AN5897

Application note

PCB thermal guidelines for the VL53L8 Time-of-Flight (ToF) multizone sensor family

Introduction

This application note covers all multizone sensors of the VL53L8 family, whatever the suffix (example: VL53L8CX and VL53L8CH).

When used in continuous mode, the VL53L8 module typically consumes 215 mW of power. Consequently, it requires careful thermal management to ensure optimum device performance and to avoid overheating.

Table 1. Main thermal parameters

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power consumption	P	—	215 (1)	320	mW
Junction temperature (2)	T_J	—	—	110	°C
Die thermal resistance	θ_{die}	—	—	43	°C/W
Operating temperature range	T	-30	25	85	°C

1. *AVDD = 2.8 V and IOVDD = 1.8 V of typical current consumption.*
2. *To prevent thermal shutdown, the junction temperature must be kept below 110 °C.*

Figure 1. VL53L8 ranging sensor module

1 Thermal design basics

The symbol θ is generally used to denote thermal resistance which is a measure of a temperature difference by which an object or material resists a heat flow. For example, when transferring from a hot object (such as silicon junction) to a cool one (such as module backside temperature or ambient air).

The formula for thermal resistance is shown below and is measured in °C/W:

$$\theta = \frac{\Delta T}{P}$$

Where ΔT is the rise in junction temperature and P is the power dissipation.

So, for example, a device with a thermal resistance of 100 °C/W exhibits a temperature differential of 100°C for a power dissipation of 1 W as measured between two reference points.

The formula is as follows:

$$\theta_{pcb} = \left(T_J - T_A\right) \div P - \theta_{die}$$

$$\theta_{pcb} = \left(110 - T_A\right) \div P - 43$$

Where:

- T_J is the junction temperature
- T_A is the ambient temperature
- θ_{die} is the die thermal resistance
- θ_{pcb} is the thermal resistance of the PCB or flex

2 Thermal resistance of PCB or flex

The maximum permitted junction temperature of the VL53L8 is 110°C. The maximum permitted PCB or flex thermal resistance is calculated as shown below. This calculation is for a power dissipation of 0.320 W, and device operation at 85°C (worst case scenario of the maximum specified ambient temperature).

$$\theta_{pcb} = \left(T_J - T_A\right) \div P - \theta_{die}\right)$$

$$\theta_{pcb} = \left(110 - 85\right) \div 0.320 - 43$$

$$\theta_{pcb} = 35°C/W$$

Note: To ensure that the maximum junction temperature is not exceeded, and to ensure optimum module performance, do not exceed the above target thermal resistance. For a typical system dissipating 320 mW, the maximum temperature rise is < 11°C. This is recommended for optimum performance of the VL53L8.

3 Layout and thermal guidelines

Use the following guidelines when designing the module PCB or flex:

- Maximize the copper cover on the PCB to increase the thermal conductivity of the board.
- Use the module, thermal pad B4 shown in Figure 2. VL53L8 pinout and thermal pad (see the datasheet for more details). Add a single large rectangle of solder paste. It should be the same size as the thermal pad (eight rectangles) as per Figure 3. Recommendation for the thermal pad and via on the PCB. STMicroelectronics recommends to stitch the eight vias from top to bottom, so the bottom mask is open and the pad is exposed.
- Use wide tracking for all signals particularly power and ground signals. Track and connect them into adjacent power planes where possible.
- Add heat sinking to the chassis or frames to distribute heat away from the device.
- Do not place next to other hot components.
- Place the device in a low power state when not in use.

Figure 2. VL53L8 pinout and thermal pad

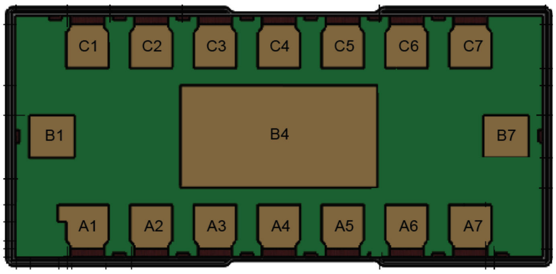
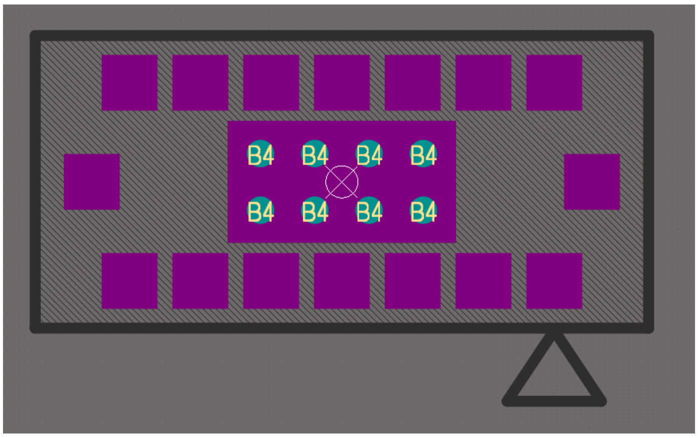


Figure 3. Recommendation for the thermal pad and via on the PCB



Revision history

Table 2. **Document revision history**

Date	Version	Changes
30-Jan-2023	1	Initial release
10-Aug-2023	2	Document updated to support the VL53L8 family of sensors.