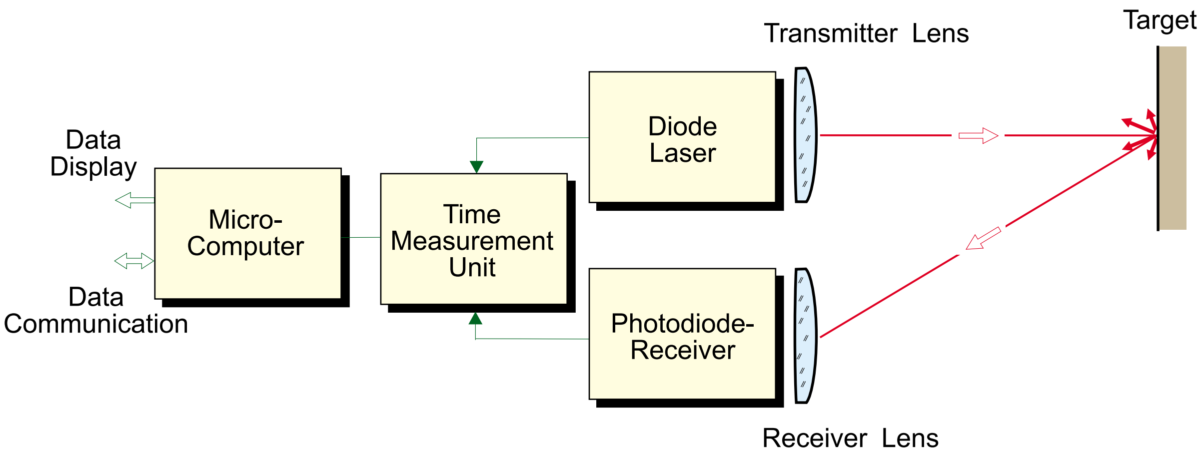
Operation of a Pulsed Laser Distance Meter

An electrical pulse generator periodically drives a semiconductor laser diode sending out infrared light pulses, which are collimated by the transmitter lens. Via the receiver lens, part of the echo signal reflected by the target hits a photodiode which generates an electrical receiver signal. The time interval between the transmitted and received pulses is counted by means of a quartz-stabilised clock frequency.
The calculated range value is fed into the internal microcomputer which processes the measured data and prepares it for range (and speed) display as well as for data output.

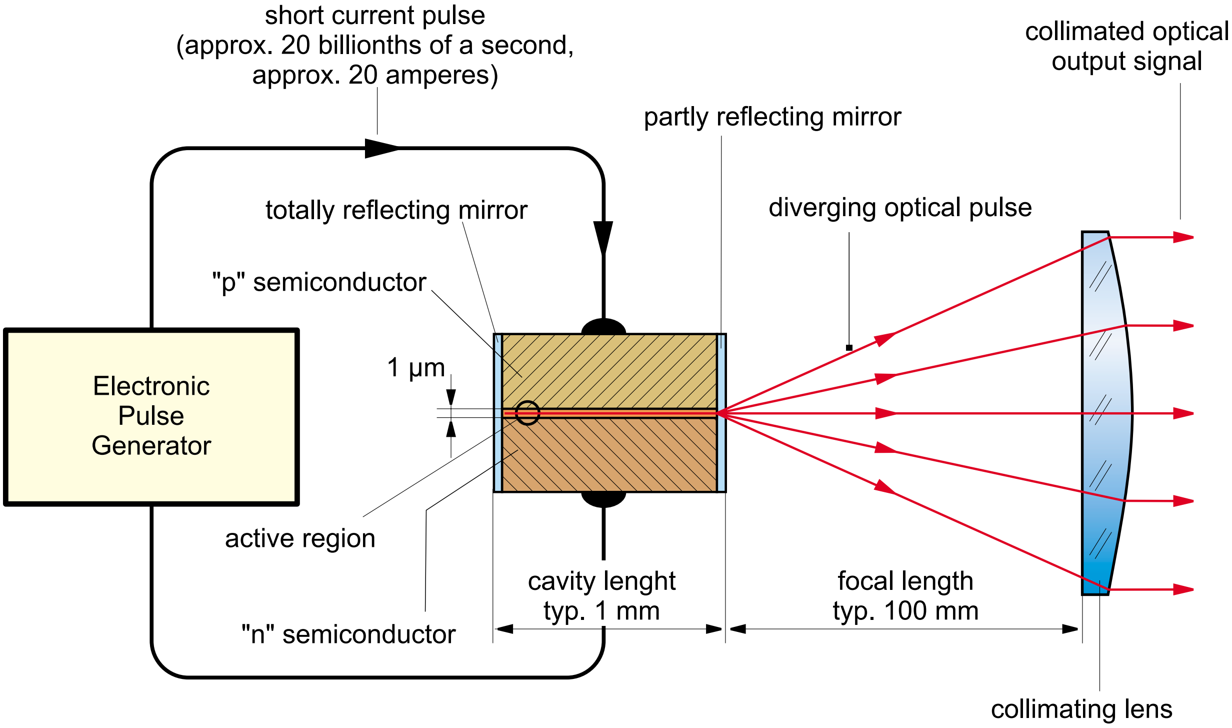


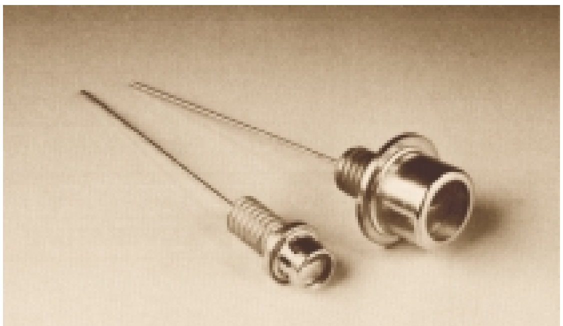
The standard instruments of series LD90-3 allow the choice between four different data processing programs, according to the prevailing conditions and requirements:

The program **FAST** enables the quickest possible measurement at undisturbed conditions simply by averaging the single-pulse distance values which are acquired within the selected measuring time.
The program **STANDARD** provides a very useful clutter suppression: occasional echo signals caused not by the target itself but by backscattering of particles between target and instrument (e.g. clouds of material in a dusty silo, or raindrops and snowflakes in free air) are eliminated and not taken into account.
The program **MAXIMUM DISTANCE** is optimized for undisturbed level measurements in a silo at the cost of a slightly higher acquisition time.
The program **MINIMUM DISTANCE** is ideal for measurements to small targets which are not easy to aim at, as it eliminates background echoes.

Operation of a Pulsed Semiconductor Laser

The key element of the laser transmitter is a small semiconductor laser, also known as diode laser or injection laser. The semiconductor laser converts electrical energy (a current pulse) into optical energy (the optical pulse) over a wide temperature range with high efficiency and high reliability. The laser itself consists of a small cube of semiconductor material (dimensions approx. 1 x 0.3 x 0.3 mm) with two of the faces cleaved so they are flat and parallel thus forming the two mirrors of the laser cavity. The light generation process takes place in the very narrow active region, i.e. a pn-junction, with a thickness of less than 1 µm.
The divergent laser radiation emitted by the partly reflecting face of the semiconductor crystal is collected by a collimating lens which forms a very narrow laser beam ideally suited for optical range finding.





Commercially available laser diodes

Reflectivity of Various Surfaces / Materials

The amount of light that is returned from a target's surface is characterised by the reflection coefficient . For a diffusely reflecting target, the maximum value of is 100 %. For mirror-like or retroreflecting targets, the (theoretical) value of can exceed 100 % by far. The reflection coefficient is, of course, depending on the wavelenght also.

Diffusely reflecting surfaces / materials [1)]

MATERIAL	REFLECTIVITY
White paper	up to 100 %
Dimension lumber (pine, clean, dry)	94 %
Snow	80 - 90 %
Beer foam	88 %
White masonry	85 %
Limestone, clay	up to > 75 %
Newspaper with print	69 %
Tissue paper, two ply	60 %
Deciduous trees	typ. 60 %
Coniferous trees	typ. 30 %
Carbonate sand (dry)	57 %
Carbonate sand (wet)	41 %
Beach sands, bare areas in desert	typ. 50 %

MATERIAL	REFLECTIVITY
Rough wood pallet (clean)	25 %
Concrete, smooth	24 %
Asphalt with pebbles	17 %
Lava	8 %
Black neoprene	5 %
Black rubber tire wall	2 %

Glossy, mirror-like or retroreflecting surfaces / materials [1)]

MATERIAL	REFLECTIVITY
Reflecting foil 3M2000X	1250 %
Opaque white plastic [2)]	110 %
Opaque black plastic [2)]	17 %
Clear plastic [2)]	50 %

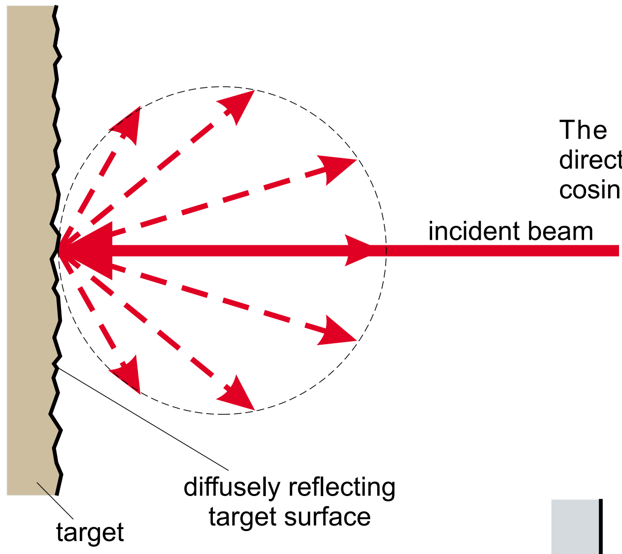
Note:

[1)] Values of reflectivity given for a wavelength of about 0.9 micrometers

[2)] For materials with shiny or glossy surfaces, the reflectivity figure represents the maximum light return, with the sensor beam exactly perpendicular to the material surface.

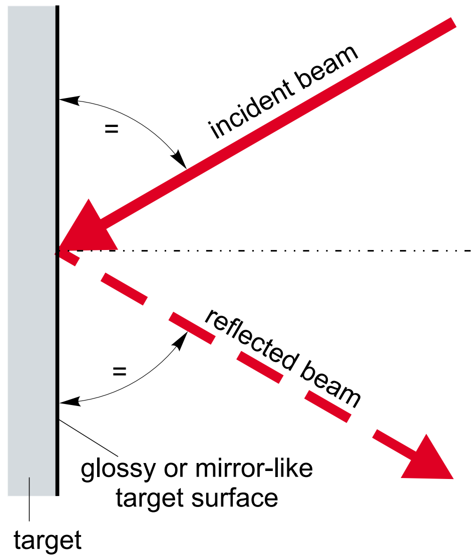
(Continued on the next page)

Reflectivity of Various Surfaces / Materials



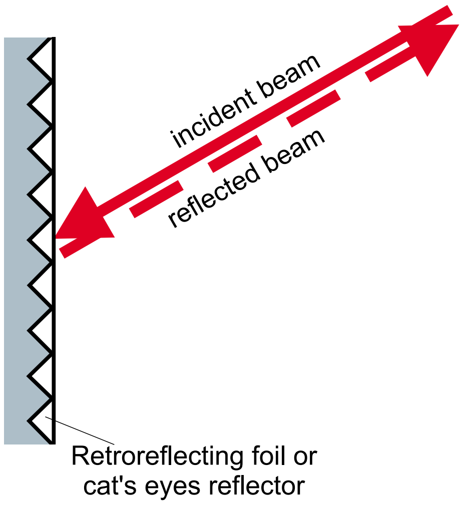
Diffuse reflection:

The signal is reflected omni-directionally according to Lambert's cosine law



Mirror-like reflection:

The angle of the reflected beam with respect to the targets surface is equal to the angle of incidence. Incident beam and reflected beam lie in the same plane.

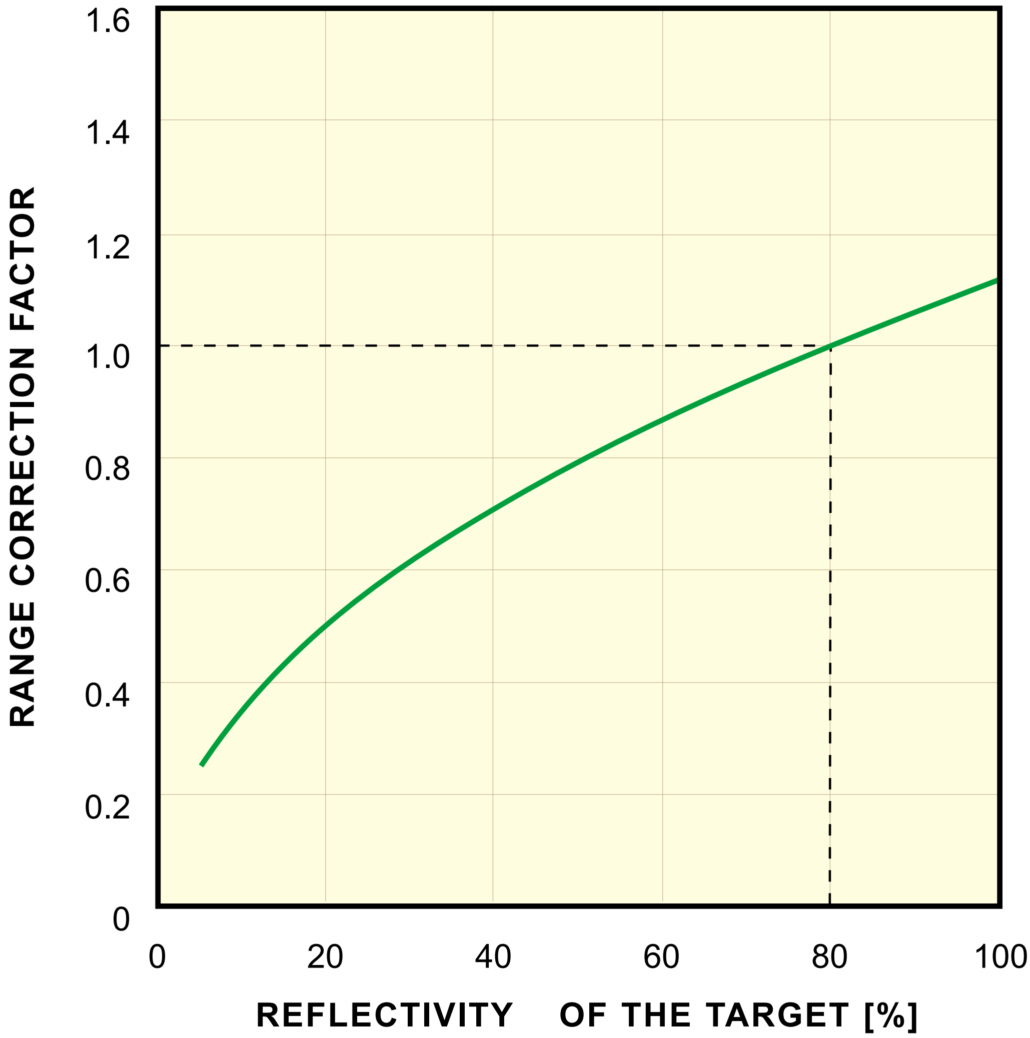


Retroreflection:

The retroreflected beam is returned in the same direction from which the incident beam came. This property is maintained over a wide range of directions of the incident beam.

Maximum Range vs Reflectivity of the Target

The maximum range achievable with a laser rangefinder depends strongly on the reflectivity of the target. Range performance as specified in the RIEGL brochures is given for a diffusely reflecting (lambertian) target with a reflectivity of 80 percent. For another reflectivity, the maximum range is found by the range correction factor as given in the diagram.



Maximum Range as a Function of Visibility

The maximum range achievable with a laser rangefinder depends strongly on the meteorologic visibility. Range performance as specified in the *RIEGL* brochures is given for a meteorologic visibility of 20 km (clear air). At lower visibility, the maximum range is reduced due to the atmospheric attenuation according to the range reduction factor as given in the diagram: