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How Reliable and Affordable Presence Detection Can Change the Space Management of the Future

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Abstract

This article will first look at the growing role of presence detection. It will then consider current market detection systems and specifically detail the advantages of active infrared sensors vs. passive infrared sensors. Finally, it will introduce a new solution for active infrared tracking.

What Is Presence Detection?

Presence detection, which is also referred to as human presence detection, is the ability to identify or locate the existence of people in a specific area or physical space.

Why Presence Detection Is Important

Presence detection in interior spaces is becoming more and more important—and especially accelerated by the recent developments of COVID-19. Interesting use cases of presence detection can range throughout interior spaces such as offices, elevator cabins, corridors, and retail space. In elevators, for example, detection can be a helpful and even life-saving tool in case of emergency situations. In retail applications, presence detection can be used to monitor behavioral patterns, and this data can help optimize product placement and in turn benefit both retailers and consumers. Additionally, presence detection can be used to detect the utility of an office space. For example, if offices are underutilized due to travel or work-from-home, a company can use presence detection to assess usage and reduce the number of office desks where/if applicable. Presence detection can also be applied in applications such as mobile offices, where in some locations a remote worker may not have a designated work desk but would need to locate an available workspace through a mobile office provider. These applications require intelligent, cost-effective solutions that are easy to integrate into current designs.

Current Market Presence Detection Systems

There are multiple solutions for presence detection on the market, such as time of flight, radar, 2D cameras, and passive or active infrared presence detectors. The price range, but also accuracy, of these can differ significantly. While a high end time of flight sensor provides the highest accuracy in presence detection, it is on the upper end of the cost scale. Thus, it is used for critical solutions such as human-robot interactions. Infrared presence detectors, on the other hand, can offer a desirable level of accuracy for less critical applications at a much lower cost.

Active Infrared Sensor Advantages over Passive Sensors

While both active and passive sensors can provide a cost-effective solution, active sensors can be used in high accuracy counting mode. Additionally, it is mandatory for a presence detection sensor to recognize even the smallest movements in a variety of lighting scenarios. The active infrared sensor is much more effective as it actively emits infrared light in order to detect people. This is in contrast to passive sensing, which relies only on reflections of infrared light from the human body.

An active infrared solution also can contain an active infrared sensor (IR) that can not only be used to detect moving, but also non-moving people, thus preventing false negatives. Due to its optical principle, the sensor can be hidden behind toned plastic or glass, which is IR transparent and can therefore be conveniently incorporated into the design of the product and the interior environment.

Active Infrared Sensing Solutions

Analog Devices' ADPD1080 evaluation board, shown in Figure 1, realizes active infrared tracking.

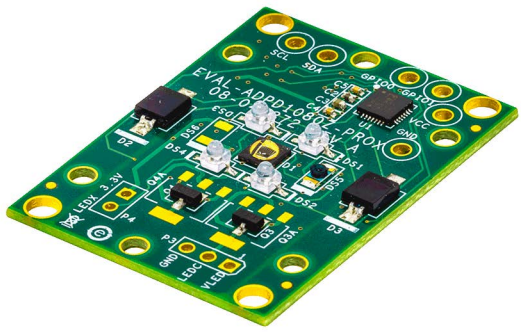

Figure 1. ADPD1080 evaluation board for motion and long-range presence detection.

The evaluation board consists of power management, one photodiode, six LEDs, and a photometric front end, the ADPD1080. The infrared LEDs emit light, and the reflected intensity of the light is measured up to 5 m away from the sensor.

Movement can be detected by the change in intensity—when there is no motion in the room, the intensity is unchanged. The photodiode is centered between the LEDs and can be placed behind a black dyed plastic screen, an added design feature providing a customer with the option for discrete placement.

The evaluation board consists of two setups. The first one is for closer proximities, and the second one works best for long-range distances. This is due to the LED intensity. The ADPD1080 is a full photometric front end with eight front-end inputs, which are connected to the photodiodes. It also has three integrated LED drivers and offers two time slots, which can be programmed independently to read out the photodiode and control the LEDs. With those time slots, different modes can be enabled without reprogramming the registers to save power (about 20% compared to the previous version). In addition, it has in-built ambient light rejection to filter for other light factors, such as sunlight, lamps, or other ambient light. Even fluorescent light bulbs, despite their broad frequency spectrum, and LED luminaires, despite their switching frequency, are effectively filtered.

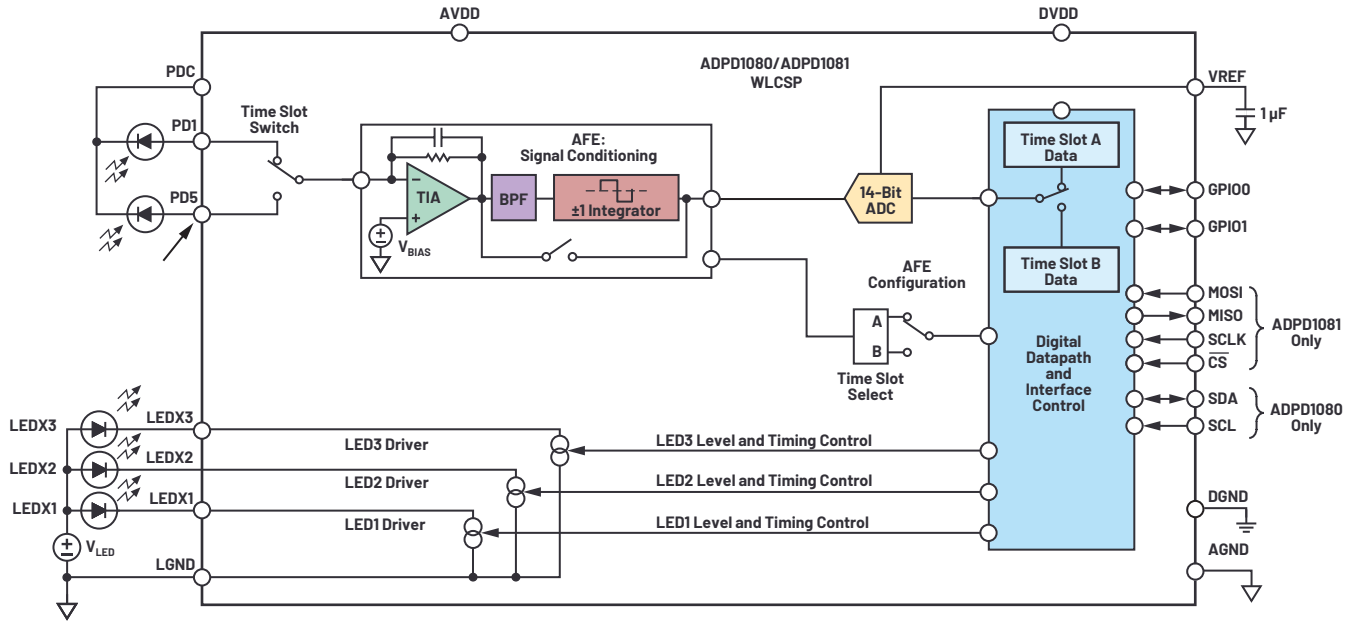

Figure 2. ADPD1080 evaluation board schematic.

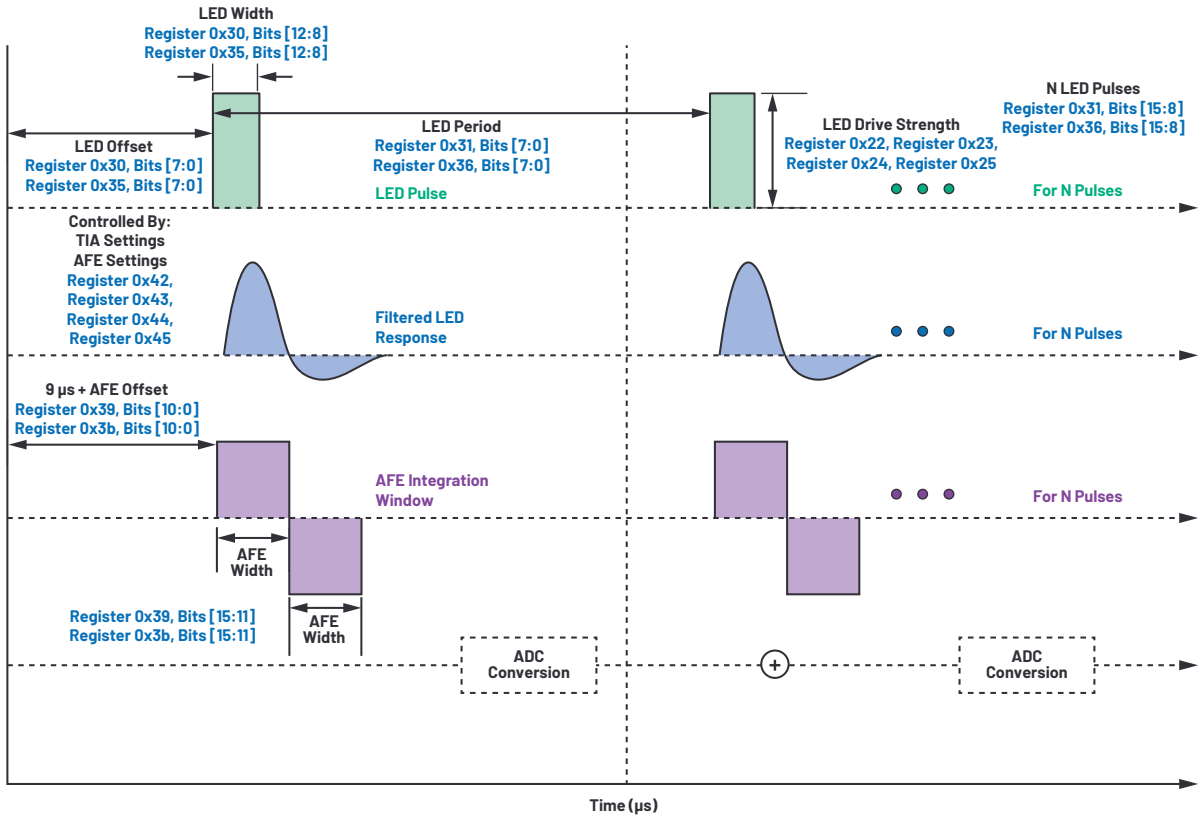

Figure 3. Timing configuration of the ADPD1080 photometric front end.

Figure 2 shows a block diagram of the ADPD1080. The current of the photodiode is amplified and converted with a transimpedance amplifier. Afterward, the band-pass filter and integrator are used for the ambient light filtering. The band-pass filter blocks the DC light, and the integrator is used to filter out the AC component of the ambient light, reducing it by 80 dB. The working principle of the analog front end is shown in Figure 3.

Real-Life Measurement Shows the Advantages

The evaluation board was tested by mounting it on the ceiling of an office in multiple test environments. For each run, the test person walked around the office in different intervals, and the signal of the sensor was recorded. Figure 4 shows the sensor signal and a clear response to movement for the represented test run. On the left side, the intensity value is plotted, while on the right side, the change of intensity is shown. The intensity change corresponding to the movement is significant.

In a second test, the evaluation board was tested under more difficult circumstances. The test person stood still while allowing only very little motion to test the detection capability of not only movement, but also people presence. Figure 5 shows the signal and a clear intensity change.

Conclusion

In conclusion, the ADPD1080 delivers an out-of-the-box experience, offering an active infrared presence detection solution that is not only low cost and highly accurate, but is also small in size. It operates at significantly lower power than time of flight or radar solutions, and can measure in a radius of up to 5 m. Its robust features allow easy integration into existing products and in addition to presence detection, it can be used for a variety of use cases, including gesture sensing. Overall, the advantages can enable customers to improve efficiency and safety at reduced costs, thus helping to shape facility management in the future.

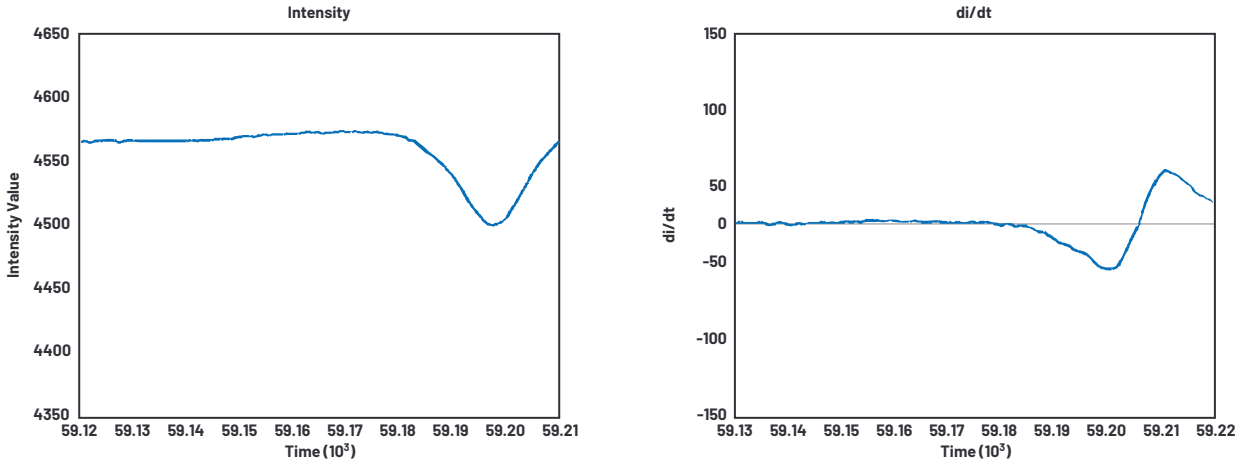

Figure 4. IR sensor response to walking motion: intensity value (left) and corresponding change in intensity (right).

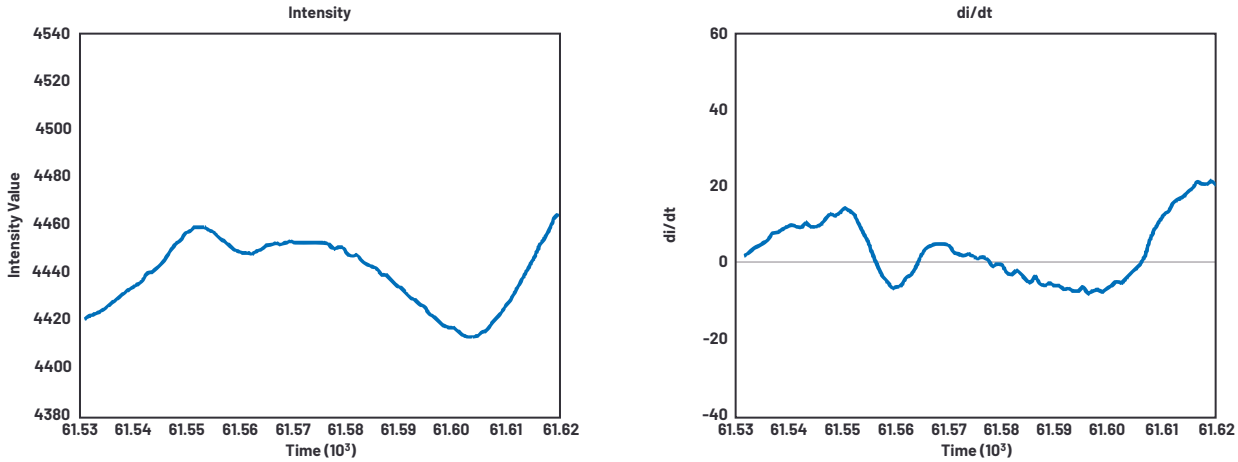

Figure 5. IR sensor response to standstill position with limited movement: intensity value (left) and corresponding change in intensity (right).

About the Author

Christoph Kämmerer has worked at Analog Devices since February 2015. He graduated in 2014 from the Friedrich-Alexander University in Erlangen with a master's in physics. Christoph also holds an MBA from Mannheim Business School, which he completed in 2020. He started as a trainee at Analog Devices and afterward became a field applications engineer for emerging applications. In 2020 Christoph joined the Analog Garage (ADI's start-up incubator), as an emerging business manager focusing on identifying new technologies and driving future innovation. He can be reached at christoph.kaemmerer@analog.com.