

This design-in guide discusses OB1203 thermal management, optical cross talk reduction, and reflective signal strength optimization for PPG and proximity measurements.

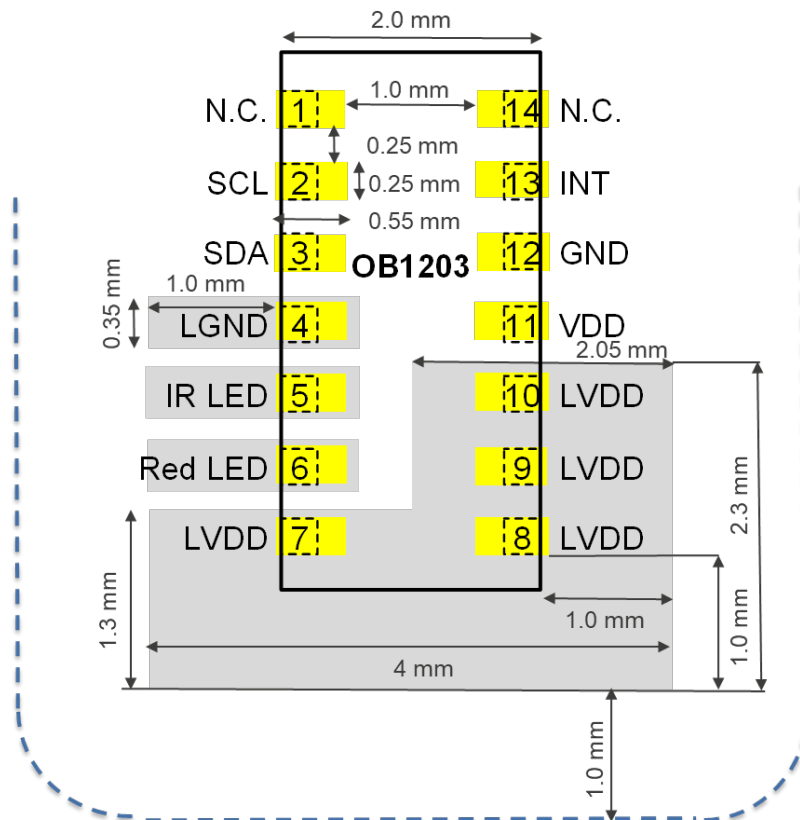
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1. PCB Layout Suggestions for Heat Dissipation

Suggested layout, 1oz Cu:

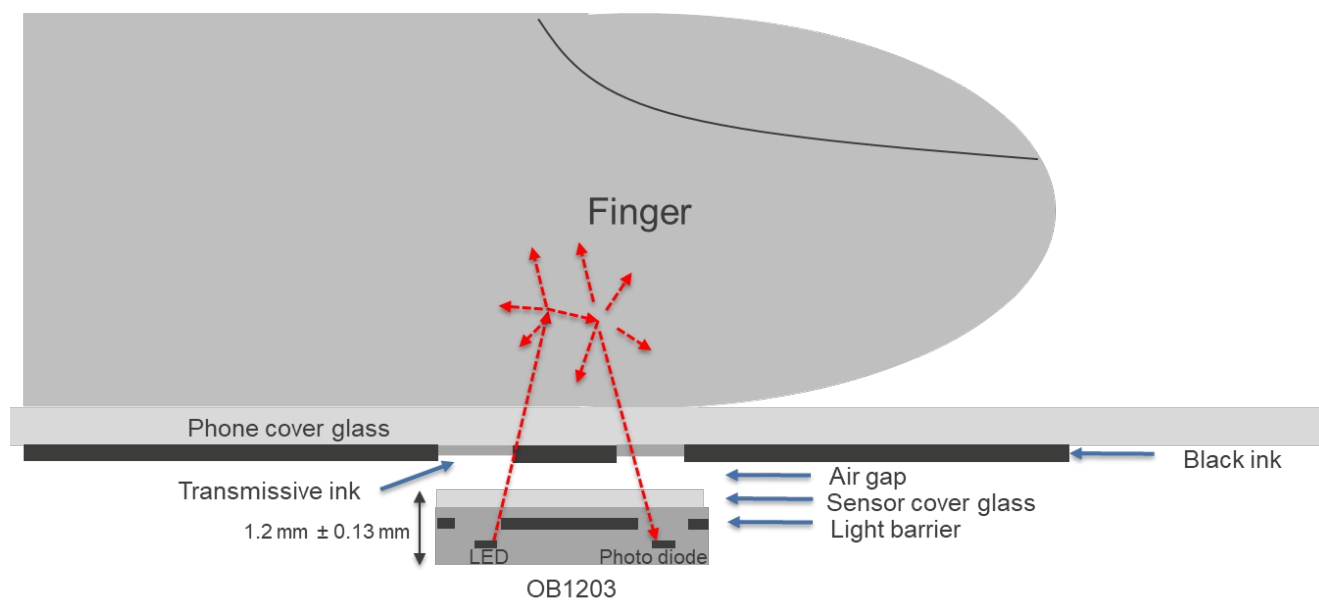
- $\geq 0.25\text{mm}$ traces for LGND and LVDD
- $\geq 0.15\text{mm}$ traces for all other pins
- $4.7\mu\text{F}$ between LVDD and LGND
- $0.1\mu\text{F}$ between VDD and GND
- Put caps as close as possible to sensor



Note: In order to reduce heat production, keep the VLED headroom small.

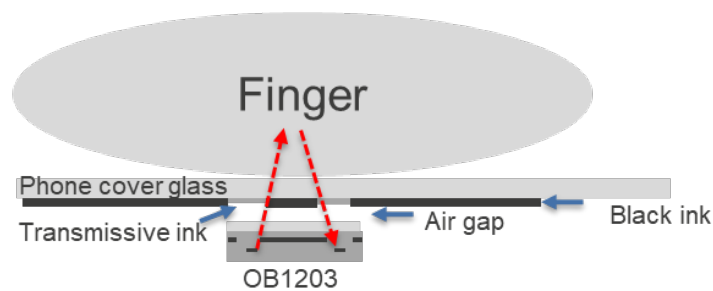
-  Top layer copper under solder mask
-  Opening in solder mask

2. Suggestions for Ink Masking



3. 50% Beam Intensity Cutoff Dimensions and Ink Hole Placement Suggestions

- Considering nominal 1.2mm package height
- Minimum hole diameter 2mm is suggested to achieve 45° RGB FOV in L-R and U-D direction at 200µm air gap (top of package to bottom of cover glass)
- 400µm air gap achieves $\sim \pm 40^\circ$ FOV
- Ink hole spacing = 2.6mm (center to center)
- Ink hole should be centered over RGB sensor array
- Matching circular hole for LEDs should be placed at least 2.6mm away (center to center) to create a central “bridge” region with black ink
- Alignment tolerance of ± 0.1 mm offers similar total FOV with center direction shifted by $\sim 6^\circ$

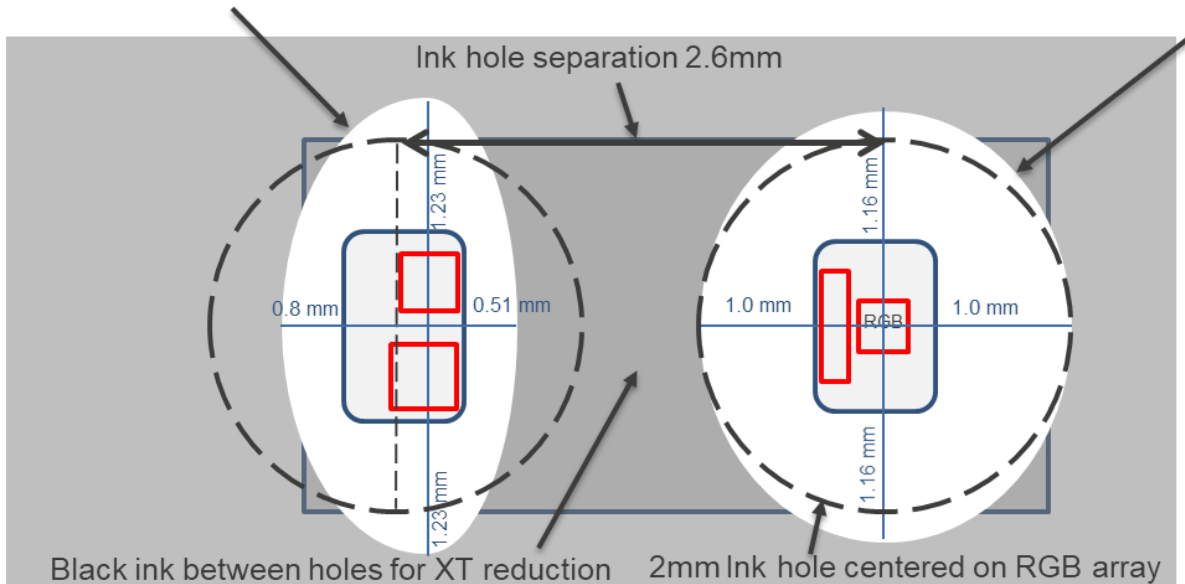


Half axes of the 50% LED FOV marginal ray (from top, clockwise):

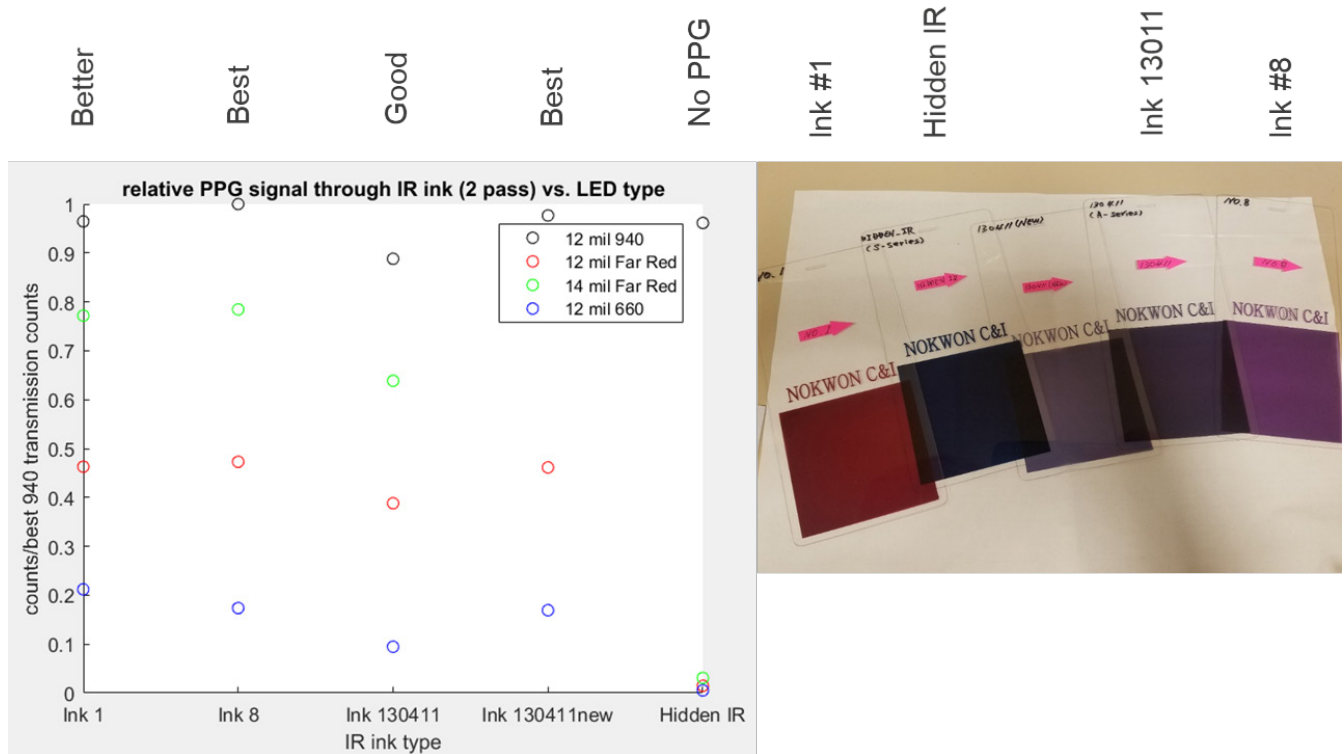
- 0.20mm air gap: 1.23mm, 0.51mm, 1.23mm, 0.80mm

Half axes of the RGB sensor 50% FOV marginal ray

- 0.20mm air gap: U/D 1.16mm (50 deg), L/R 1.00mm (45deg)
- 0.40mm air gap: U/D 1.40mm (50 deg), L/R 1.20mm (45deg)



4. IR Ink Type and LED Wavelength Comparison: Relative PPG Signal



Analysis:

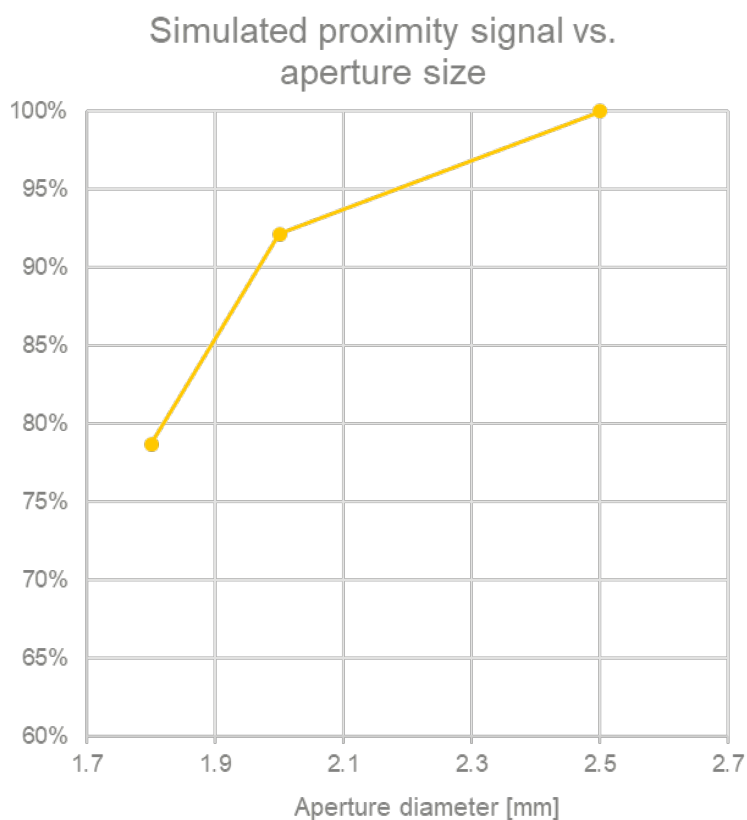
- Far red signal superior to 660 nm light
- Far red signal is 90% of 940 with no ink
- Observed 2-pass ink transmission at 75-80% of 940 signal.

5. Hole vs. Racetrack Comparison

Result		II	III
			
PS	Signal (uW/cm ²)	13.63	13.63
	xtalk (uW/cm ²)	0.16	0.53
	SBR	85.9	25.7

- Racetrack (single oval) design (III) has 3.3 x higher crosstalk for proximity sensing (0.53μW / cm²) than the design with two 2mm holes
- Racetrack (single oval) design has about 15% higher bio signal
- Two holes are suggested for low cross talk designs

6. Proximity Signal Aperture Scaling



- Proximity signal varies little for apertures ≥ 2.0 mm
- $< \pm 10\%$ variation for 1.8μm hole and $\pm 200\mu\text{m}$ xy tolerance

7. PPG Measurements with Cover Glass without Ink Masking

Transparent covers on top of the sensor may increase optical crosstalk due to Fresnel reflections at the added cover-air interfaces and due to potential light diffusion within the material. In general, crosstalk is different for IR and red light (due to the wave length and the location of the LEDs / sensors in the sensor package) affecting the data for the SpO₂ calculation, and therefore, the SpO₂ value itself.

The following table lists a few examples of non-glass cover materials and their IR and red light crosstalk. As crosstalk changes with LED current, the normalized crosstalk in the last two columns is a good measure for the magnitude of the crosstalk. The crosstalk was measured in ADC counts of the sensor signal without any target object on top of the sensor. The LED current was the current during the crosstalk detection.

Material	Material Thickness and Air gap in mm	IR Crosstalk in ADC Counts	Measured at IR LED Current in mA	Red Crosstalk in ADC Counts	Measured at Red LED Current in mA	IR ADC Count / mA	Red ADC Count / mA
No cover	NA	130	96	80	64	1	1
High-Density Polyethylene	0.3mm thick, no air gap	940	170	910	127	6	7
High-Density Polyethylene	0.3mm thick, 1mm air gap	6070	170	5050	127	36	40
Acrylic	3mm thick, no air gap	5270	168	3500	127	31	28
Optical Silicone	1mm thick, no air gap	2040	170	3140	126	12	25
Optical Silicone	1mm thick, 1mm air gap	12700	169	13500	125	75	108
Polypropylene	1mm thick, no air gap	27200	106	33200	77	257	431

The crosstalk can add a significant ADC count to the PPG signal. Due to skin color and perfusion, the normalized PPG signal (without crosstalk) at the finger-tip may decrease to the range of:

- 150 counts / mA for IR
- 200 counts / mA for red

According to the table, High-Density Polyethylene, Acrylic, and optical Silicone (the last one if used without air gap) are suitable choices showing the lowest ADC counts per mA.

Optical crosstalk can be subtracted from the red and IR ADC count by software (before the ADC counts is used in the SpO₂ algorithm). As crosstalk is linear with the LED current, the crosstalk correction needs to be multiplied with the LED current.

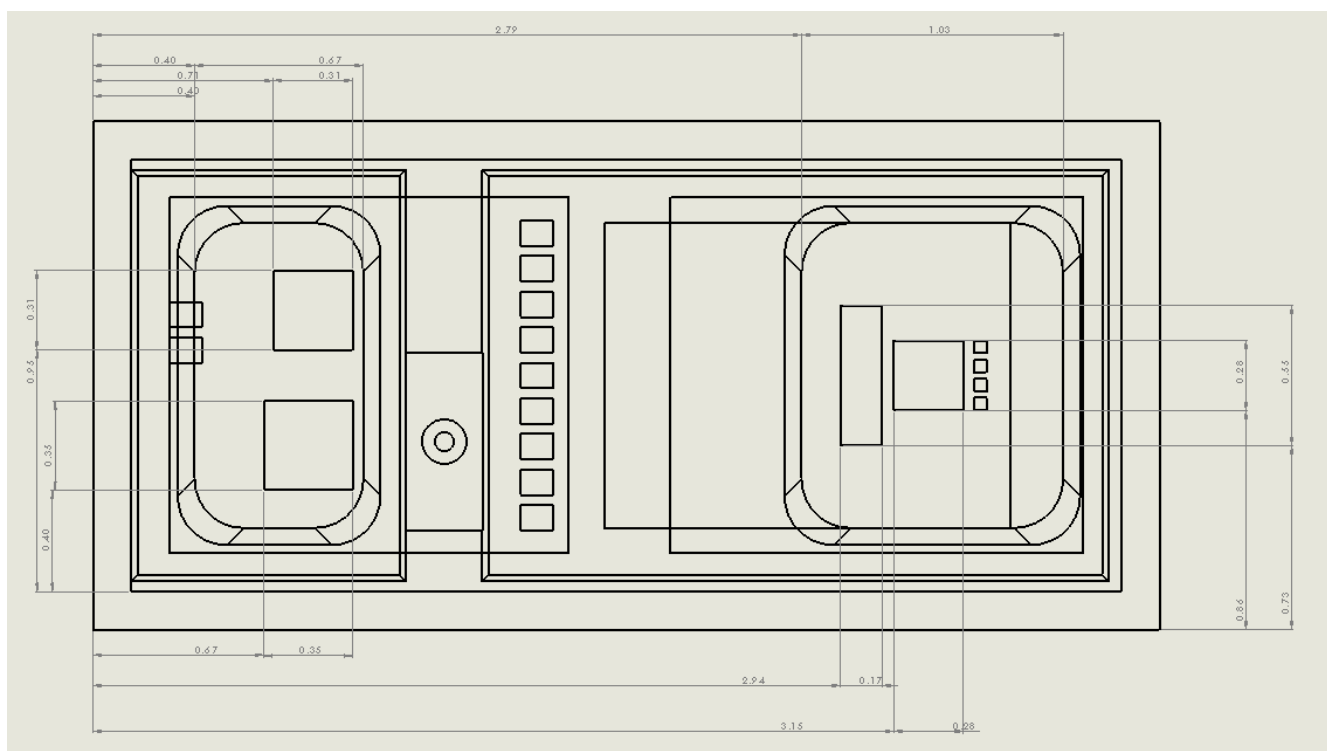
Crosstalk may change due to contamination or mechanical pressure on a mechanical flexible sensor cover (like silicone) and can differ from assembly to assembly. Therefore, crosstalk cancellation works best when relative crosstalk changes and the crosstalk itself are small.

8. PPG Measurements without Cover Glass

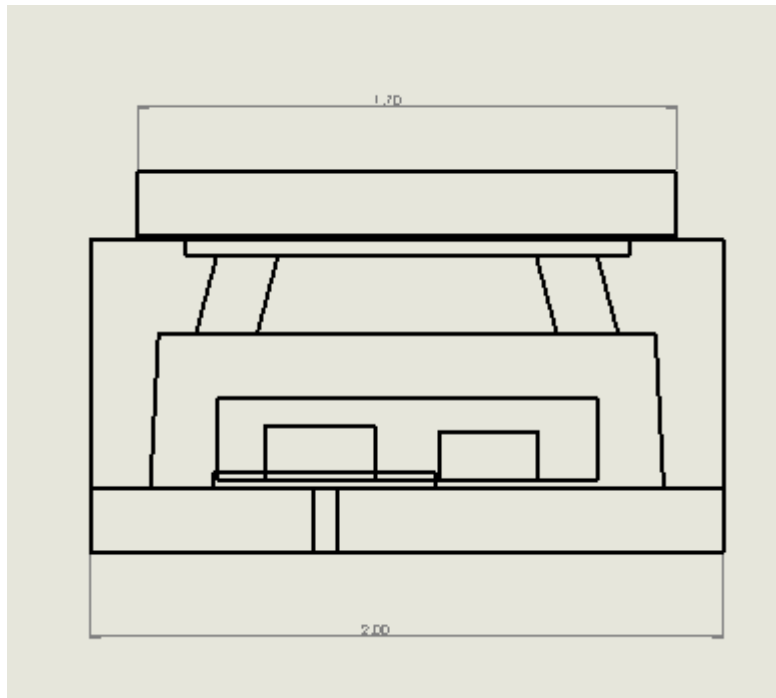


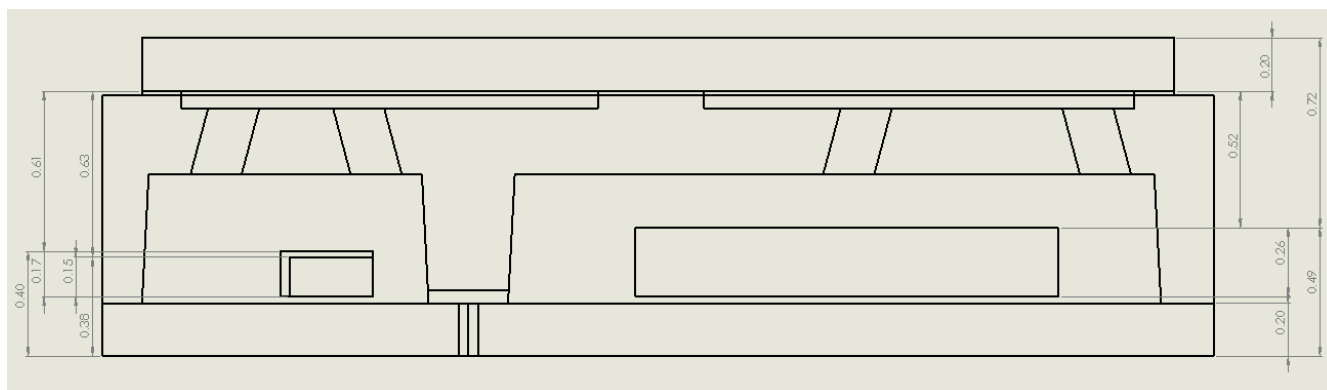
- Pressing the sensor directly into the skin restricts blood flow and the modulation of the PPG signal during a heartbeat.
- A finger rest reduces the finger / sensor pressure and variability.
- To keep the optical crosstalk low, the finger rest should not reach above the sensor glass and/or be black in color (see figure).
- A diffuse white finger rest recollects laterally scattered light from a larger tissue volume improving the SNR.

9. Optical Element Locations and Package Dimensions

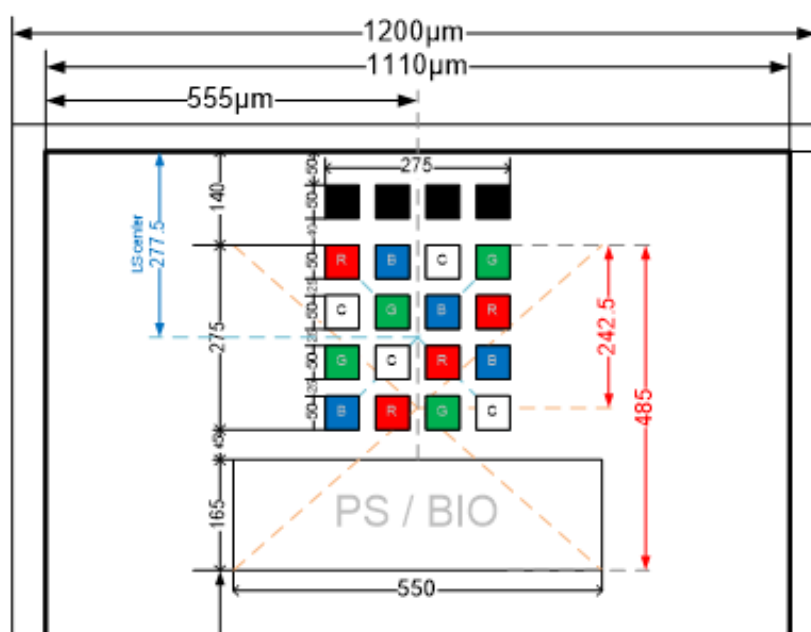


Side views





10. Optical Sensor Geometry Details



11. Revision History

Revision	Date	Description
1.1	Mar 3, 2021	Added PPG Measurements with Cover Glass without Ink Masking
1.0	Oct 29, 2020	Initial release.

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(Rev.1.0 Mar 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

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