The advent of high-efficiency infrared LEDs has made intuitive and robust touchscreens for various devices and controllers attractive to both industry and the end-user.

Infrared LED technology for touchscreens

This technology is used in applications ranging from small displays on smartphones to huge screens used by several people simultaneously. Optical solutions were originally preferred for large displays but this technology is currently used even for small touch panels such as those on notebooks. The launch of Windows 8 in October 2012 gave the already popular touchscreen a further boost. The operating system is designed specifically for this type of input and is a driving force behind the development of “all-in-one” computers and notebooks. Feedback from users has indicated that they prefer being able to use fully featured computer programmes by touching the screen, particularly when working with photos and graphics.

Here are different ways in which the position of a finger or stylus on the screen can be detected. Resistive displays are equipped with two conductive films separated by an air gap and coated on a glass display. Pressing down with your finger closes the gap between the two layers of film, allowing current to flow. Electrical resistance is then used to calculate the point of contact.

Capacitive solutions produce an electrical field in a special surface layer. Contact between this layer and a conductive object such as a finger causes a change in the electrical field. Optical touchscreens can be realised by creating a light grid over the display using infrared LEDs (IREDs), in which an object touching the display either casts a shadow or causes light to be reflected, depending on the design.

Optical touchscreens

Optical solutions are now on the uptake, particularly for large displays.

Information from Osram

They produce excellent image quality because they do not need any special coatings which absorb a percentage of the backlighting. They can detect any type of pointer or stylus and even fingers in gloves because they do not rely on the conductivity of these objects.

Optical designs are not at all sensitive to scratches and, depending on the power of the emitters, can be used for any size of screen diagonal. In most cases, the optical components are mounted in a frame around the display so that this technology can be used to upgrade existing displays without difficulty.

Optical touchscreens used to be considered too expensive, too large and too sensitive to ambient light, but new, compact infrared IREDs provide the basis for cost-effective, low-profile touchscreens, thereby countering the former argument. Their sensitivity to ambient light can be overcome by appropriate designs.

The commonly used technologies for optical touchscreens are presented here. They all benefit from highly efficient, thin-film chip technology providing the basis for compact IREDs with high efficiency.
optical output. There is a wide range of packages for all design options, from narrow-angle emitters for light grids to high-power emitters for illuminating large displays. With a wavelength of 850 nm, IREDs meet the requirements for touchscreens perfectly. Their light is barely visible to the naked eye but is registered easily by the detectors. Chips measuring 940 nm are available for exceptional cases in which the residual visible light from the 850 nm emitter is unwelcome.

**Light grids**

The simplest solution for optical touchscreens is a light grid created by rows of infrared emitters and detectors placed opposite one-another. The components are mounted in a low-profile frame around the screen, just a few millimeters deep, known as a “bezel”. A finger or stylus blocks the light beams, causing the detector signal to attenuate at the appropriate point (see Fig. 1). This design can be used as a multi-touch version if the emitters and detectors are switched sequentially and if the signals are evaluated appropriately.

Important factors for selecting an emitter are the size of the component, its optical output and its radiant intensity – in other words, the distribution of the light. High radiant intensity is synonymous with an intense narrow-angle beam. High radiant intensities enable large screen diagonals to be covered. Narrow beam angles, coupled with narrow detection angles on the detectors, ensure that the beams from the individual emitters do not hit more than one sensor, even on large displays.

IREDs and phototransistors in Midled packages with an angle of some 15°, allowing bezel depths of around 2,3 mm, are ideal for such applications. If Chipled products are used, the bezel depth can be under 2 mm. In some applications, particularly ones where there is strong halogen lighting, it is advisable to use daylight filters to reduce the influence of ambient light on the detectors.

The design of such a light grid can be scaled up to larger screen diagonals with ease. Compared with non-optical technologies, this scaling is less expensive because the functional components are mounted in the frame around the display. The scaling factor in the case of optical touchscreens is dependent on the circumference; in all other technologies the scaling factor is dependent on the square of the display.

Bear in mind, however, that light output reduces in proportion to the square of the distance from the detector. This, in turn, leads to a poorer signal-to-noise ratio for the touch signal and it may be necessary to adjust the emitter current accordingly. Osram Opto Semiconductors has compiled a selection of suitable emitters and detectors in an application note on the subject of touchscreens (see Fig. 2).

**Light from the corners**

A setup with line sensors needs far fewer components than the light grid version. In this setup, high-power IREDs are
used to flood the display with infrared light from two corners. There are also detectors – optically separated to prevent crosstalk – which only receive a signal when objects on the display reflect the infrared beams (see Fig. 3).

In most cases, the sensors are line scanners such as those used for barcode readers or flat-bed scanners. The precise position and size of the finger or stylus is calculated by evaluating both signals using a procedure similar to triangulation. This design has the potential to produce touchscreens with a much higher resolution than with other technologies, depending on the resolution of the sensor. The design is also particularly attractive because it can be scaled up to larger screens without the need for additional components, as long as you ensure that the emitters produce enough light. At present, displays with a screen diagonal of 12" and higher are mainly used.

In a slightly modified version, light guides are mounted around the display and are “fed” light by IREDs at the corners. Light exits the light guide at certain intervals along its length, creating a curtain of light over the display. The line sensors register the shadows cast by objects on the display.

Both solutions require IREDs with sufficient optical output to illuminate the entire screen. They must, however, be small enough for low-profile displays. The latest development for this area of application is the Chipled SFH 4053. Measuring only 0,5 x 1 x 0,45 mm, it is one of the slimmest components of its output class (see Fig. 4). With an 8 mm chip in thin-film technology, this IRED produces 40 mW at 70 mA and up to 260 mW at 700 mA in pulse mode, so it can illuminate a notebook screen easily.

While IREDs with a wide beam angle are suitable for illuminating from the corners, the choice of emitters for the light guide version depends on the light guide’s design. Miled l types, which have a narrow beam angle and a flat surface, are ideal for injecting light into light guides. The Osram application note provides more information on the design of the light guide solution. One option to free the touch signal from ambient light influences is to measure first without infrared illumination, and then with infrared illumination, and to calculate the difference between the two signals.

**Projection**

Large projection panels and consoles are mostly backlit with infrared light. A finger or stylus on the display reflects the light to one or more cameras (see Fig. 5). Such a panel emits infrared light on the surface. If the display is recorded by cameras, in a TV studio, for example, the light can interfere with the camera signal. One possible solution is to use 940 nm emitters. Alternatively, a design in which the infrared light is injected into an glass of the display can be used (see Fig. 6). IRED emits light into the glass so that the beams are totally reflected at the top and bottom surfaces. Only when an object touches the surface can the light escape. It is scattered so that the signal at the detectors changes (this is known as frustrated total reflection or FTR).

These two versions of optical touchscreens do not require bezels and therefore give designers greater flexibility.

Projection solutions generally need IREDs with extremely high output, such as Dragon, Oslon or Ostar components. In FTR technology, the design must ensure a high number of internal reflections. The application note describes the relevant requirements and lists appropriate emitters. Depending on the setup, suitable components may, for example, be narrow-angle Midleds which achieve very high optical output thanks to nanostack technology, or infrared Osram IREDs, currently the smallest IREDs in the 1 W class.

The simplest way to eliminate ambient light effects in projection systems is to place bandpass filters in front of the camera sensor.

**In-cell sensors**

In-cell technology is a relatively new development. These touchpanels have a photo transistor integrated in each pixel of the LCD display. In bright surroundings, a finger or stylus casts a shadow over the detectors; in dark surroundings they reflect the LCD backlighting. In dark surroundings and with a dark display, however, the photo transistor signal is very weak. This is remedied by additional infrared illumination from the side – for example, with super-small Smartled components.

**Summary**

High-power infrared LEDs provide the basis for optical touchscreens with large image diagonals. The process of transferring these chip technologies to compact IREDs has also led to cost-effective solutions for small and medium-sized touchpads.

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