
# Robust, responsive and cost effective touch in cars

There is an increasing demand for safety and comfort in cars. More complex systems with ever increasing options and features are to be combined with smooth, responsive and intuitive interfaces so that the driver can concentrate on maneuvering the car. This is not an easy task to accomplish. Apart from the user interface design the car manufacturers will have to adapt to the demand trends (in the business) and the buyer's preferences and expectations. For many buyers, the infotainment system has recently become a key factor in the decision-making process. In particular, a critical part of a well-designed infotainment system is a touch screen that surpasses the buyer's expectations in the market segment. The challenge is to offer a robust and responsive touch with a premium feel at a competitive price.

## Introduction [1]

Two of the most distinct trends in car center stack displays are the following

- The touch screen enters all price segments and basically a screen in the center stack is assumed to be touch operable.
- The screen size is ever increasing. An almost universal expectation is that the next generation of a car should have a larger screen than the previous one had.

## Available technologies

Touch screens have been available in cars since 1986. By now it is a mature business with millions of units deployed every year. The three most commonly used technologies in cars today are described below, with their respective strengths and weaknesses.

### Resistive touch technology [2]

The resistive touch technology relies on several layers of thin films in front of the screen. When a user touches the sensor these films are pressed together and this action reduces the resistance between them. This change in resistance is interpreted into touch coordinates. The multiple layers required between the display and the user reduce the brightness of the display significantly. Furthermore, when exposed to ambient light the screen appears dull, with low contrast and grayish blacks. The screen is not very sensitive to light touches and gestures. On a positive note, the resistive touch is cheap and allows for a matte surface. Having a resistive touch is an upgrade to not having touch but in terms of premium feel not much is on offer.

### Capacitive touch technology [3]

Capacitive touch in its different forms relies on measuring the change in capacitance imposed by the presence of a finger or a suitable stylus. In the following I will concentrate on projected capacitive touch (PCAP), being the most relevant in the automotive space. The sensitivity to light touches is much better than that of resistive touch and PCAP has no problems handling gestures. This technology also requires layers in front of the display, causing brightness drop and a reduced contrast, though not at the level of resistive touch. In particular it requires a glossy front glass with a substantial risk for glare. The capacitive touch technology is more expensive than the resistive touch which so far has restricted its usage to the more expensive market segments.

### Optical touch technology

Optical touch comes in several flavors, the two main ones being imaging with cameras and infrared grid. Camera based technologies are more used for television screens and white boards while for small and intermediate sized screens the infrared grid is the most relevant. It is based on infrared light sent above and across the touch surface. When an object touches the surface the light is blocked thus creating shadows and the touch coordinate is calculated based on these shadows. Neonode® zForce® blocking technology is a refined infrared grid technology, with touch provided in cars since 2013. As of September 2019 it has been deployed in more than 4 million vehicles. The principles and the benefits of the Neonode touch solution are described in the following sections.

## Neonode touch solution

Going slightly more into details, the source of the light is a set of evenly spaced emitters (infrared light emitting diodes or IR LEDs) placed on two sides of the screen. The emitted light is directed above and across the screen by a plastic optic frame. In a corresponding fashion the optical frame on the other sides of the screen collects and directs the light to a set of evenly spaced detectors (photo diodes or PDs).

So far the description is valid of classic infrared grid technology. In the following section it is described how Neonode's zForce optical blocking technology has improved the concept further, making infrared optical touch a viable solution for the demanding consumer electronics and automotive markets.

Apart from utilizing diodes and light guides, the zForce blocking technology consists of a Neonode specific scanning IC that sequentially activates the LEDs and collect the signals from the PDs. The signals are fed into an off-the-shelf host IC that runs Neonode's proprietary software. The software keeps the system self-calibrated and calculates position with high resolution and accuracy as well as object size. The scanning IC allows for low power consumption, high scanning speeds and low latencies as well as a low bill of material. The detailed explanation is illustrated by the vertical fields in figure 1 and figure 2, but naturally applies to the horizontal dimension as well. In the simple grid version of optical touch there is a detector in front of every emitter and an emitter – detector pair constitute a signal channel. In the zForce blocking technology, however, there is an off-set between the row of emitters and the row of detectors. In figure 1, this is illustrated. In front of IR LED 3 there are two PDs, D to the left and C to the right. So every LED shines light onto two PDs and every PD receives light from two LEDs. This means that an object will always block at least two channels which allows for interpolation and a high resolution. This is illustrated in figure 2, where the object blocks more of the light going towards PD E than PD D, thus indicating that the object is more to the left. So, by using the signals from all partially or fully blocked channels in both the horizontal and the vertical direction a high accuracy position of the object is calculated. The detailed design of the optical frame is tailored to the mechanical preferences for the system, thus allowing for design freedom. For example, it is possible to add soft buttons and touch active area outside the display.

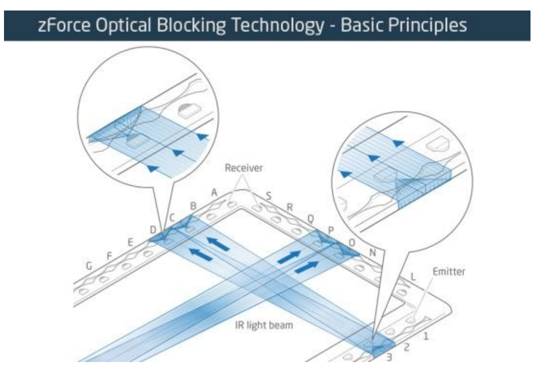


*Figure 1. Every emitter shines light onto two detectors.*

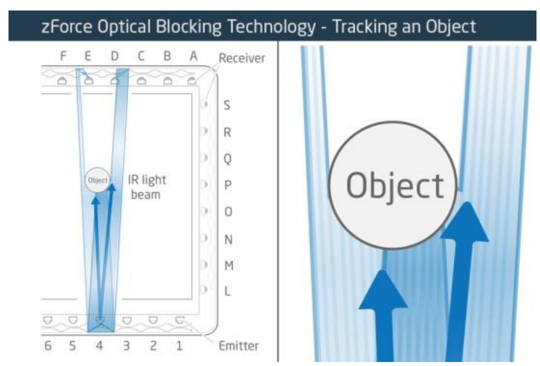


*Figure 2. The relative blocking of the two light fields give positional information.*

## Benefits of the zForce optical blocking technology

The many benefits of the Neonode optical blocking technology includes:

- Robust technology based on standard industry manufacturing technology.
- Ultra low latency touch with update frequencies up to several hundred Hertz.
- Responsive touch with full glove support and smooth gesture control.
- Full choice of cover glass solution – matte or glossy, plastic or glass or display only.
- Design freedom in collaboration with Neonode's engineering team.

## Neonode 2019 touch solution offering

So, what if the proven Neonode touch solution would be available at larger screens and at a reduced price. Well, this is now on the table in the shape of our offer – Neonode 2019 touch solution, with the technical specification presented in table 1 below. In this new variation the bill of material is significantly reduced, mainly by a reduction in the number of LEDs and PDs required. The BOM excluding PCB is approaching 0.5 USD / diagonal inch in sizes from 9" to 15". The robust, low latency, responsive touch is still there. An affordable solution with a premium feel.

| Display size | 6″ | 9″ | 12″ | 15″ |
|---|---|---|---|---|
| Default touch size (cylinder diameter) | 12 mm | | | |
| Minimum touch object diameter | 6 mm | | | |
| Accuracy (for default touch size) | ≤ 2.5 mm | | | |
| Linearity | +/- 2.5 mm | | | |
| Default resolution | 0.1 mm | | | |
| Touch report latency | 10 ms max at maximum report rate | | | |
| Gestures permitted by technology | Tap, Double Tap, Hold, Swipe, Flick, Pan, Drag, Pinch & Spread. | | | |
| Optical bezel height (mm) | 1.2 | 1.5 | 2.1 | 2.1 |
| Maximum scanning frequency (Hz) | 450 | 400 | 300 | 200 |
| Current consumption - active mode (mA) | 3.6 | 4.5 | 5.1 | 5.6 |
| Operating temperature | Low: -40°C | | High: 85°C | |

*Table 1. Neonode touch solution, automotive specification.*

## References


1. *Evolving Display Technologies and Supply Chain*, page 7 of the IHS Markit presentation by Brian Rhodes at SID Vehicles Displays, Detroit 2017, page 31 in document: [https://www.vehicledisplay.org/VehicleDisplays17.pdf](https://www.vehicledisplay.org/VehicleDisplays17.pdf)
2. *Chapter 2 "Touch Sensing"*, pages 51-61 by Geoff Walker in *Interactive Displays: Natural Human-Interface Technologies*, First Edition, Edited by A. K. Bhowmik, 2015, John Wiley & Sons, Ltd.
3. *Chapter 2 "Touch Sensing"*, pages 35-51 by Geoff Walker in *Interactive Displays: Natural Human-Interface Technologies*, First Edition, Edited by A. K. Bhowmik, 2015, John Wiley & Sons, Ltd.


## About the Author

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Stefan Holmgren is a Senior Optical Engineer at Neonode with more than 20 years of experience in laser physics and optics. He holds a PhD degree in Physics from the Royal Institute of Technology, Stockholm, Sweden.

## About Neonode

Neonode Inc. (NASDAQ:NEON) develops and licenses user interfaces and optical interactive touch solutions based on its zForce optical blocking technology. Neonode touch solutions enable touch interaction on any surface and are ideal for integration in a wide range of applications within the automotive, consumer electronics, medical, robotics and other markets. The company also develops, manufactures and sells advanced sensor modules based on the company's proprietary zForce optical reflecting technology. These sensors allow for touch interaction, mid-air interaction and object sensing. To date, Neonode's technology has been deployed in approximately 72 million products, including 4 million cars and 68 million consumer devices.



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