First Sensor

Avalanche Photodiodes for LIDAR Applications

To meet the growing market of laser based distance measurement, laser scanning and mapping, shape recognition and remote sensing, Avalanche Photodiodes (APD) especially suitable for LIDAR (Light Detection and Ranging) are needed. Preferentially, APDs are used for applications with very low optical signal strength or with high modulation frequencies, as it is the case with LIDAR.

LIDAR is an optical remote sensing technology. An emitter sends out infrared laser pulses and the reflected light is detected by a photodiode. The distance and relative speed of other objects can be determined from the runtime of the signal (time of flight) and the speed of light. This measurement method is similar to radar. Both technologies offer similar ranges for similar applications but LIDAR has the significant advantage of a much higher resolution. In addition, LIDAR systems can usually be produced at lower costs because of the less expensive components and a single system can cover short and long ranges.

The advantage of a much higher angular resolution gives APDs an outstanding role, especially when it comes to more complex **automotive applications**. Advanced driver assistance systems such as adaptive cruise control (ACC) or collision avoidance systems do not only provide a more comfortable driving experience but are also able to reduce the severity of accidents or even prevent crashes entirely. While some of these systems are already well established in higher vehicle classes, even better assistance systems are introduced to deal with more and more complex traffic situations. The angular resolution of LIDAR systems makes it possible to identify the horizontal or vertical position of a car or pedestrian more precisely, and to distinguish different objects that are located in same distance and moving with the same speed. Unlike radar, LIDAR sensors are also able to recognize the size and thereby draw conclusions about the type of the object. LIDAR technology sometimes still has the reputation of losing performance at bad weather conditions, but new generations of LIDAR systems insure a high functionality even with rain or fog by receiving multiple echoes from a single laser beam.

For many years, conventional LIDAR range finding systems have been in use for **civil and defense applications**. Similar technology is being used to create a 3D image of fixed or moving objects, the so-called laser radar (LADAR). This is interesting, especially for surveillance and orientation tasks to complement conventional image technologies in unmanned aerial vehicles (UAVs) and other autonomous vehicle systems. In another application a Laser Radar seeker can detect objects and identify specific features (such as the shape of a flying object) with a resolution of 10-15 cm from a distance of 350 m and can react with countermeasure activities. The conventional approach was to use a laser opto-mechanical scanner requiring sophisticated optics. A matrix APD array enables a real-time LADAR imaging of moving targets with a single pulse. Within a single laser pulse each channel of the array receives the reflected signal from the object in a timed sequence. In contrast to CMOS based solutions APD arrays have a much higher sensitivity enabling detection and identification of objects hundreds or thousands of meters away.

LIDAR systems also become more and more relevant for **environmental applications**. Based on the differences in the backscattering of various particles, LIDAR systems are used for atmospheric measurements, e. g. for the analysis of clouds, layers of aerosols and the status parameters of atmosphere or for the detection of traces of gases relevant to the climate. Additionally, the significance of the technology is steadily increasing for wind energy industry where it´s used for the measurement of wind speed and direction. Cartography or Mapping is another large field for LIDAR applications. Here, sensors are fixed on an airplane and scan the earth's surface and objects on it. The data are used to create 3D maps which are the basis for e. g. the analysis of coastal erosions or the risk of landslides to save lives as well as for geographic information systems or major construction projects all over the world.

First Sensor manufactures and improves silicon APDs for over 20 years for demanding sensor solutions and offers a wide selection of APDs for range finding and distance measurement applications. First Sensor's series -9 APDs is optimized for 905 nm laser radiation, has a high quantum efficiency, fast rise time, low noise and slow slope gain curve and is therefore particularly suited for LIDAR applications. The product line includes single element APDs as well as arrays in 5 x 5 (25 APD-pixel) and 8 x 8 (64 APD-pixel) matrix geometries and in linear configuration with up to 16 elements to serve specific needs. First Sensor offers these arrays both as component level devices and as hybrid modules simplifying the integration and evaluation into your system. The available high reliability packages include standard TOs and ceramic carriers as well as cost efficient organic carrier SMD packages. All packages can be built with specific band pass filters matching the laser wavelength to improve signal-to-noise performance.

All our products are customizable and can be adapted or developed to fit specific requirements or applications. Please contact us if you need more information regarding specification or packaging solutions.

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