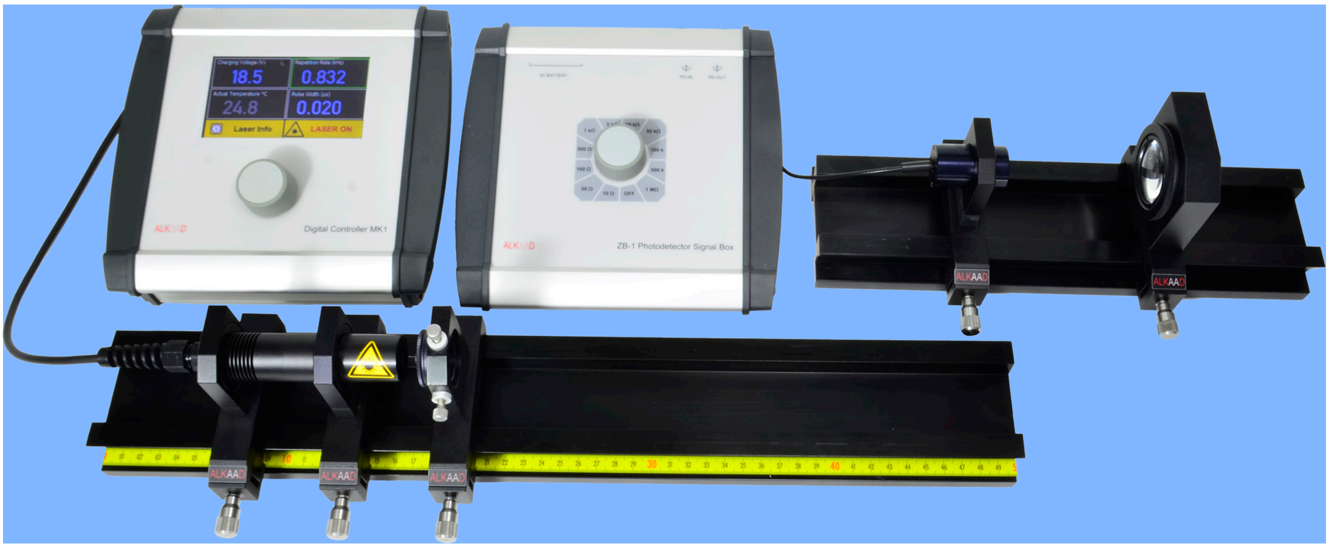
LM-0400 Laser Range Finder



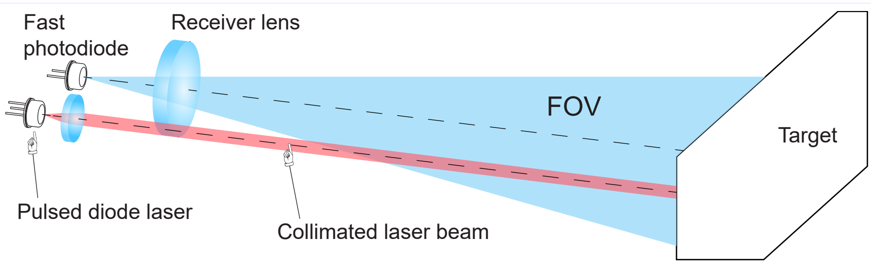
Keywords

Short pulse laser diode
Beam Collimator
Time of Flight
Peak Power
Fast Si PIN Photodetector
LIDAR
Laser Energy
Light Echoes

Introduction

Laser range finding is one of the applications of light detection and ranging known as LIDAR. The principle of this technique is well known from the RADAR (Radio wave Detection And Ranging). Instead of using radio waves, the LIDAR uses light as electromagnetic wave. Both techniques are based on the emission of a short pulse of electromagnetic radiation and the reception of back scattered signals from a target. The time t between the emission and reception of the pulse is measured and the distance d is calculated based on the velocity v of electromagnetic radiation. Using $v \approx 3\times10^8$ m/s for the speed of light, the time interval t for a distance d of 10 m will be 66 ns. The pulse duration must be modified to match the required resolution and distance. In this experiment the shortest pulse duration is 50 ns with a rise time of 5 ns. When the laser pulse is launched, the receiver photo detector is also used to generate a start pulse signal which serves as trigger for the oscilloscope. The peak power of the laser diode amounts to 70 W within 100 ns which is related to an energy of 4 µJ only. The intensity of the back scattered light is very low compared to the laser pulse it self and depends on the scatter efficiency of the target. Furthermore the intensity drops with $1/r^2$ where r is the distance to the target. Consequently a photodetector with amplifier is used. The controller allows also the characterization of the laser diode itself. The output power and pulse width as function of the parameters like charge voltage and discharge time can be measured and optimised for the length to be measured.

How it works



The emission of the pulsed diode laser is collimated to an almost parallel laser beam. At a certain distance it hits the target from which scattered light travels back depending on the scatter properties of the target. The receiver lens captures according to its field of view (FOV) a small fraction of it and focuses it onto a fast photodiode. Due to the fact that only a small fraction of the incident light comes back, a fast and sensitive amplifier is needed.

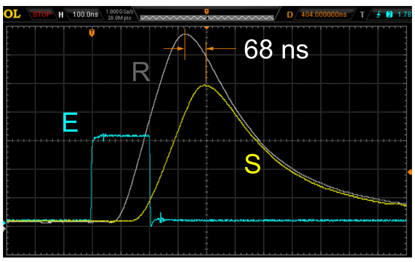


Fig. 2.28: Measurement of the time of flight

For the operation of the laser range finder an oscilloscope is required. The Fig. 2.28 shows the principle of a measurement with target which is 10 m apart. The blue trace (E) shows the electrical pulse for the diode laser. To get the optical laser pulse at zero distance a target (sheet of A4 paper for instance) is held in front of the setup and the resulting curve is stored on the scope as reference curve (R). After removing the target at the zero position the new curve is stored as well. At the peak of the reference the time is defined as zero and the distance to the next peak gives the time of flight t for one round trip.

$$2 \cdot s = v \cdot t$$

According to this, the travelled distance s is:

$$s = \frac{1}{2} v \cdot t$$

whereby *v* is the speed of light. If the distance is known we can also determine the speed of light.

LM-0400 Laser Range Finder consisting of:

Item	*Code*	*Qty.*	*Description*	*Details page*
1	CA-0060	1	Infrared display card 0.8 -1.4 µm	127 (10)
2	CA-0450	2	BNC connection cable 1 m	130 (28)
3	DC-0050	1	Pulsed laser diode controller MK1	121 (5)
4	DC-0220	1	SiPIN Photodetector, ultrafast with amplifier	124 (22)
5	MP-0130	2	Optical Bench MG-65, 300 mm	93 (7)
6	OM-0520	1	Pulsed diode laser head in twofold rotary mount	113 (22)
7	OM-0620	1	Collimating optics on carrier MG20	114 (30)
8	OM-0622	1	Focussing optics, f=60 mm on carrier MG20	115 (31)
9	UM-LM04	1	Manual Laser range finder	
	Required Option (order separately)			
10	CA-0200	1	Oscilloscope 100 MHz digital, two channel	128 (19)