Application Note

AN000709

# Proximity Design Considerations

## Narrow Bezel, Large Airgap

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# Content Guide

# 1 Introduction

**ams'** proximity sensors function by pulsing an IR emitter, which can be either an Infrared Light Emitting Diode (IR-LED) or a Vertical Cavity Surface Emitting Laser (VCSEL), and measuring the reflected IR returned from a target. The amount of reflected IR is inversely proportional to the target distance and proportional to the target size and reflectance. The trend toward narrow bezel and no bezel smart phone designs, with a higher screen-to-body ratio, presents new challenges for proximity detection. Challenges beyond those that occur with traditional proximity system designs that use IR ink apertures on a wide bezel with a small airgap. One option for these modern designs is to place the proximity sensor in the narrow channel that exists where the cover glass meets the frame. The TMD2755 was specifically designed for this type of application, where the ALS and proximity sensing is achieved through a narrow channel (0.6mm minimum) with a large air gap (up to 3mm). This application note discusses the challenges associated with narrow channel, large air gap designs using the TMD2755.

# 2 Narrow Bezel Design

Figure 1 illustrates a typical smart phone with narrow bezel. The high screen-to-body ratio means there is only a narrow channel between the frame of the phone and the LCD display for the proximity sensor to be placed. This generally forces the sensor to be located farther below the surface of the display, resulting in a large air gap, a restricted Field of View (FOV) for the photodiode, and restricted Field of Illumination (FOI) for the emitter. This concept is more clearly illustrated in Figure 2, which shows a side view of the TMD2755 at the bottom of the narrow channel.

An opto-mechanical design of this type introduces several challenges that need to be addressed:

1. Higher crosstalk due to the large air gap.
2. Reduced response due to FOI/FOV restrictions.
3. Light leakage from the emitter aperture.
4. Crosstalk and light leakage from the edge of the LCD display.

**Figure 1:**
**Top View of Narrow Bezel Smart Phone**

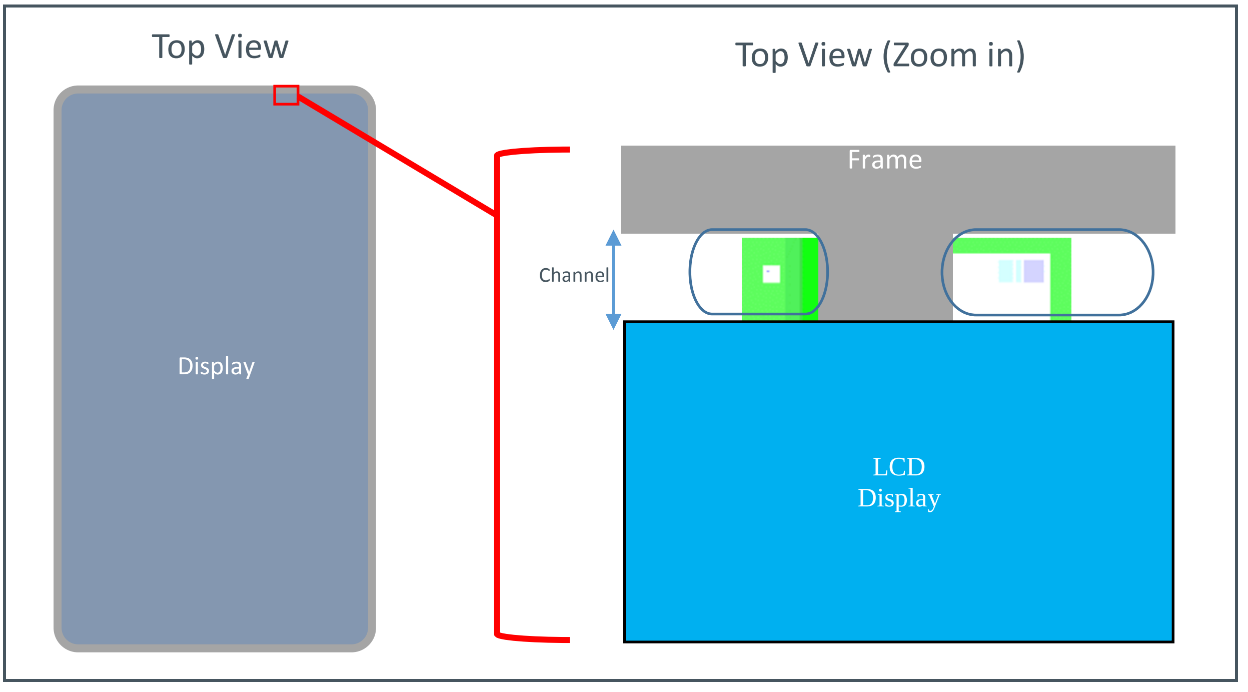
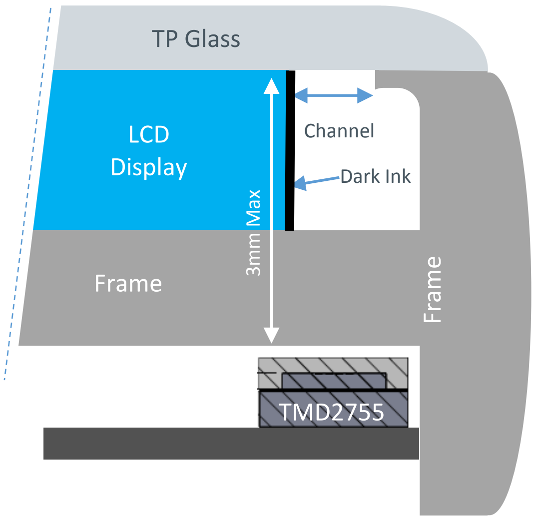


**Figure 2:**
**End View of the TMD2755 and Channel**




Because of the large air gap, it is important to design the optical stack to minimize the crosstalk. High crosstalk will be primarily due to reflections off the cover glass, but also due to reflections from every surface within the channel between the sensor device and the cover glass. This crosstalk potential is worsened by the intersection of the FOV/FOI cones below the surface of the glass. The worst contributors to the crosstalk will be the direct (single-bounce) reflections of the emitted IR from the underside of the glass. However, weaker multi-path reflections from every surface in the channel will all add up to increase the crosstalk. In order to minimize system crosstalk, the following crosstalk reduction techniques should be implemented (refer to Figure 3):

- Employ an optical barrier between the emitter and the detector from the top of the sensor device to the bottom side of the cover glass. This will effectively create two separate channels: one for the emitter and one for the detector. The barrier should be made of an opaque, low-reflectance black material with a matte finish.
- Within each of the channels created by the barrier (emitter and detector), the surfaces should be coated or lined with a black matte, low-reflectance material.
- Add an ink stripe to the bottom side of the glass between the emitter and the detector.

Notable in Figure 3 is the diffusor above the photodiode aperture. This diffusor is required in order to achieve a reasonable FOV for Ambient Light Sensing (ALS). If the application is proximity only, the diffusor is not required, and removing it will improve proximity performance. This is due to the higher transmissivity without the diffusor allowing additional reflected IR to reach the phototdiode.

**Figure 3:**
**Optical Stack Crosstalk Reduction**

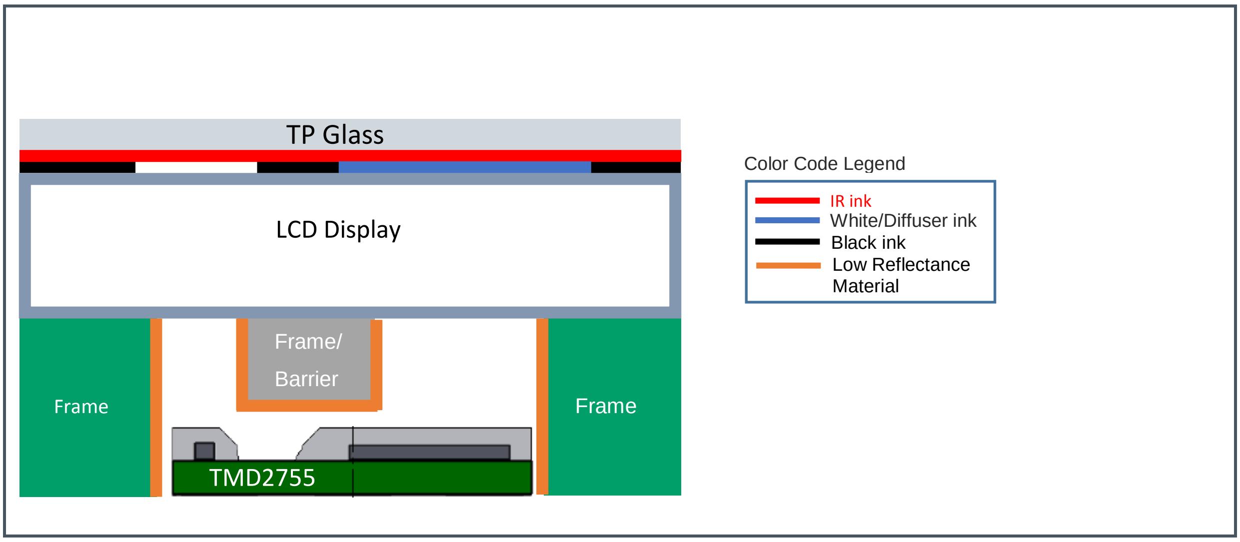
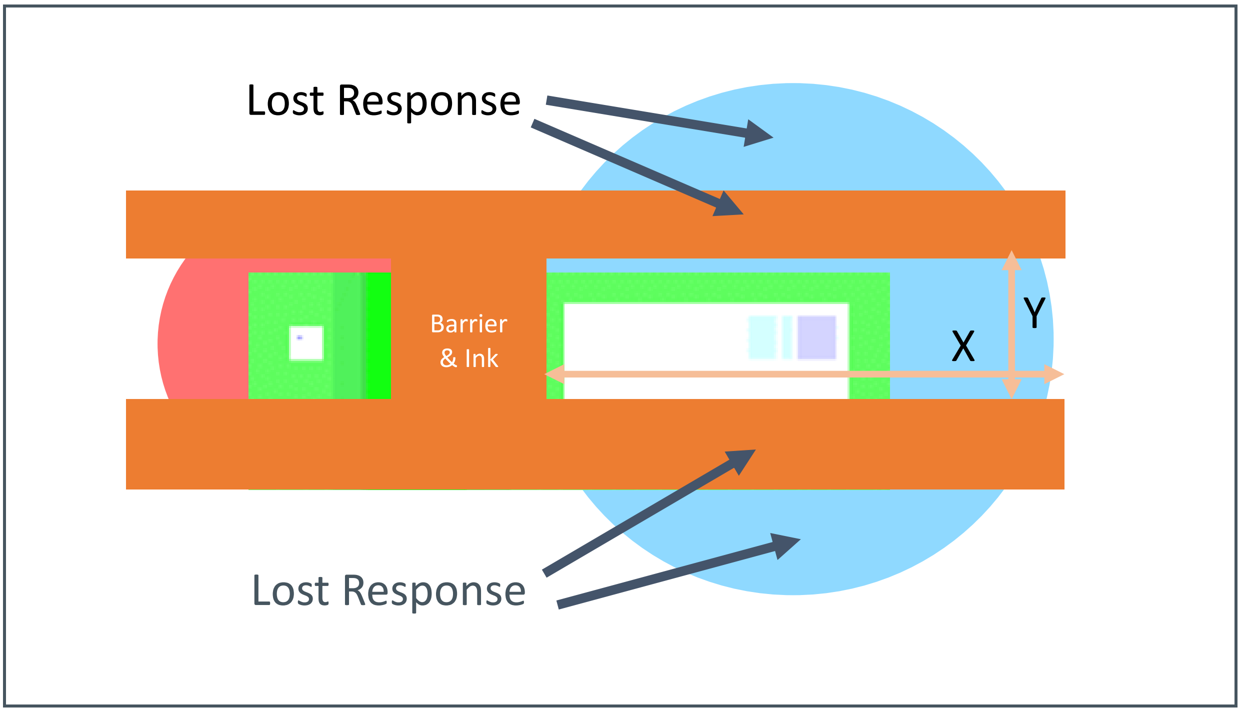



Figure 4 illustrates the effect on the FOI and FOV when a sensor is placed in a narrow channel. The red circle represents the FOI of the emitter and the blue circle represents the FOV of the photodiode. Clearly, both are restricted by the mechanical structure of this design. This loss of emitter power and loss of photodiode response means more power will be required to get an acceptable proximity response curve. With more power comes higher crosstalk, so it will be necessary to make performance tradeoffs (power vs. crosstalk vs. detect/release distance). Using the widest possible channel (Y), designing the apertures so there is minimal, if any, “clipping” in the “X” direction, and maintaining tight mechanical tolerances will be key to getting the best performance.

On the photodiode side, the use of a diffusor or a light pipe will effectively widen the FOV. On the emitter side, the aperture should remain IR ink to keep the transmissivity high and to reduce scatter.

**Figure 4:**
**FOI/FOV Restrictions**




Light leakage from the emitter aperture refers to any external light that finds a path from the emitter aperture directly or indirectly to the photodiode, potentially affecting either proximity or ALS measurements. This light leakage can be minimized using the same techniques previously discussed: a barrier, coating surfaces with low-reflectance, black matte material, ink stripe, etc.

The edge of the LCD screen could be reflective enough to create crosstalk. It could also emit light that would affect the ALS measurement. To eliminate these effects, add black ink, black film, etc. along the display edge.

# 3 Conclusion

The optical stack for a narrow bezel TMD2755 design should be carefully designed to overcome all the large airgap challenges. It is recommended to simulate the optical stack design performance and build prototypes for testing.

# 4 Glossary

- IR-LED: Infrared Light Emitting Diode
- VCSEL: Vertical Cavity Surface Emitting Laser
- ALS: Ambient Light Sensing
- FOV: Field of View
- FOI: Field of Illumination
- IR Ink: Ink that passes IR wavelengths and blocks visible wavelengths

**For further information, please refer to the following documents:**

- TMD2755 Optical Design Guide …

# 5 Revision Information

| Changes from previous version to current revision v1-00 | Page |
| --- | --- |
| Initial version | |
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- Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
- Correction of typographical errors is not explicitly mentioned.

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