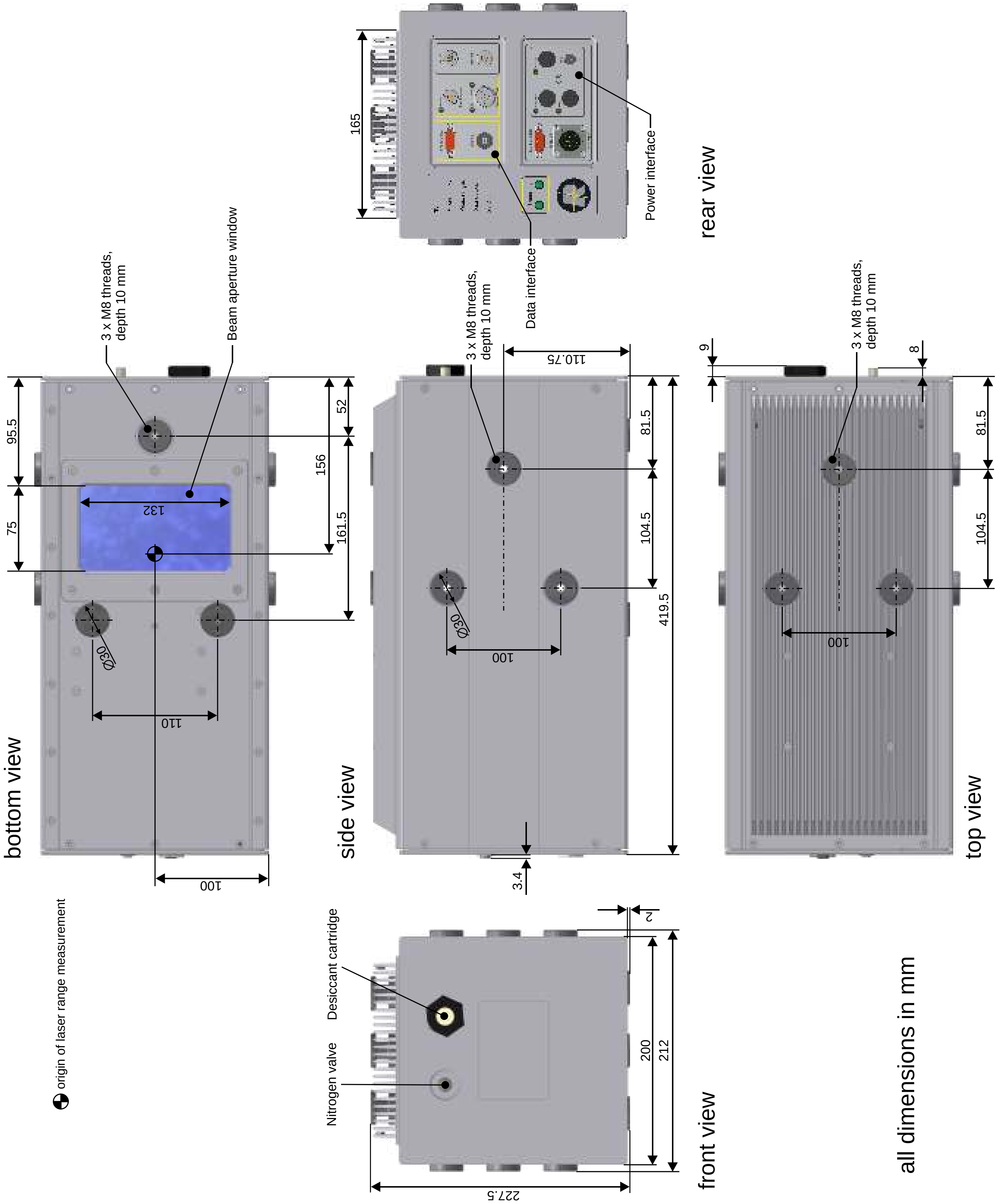


The following conditions are assumed:
Flat target larger than footprint of laser beam, perpendicular angle of incidence, average brightness



Example of scan pattern on ground:
Scan & flight parameters: PRR = 200 kHz, 120 scans/s, FOV 60 deg, flight altitude 500 m (1640 ft.) AGL, airspeed 200 km/h (108 kt)
Resulting scan pattern on ground: point spacing within a scanline = 0.47 m (mean value), width of scan line = 577 m, distance between consecutive scan lines = 0.46 m, # of laser measurements per square meter = 4.2 pts/m^2

RIEGL LMS-Q560 Dimensional Drawings



Information contained herein is believed to be accurate and reliable. However, no responsibility is assumed by *RIEGL* for its use. Technical data are subject to change without notice.

Data sheet-02, LMS-Q560, 15/01/2008

RIEGL LASER MEASUREMENT SYSTEMS
www.riegl.com

RIEGL Laser Measurement Systems GmbH, A-3580 Horn, Austria
Tel.: +43-2982-4211, Fax: +43-2982-4210, E-mail: office@riegl.co.at

RIEGL USA Inc., Orlando, Florida 32819, USA
Tel.: +1-407-248-9927, Fax: +1-407-248-2636, E-mail: info@rieglusa.com

RIEGL Japan Ltd., Tokyo 1640013, Japan
Tel.: +81-3-3382-7340, Fax: +81-3-3382-5843, E-mail: info@riegl-japan.co.jp