LiDAR

APPLICATION NOTE

sensL
SENSE LIGHT

BENEFITS OF USING AN SPM

PERFORMANCE

Compared to avalanche photodiodes commonly used in low cost LiDAR systems, SPMs offer superior responsivity and noise equivalent power that results in better ranging and requires lower laser power. High intrinsic signal gain simplifies front-end electronics and eliminates the need for low noise amplifiers.

LOW VOLTAGE OPERATION

SPMs operate at low bias voltage with stable response over a relatively wide voltage range. This reduces power consumption and the cost for bias supply components while eliminating the need for electrical shock protection.

TEMPERATURE DEPENDENCE OF SPM SIGNAL

Temperature dependence of SPM response is less than 2.5% per °C and linear over a very wide range. This allows for simple temperature offset compensation, either through the bias supply or during signal amplification.

LOW COST

SPMs are manufactured in a standard CMOS process offering very high production uniformity, low cost and excellent economies of scale.

LIDAR APPLICATIONS

RANGE DETECTION SYSTEMS

Based on pulse time-of-flight principle, handheld systems can measure several hundred meters using very low cost detectors operating over a wide range of ambient temperatures

AERIAL SURVEYING

Forestry, geology, archaeology, marine and agriculture applications use LiDAR-based remote sensing aerial surveys over a wide range of operating conditions

ROBOTICS

LiDAR systems are used in wide range of sensing and perception applications for both indoor and outdoor robotics applications

TRANSPORTATION

Autonomous vehicle control for navigation and adaptive cruise control

3D IMAGING

LiDAR systems offer high-precision scanning abilities, with either single-face or 360-degree scanning modes

GAMING

The speed and precision of LiDAR allows the gaming industry to faithfully replicate popular gaming environments such as cities, buildings, and racetracks in 3D software

LiDAR Market Overview

LiDAR technology is becoming increasingly important in a wide variety of applications. LiDAR is a relative newcomer in the market and has proven utility in fields such as remote sensing, geographical information system (GIS) and many others. The demands for LiDAR are increasing; for example, many mapping firms are now integrating LiDAR technology with remote sensing systems in order to receive more detailed information about the image.

Traditionally LiDAR detection techniques have relied on photomultiplier tubes at the upper end of the market while standard APD detectors have dominated the lower end of the market, such as portable range finders. The use of an SPM in the portable and hand-held markets will allow users to attain performance similar to that of a photomultiplier, but at a fraction of the cost.

SensL sees the reduction in size and form factor of portable LiDAR systems as a key market which SPM's can readily address – today.

Benefits of a Silicon Photomultiplier in LiDAR

SensL's SPM detectors are small, low-weight compact detectors. Silicon photomultipliers have inherently high gain at the point where the photon is detected. This contributes to the high signal to noise ratio achievable with these detectors and enables the readout architecture to be simplified considerably. SPM have fast response times for use in high-speed applications and are not damaged by over-exposure to ambient light. The responsivity of silicon photomultipliers is extremely high.

Silicon photomultipliers can be operated at low bias voltages - SensL devices operate at approximately 30V - and have very lower power consumption. They are robust detectors that are immune to magnetic fields, highly uniform, manufactured using state-of-art semiconductor manufacturing enabling SPMs to be utilized in a range of low cost to high performance systems.

SensL's SPM detectors are designed for use in small miniaturized hand-held systems as well as integrated in larger arrays that can also be magnetic-field immune.

LiDAR Imaging Application Example

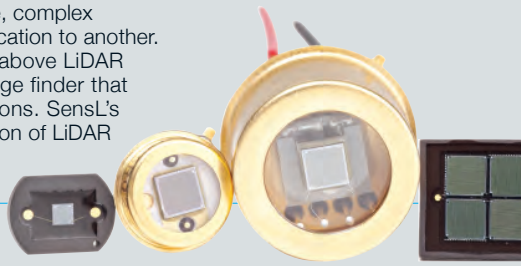
3D LiDAR imaging is a key enabling technology for automatic navigation of future spacecrafts, including landing, rendezvous docking and rover navigation. Landing is the most demanding task because of the range of operation, speed of movement, field of view and the spatial resolution required. When these parameters are combined with limited mass and power budget, typical for interplanetary operations, the technological challenge becomes significant. It can be met by optimization and innovation.

SensL has participated in a program with the European Space Agency (ESA) in a novel LiDAR imaging program. SensL's detector technology can be used to reduce the laser power requirements in such applications by orders of magnitude while an array detector format can speed up the data acquisition.

ESA has concluded a series of studies, exploring various technologies that may enable safe landing. LiDAR imaging has been assessed as one of the prospective navigation technologies and has been selected for further development.

Handheld Laser Range Finder Example

LiDAR imaging systems often tend to be large, complex devices that are not easily moved from one location to another. On the opposite end of the spectrum to the above LiDAR imaging application is a simple handheld range finder that can be deployed in a wide range of applications. SensL's SPM technology is well suited to this application of LiDAR due to the key benefits that SPM technology.



SensL Micro Detector Series of SPM's

The SensL Micro family includes low cost solid-state detectors sensitive to single photons. Each detector consists of an array of Geiger Mode Avalanche Photodiodes (APDs), each individually coupled to integrated quench electronics. The SensL Micro combines excellent noise equivalent power with high gain and responsivity characteristics comparable to Photomultiplier Tube (PMT) detectors with the additional benefits of silicon technology such as compact size, magnetic field insensitivity, low operating voltage, robustness, low cost and tolerance to light overexposure. The temperature dependence of SensL's SPMs is low enough to make them an attractive choice for handheld LiDAR systems that can be used in a wide variety of ambient temperatures.

The block diagram below shows the simplicity of a system using an SPM detector. The low operating voltage and high gain of the SPM reduce the cost and complexity of the system design considerably, making the SPM an ideal detector for LiDAR systems.

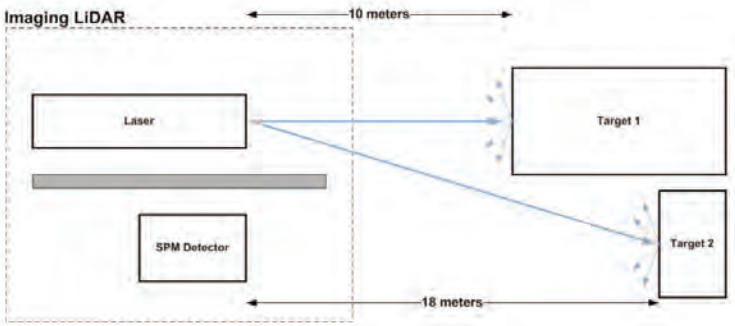


Figure 1: LiDAR imaging system showing light source, detector and adjacent targets of varying heights.

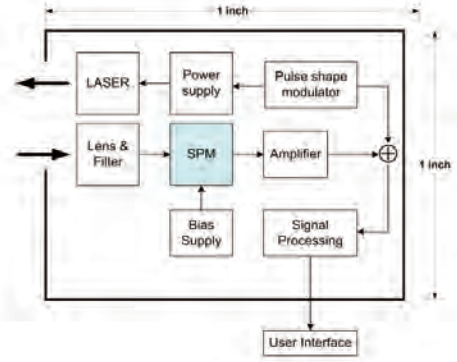


Figure 2: Block diagram of a handheld laser range detector