AN5853

Application note

PCB thermal guidelines for the VL53L7 Time-of-Flight (ToF) multizone sensor family

Introduction

This application note covers all multizone sensors of the VL53L7 family, whatever the suffix (example: VL53L7CX and VL53L7CH).

When used in continuous mode, the VL53L7 sensors require 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	—	216 (1)	430 (2)	mW
Module thermal resistance	θ_{mod}	—	40	—	°C/W
Junction temperature (3)	T_J	—	—	100	°C
Operating temperature range	T	-30	25	70	°C

1. *AVDD = 2.8 V; IOVDD = 1.8 V typical current consumption.*
2. *AVDD = 3.3 V; IOVDD = 3.3 V maximum current consumption.*
3. *To prevent thermal shutdown, the junction temperature must be kept below 110°C.*

Figure 1. VL53L7 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.

If a module is soldered to a PCB or flex then the total system thermal resistance is the sum of the module thermal resistance and the thermal resistance of the PCB or flex to the ambient/air. The formula is as follows:

$$\Delta T = \left(T_J - T_A\right) = P \times \left(\theta_{\mathrm{mod}} + \theta_{pcb}\right)$$

Where:

- T_J is the junction temperature
- T_A is the ambient temperature
- θ_{mod} is the module 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 VL53L7 sensors is 100°C. So, for a power dissipation of 0.43 W, operating at the maximum specified ambient temperature of 70°C (worst case scenario), the maximum permitted PCB or flex thermal resistance is calculated as follows:

- $T_J - T_A = P \times (\theta_{mod} + \theta_{pcb})$
- $100 - 70 = 0.43 \times (40 + \theta_{pcb})$
- $\theta_{pcb} = \frac{100 - 70}{0.43} - 40$
- $\theta_{pcb} \approx 30°C/W$

This gives a combined system thermal resistance of 70°C/W ($\theta_{mod} + \theta_{pcb}$).

Note: To ensure that the maximum junction temperature is not exceeded, and to ensure optimum module performance, STMicroelectronics recommends that you do not exceed the above target thermal resistance.

For a typical system dissipating of 216 mW, the maximum temperature rise is < 20°C. This is recommended for optimum performance of the VL53L7 sensors.

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. VL53L7 pinout and thermal pad (see the datasheet for more details). Add as many thermal vias as possible to maximize thermal conductivity into adjacent power planes (refer to Figure 3. Recommendation for the thermal pad and via on the PCB).
- 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. VL53L7 pinout and thermal pad

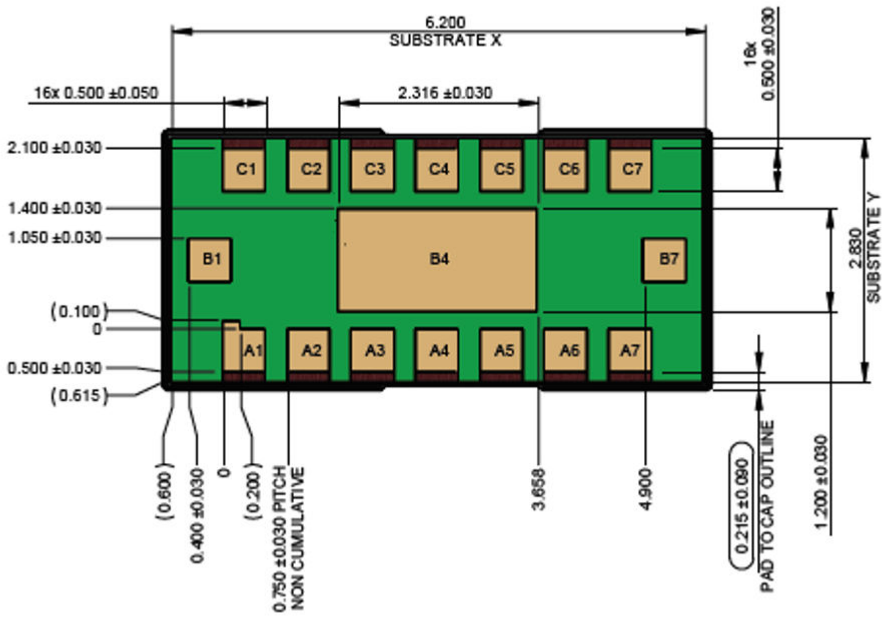
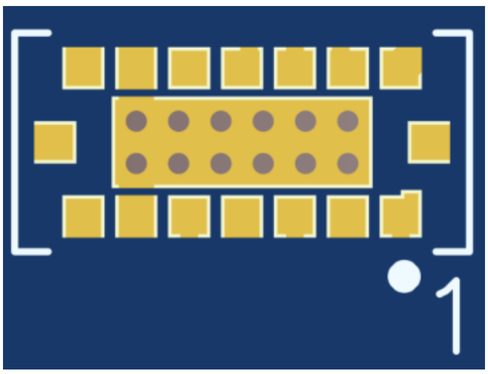


Figure 3. Recommendation for the thermal pad and via on the PCB



Revision history

Table 2. **Document revision history**

Date	Version	Changes
20-Sep-2022	1	Initial release
10-Aug-2023	2	Document updated to support the VL53L7 family of sensors.