Construction of trays for pmd ToF devices for the use in calibration boxes

*by **pmd**technologies*

Abstract

For calibration of ToF devices ***pmd**technologies* ag uses two calibration boxes. On top of each box the ToF devices are mounted into a special tray. There are several requirements the tray has to fulfill like a fixed and reproducible position and an easily built-in and –out process of the ToF device. Considering those features for designing the tray is content of this document.

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1. General Requirements

The tray is put on top every calibration box – in a notch of a black housing plate. This notch accepts dimensions of 250mm times 150mm (the thickness depends on the size of the ToF device) for the tray. Figure 1 shows the arrangement of the tray (grey) together with a ToF device (blue) within the top black housing plate (black) of the calibration box. It is centered and the orientation is consistent to the field of view (FoV) of the ToF device (usually in a landscape view).

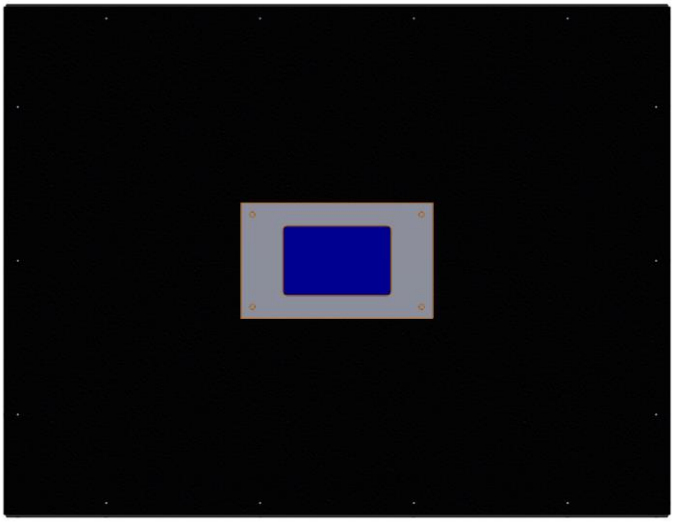

Figure 1: Tray (grey) position is centered within the black housing plate (black). The orientation of the ToF device (blue) corresponds to the tray orientation.

1.1. Choice of material

The material for the tray has to be chosen to fulfill the following requirements:

1) Hard enough to guarantee stiffness,
2) soft enough to not damage (like scratches etc.) the ToF device while (dis-)mounting,
3) nonmetallic to prevent eletrical shortcuts in a ToF device without housing,
4) light-tight to avoid any unwanted light reflections from outside the calibration box or inside the tray,
5) easily manufacturable.

Black Polyoxymethylene (POM) has been proved successfully to satisfy all these requirements and is recommended by pmdtechnologies ag. Nevertheless, the bottom part of the tray has to be coated with cellular rubber to eliminate reflections.

1.2. Tray mounting

There are two aluminum strut profiles (bright blue) on top of the calibration box. The tray is mounted on top of these two strut profiles with 4 M6 screws at the edges. It can be shifted in all directions (red and purple arrows) to plumb the center as shown in Figure 2. It is limited to a few mm in each direction due to the top black housing plate.

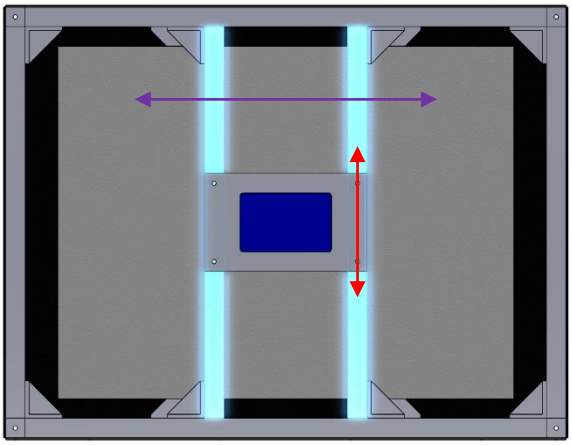

Figure 2: Tray mounting onto aluminum strut profiles (light blue). Shift is possible in all four directions to plumb the center.

The ToF device inside the tray has to be arranged in that way, that the lens (green) of the ToF device is centered inside the tray (grey) and thus inside the whole box (c.f. Figure 3).

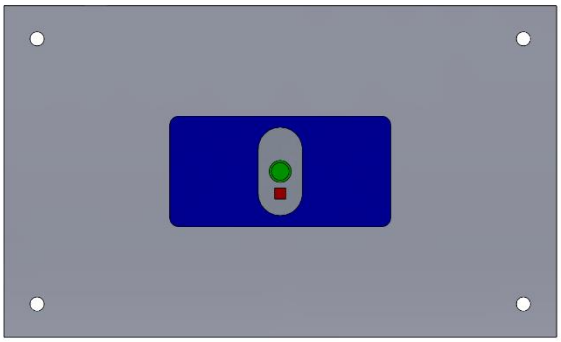

Figure 3: Bottom view of the tray: The ToF device (blue) has to be mounted into the tray (grey) in that way that the lens (green) lies exactly in the center of the tray.

2. Active illumination fiber coupling

Coupling out the whole light from the active illumination (like VCSELs, LEDs) into a bundle of light fibers is necessary for calculating the wiggling parameters in the fiber calibration box. A schematic principle of how to do this coupling is presented in Figure 4.

In this example the light (light yellow) is emitted from the VCSEL (yellow). A prism (grey) deflects the light beam into a fiber bundle (purple). The widespread opening angle of the VCSEL causes the intensity of the light hitting the prism to decrease enormously with distance. Therefore both distances between VCSEL and prism on the one hand and between the prism and the fiber bundle have to be as small as possible.

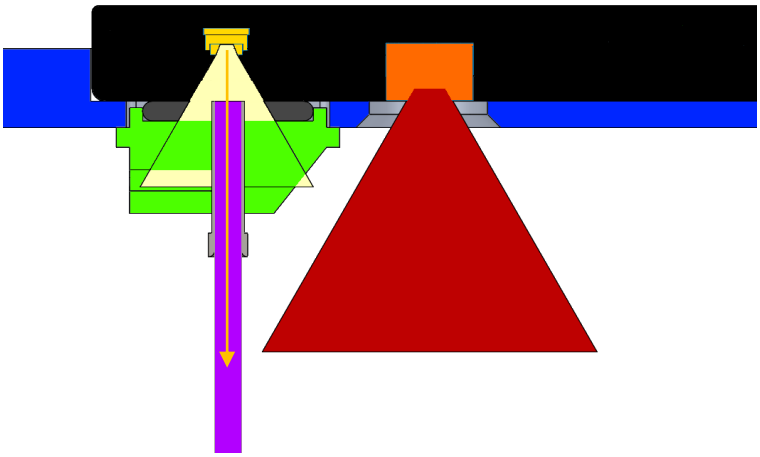

Figure 4: VCSEL light coupling into a fiber bundle. Light (light yellow) from the VCSEL (yellow) propagates directly into a fiber bundle (purple). A seal ring (grey around purple) is used to avoid stray light from around the fiber bundle. The FoV (red) of the lens (orange) is not distorted by mechanical parts of the tray (blue and green).

The fiber bundle can be fixed light-tight in a nonmetallic component (green) via a small screw from the bottom (not shown in the sketch), so that no stray light can intrude and the position is reproducible. It is important to guarantee that no direct light from the VCSEL reaches the inner part of the lens or the ToF sensor chip. Cellular rubber (dark grey) is necessary between all boundary layers to avoid this.

Alternatively the fiber bundle can be mounted directly onto the VCSEL but at a certain angle (not shown in the figure) to not appear in the FoV (red, as shown in Figure 4) of the lens. Using a prism makes reaching this aim easier.

3. ToF device mounting

The ToF device has to be mounted inside the tray at a precise and reproducible position. Switching from one device to another has to be done very fast and easily forcing the use of quick release skewers rather than screws.

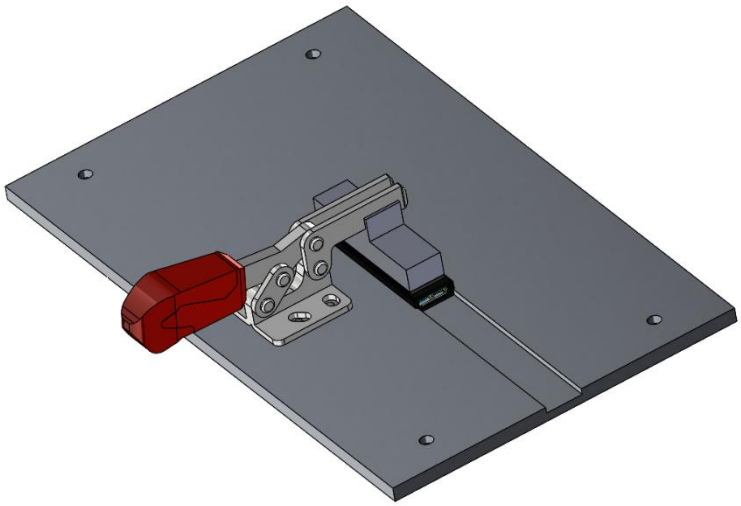

Figure 5: Mounting the ToF device (black) inside a deepening in the middle of the tray. A toggle clamp fixes the ToF device in a reproducible position with the possibility of easily changing it.

Reproducibility is absolutely necessary to guarantee a working VCSEL light coupling into the fiber (cf. section 0

Active illumination fiber coupling) and the lens being in the center position (cf. section 0

Tray mounting).

The fast and easily switching can be guaranteed by e.g. using a toggle clamp as shown in Figure 5. The ToF device lies in a deepening which allows reproducibility after switching the device.

In case the ToF devices are connected via e.g. USB plugs, enough space for this connector has to be designed. If the ToF device is already built within a standalone device like a phablet, smartphone or tablet, its touchscreen has to be accessible to launch apps.

4. Dummy

The LED calibration box needs an exact alignment of the lens being directly above a red center LED. Otherwise the lens calibration cannot be performed. The easiest way to get the correct position of the lens is to design a simple dummy (red) of the ToF device and to design a small hole at exactly that position, where the center of the lens is located. This is shown in Figure 6.

This dummy does not need to have many details or any functionality, it just has to fit inside the tray and sit there as fixed as a ToF device would do. The small hole for the lens has to be about 1mm in diameter to lead a string with a plumb bob (cf. LED calibration box). The toggle clamp can be used to fix the string and to exploring the center position.

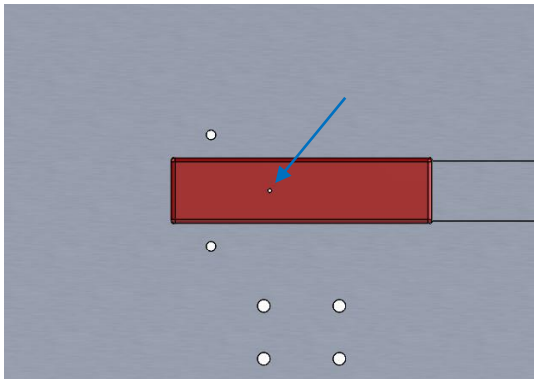

Figure 6: Dummy (red) inside the tray (grey). It is fixed in the same position as a ToF device is. A small hole (indicated by blue arrow) to lead a string through indicates the center of the lens of the ToF device.

Document History

Document title: Tray design for calibration boxes – Cal-1-5-AN

Revision	Origin of Change	Submission Date	Description of Change
0	SMa	2016-04-26	New Application Note
1	SMa	2016-11-11	Update VCSEL coupling