World smallest Time-of-Flight ranging and gesture detection sensor

世界上最小的飞行时间测距和姿态检测传感器

## Applications

## 应用程序

**Datasheet** - **production data**

**数据表-生产数据**



## Features

## 特征

* Fully integrated miniature module
* 完全集成的微型模块
  + 940nm Laser VCSEL
  + 940纳米激光垂直腔面发射激光器
  + VCSEL driver
  + VCSEL驱动器
  + Ranging sensor with advanced embedded micro controller
  + 具有先进嵌入式微控制器的测距传感器

– 4.4 x 2.4 x 1.0mm

–4.4 x 2.4 x 1.0毫米

* Fast, accurate distance ranging
* 快速、精确的测距
  + Measures absolute range up to 2m
  + 测量最高2米的绝对范围
  + Reported range is independent of the target reflectance
  + 报告的范围与目标反射率无关
  + Operates in high infrared ambient light levels
  + 在高红外环境光水平下工作
  + Advanced embedded optical cross-talk compensation to simplify cover glass selection
  + 先进的嵌入式光学串扰补偿，简化盖板玻璃选择
* Eye safe
* 眼睛安全
  + Class 1 laser device compliant with latest standard IEC 60825-1:2014 - 3rd edition
  + 符合最新标准IEC 60825-1:2014第三版的1级激光设备
* Easy integration
* 易于集成
  + Single reflowable component
  + 单个可回流元件
  + No additional optics
  + 没有附加光学器件
  + Single power supply
  + 单电源
  + I2C interface for device control and data transfer
  + 用于设备控制和数据传输的I2C接口
  + Xshutdown (Reset) and interrupt GPIO
  + Xshutdown(复位)并中断GPIO
  + Programmable I2C address
  + 可编程I2C地址
* User detection for Personal Computers/ Laptops/Tablets and IoT (Energy saving).
* 个人电脑/笔记本电脑/平板电脑和物联网(节能)的用户检测。
* Robotics (obstacle detection).
* 机器人技术(障碍物检测)。
* White goods (hand detection in automatic faucets, soap dispensers etc...)
* 白色家电(自动水龙头、皂液器等的手部检测...)
* 1D gesture recognition.
* 1D手势识别。
* Laser assisted Auto-Focus. Enhances and speeds-up camera AF system performance, especially in difficult scenes (low light levels, low contrast) or fast moving video mode.
* 激光辅助自动对焦。增强和加快相机自动对焦系统的性能，尤其是在困难的场景(低亮度、低对比度)或快速移动视频模式下。

## Description

## 描述

The VL53L0X is a new generation Time-of-Flight (ToF) laser-ranging module housed in the smallest package on the market today, providing accurate distance measurement whatever the target reflectances unlike conventional technologies. It can measure absolute distances up to 2m, setting a new benchmark in ranging performance levels, opening the door to various new applications.

VL53L0X是新一代飞行时间(ToF)激光测距模块，采用当今市场上最小的封装，与传统技术不同，无论目标反射率如何，都能提供精确的距离测量。它可以测量高达2米的绝对距离，在测距性能水平方面树立了新的基准，为各种新应用打开了大门。

The VL53L0X integrates a leading-edge SPAD array (Single Photon Avalanche Diodes) and embeds ST’s second generation FlightSenseTM patented technology.

VL53L0X集成了前沿的SPAD阵列(单光子雪崩二极管)，并嵌入了ST的第二代FlightSenseTM专利技术。

The VL53L0X’s 940nm VCSEL emitter (Vertical Cavity Surface-Emitting Laser), is totally invisible to the human eye, coupled with internal physical infrared filters, it enables longer ranging distance, higher immunity to ambient light and better robustness to cover-glass optical cross-talk.

VL53L0X的940纳米垂直腔面发射激光器发射器(垂直腔面发射激光器)，人眼完全看不见，加上内部的物理红外滤波器，它能够实现更长的测距距离、更高的环境光抗扰度以及对盖玻片光学串扰的更好鲁棒性。

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## Technical specification

## 技术规范

#### Table 1. Technical specification

#### 表1。技术规范

|  |  |
| --- | --- |
| **Feature** | **Detail** |
| Package | Optical LGA12 |
| Size | 4.40 x 2.40 x 1.00 mm |
| Operating voltage | 2.6 to 3.5 V |
| Operating temperature: | -20 to 70°C |
| Infrared emitter | 940 nm |
| I2C | Up to 400 kHz (FAST mode) serial bus Address: 0x52 |

|  |  |
| --- | --- |
| **特征** | **详述** |
| 包裹 | 光学LGA12 |
| 大小 | 4.40 x 2.40 x 1.00毫米 |
| 工作电压 | 2.6至3.5伏 |
| 工作温度: | -20至70℃ |
| 红外发射器 | 940牛米 |
| I2C | 最高400千赫(快速模式)串行总线地址:0x52 |

## System block diagram

## 系统框图

**Figure 1. VL53L0X block diagram**

**图1。VL53L0X框图**



940QP

$9''9&6(/

,5-

,5+

$9669&6(/

**9&6(/ 'ULYHU**

\*3,21

**5$0**

6&/

;6+87

**520**

6'$

$9''

\*1'

**9/53/0; PRGXOH**

**9/53/0; VLOLFRQ**

**$GYDQFHG 5DQJLQJ &RUH**

**0LFURFRQWUROOHU**

**1RQ 9RODWLOH**

**0HPRU\**

**'HWHFWLRQ DUUD\**

**6LQJOH 3KRWRQ**

**$YDODQFKH 'LRGH (63$')**



940QP

$9''9&6(/

,5-

,5+

$9669&6(/

**9&6(/ 'ULYHU**

\*3,21

**5$0**

6&/

;6+87

**520**

6'$

$9''

\*1'

**9/53/0; PRGXOH**

**9/53/0; VLOLFRQ**

**$GYDQFHG 5DQJLQJ &RUH**

**0LFURFRQWUROOHU**

**1RQ 9RODWLOH**

**0HPRU\**

**'HWHFWLRQ DUUD\**

**6LQJOH 3KRWRQ**

**$YDODQFKH 'LRGH (63$')**

[*Figure 2*](#_bookmark6) shows the pinout of the VL53L0X (see also [*Figure 22*](#_bookmark74)).

[*Figure 2*](#_bookmark6) 显示了VL53L0X的引脚排列(另请参见[*Figure 22*](#_bookmark74)

#### Figure 2. VL53L0X pinout (bottom view)

#### 图2。VL53L0X引脚排列(仰视图)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | \*1'3 |  | | |
| \*3,21 | **7** | **6** | **5** |  | ;6+87 |
| '1& | **8** |  | **4** |  | \*1'2 |
| 6'$ | **9** |  | **3** |  | \*1' |
| 6&/ | **10** |  | **2** |  | $9669&6(/ |
| $9'' | **11** | **12** | **1** |  | $9''9&6(/ |
|  |  |  |  |  |  |
|  |  | \*1'4 |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | \*1'3 |  | | |
| \*3,21 | **七** | **6** | **5** |  | ；6+87 |
| '1& | **8** |  | **四** |  | \*1'2 |
| 6'$ | **9** |  | **3** |  | \*1' |
| 6&/ | **10** |  | **2** |  | $9669&6(/ |
| $9'' | **11** | **12** | **一** |  | $9''9&6(/ |
|  |  |  |  |  |  |
|  |  | \*1'4 |  |  |  |

**Table 2. VL53L0X pin description**

**表2。VL53L0X引脚描述**

|  |  |  |  |
| --- | --- | --- | --- |
| **Pin number** | **Signal name** | **Signal type** | **Signal description** |
| 1 | AVDDVCSEL | Supply | VCSEL Supply, to be connected to main supply |
| 2 | AVSSVCSEL | Ground | VCSEL Ground, to be connected to main ground |
| 3 | GND | Ground | To be connected to main ground |
| 4 | GND2 | Ground | To be connected to main ground |
| 5 | XSHUT | Digital input | Xshutdown pin, Active LOW |
| 6 | GND3 | Ground | To be connected to main ground |
| 7 | GPIO1 | Digital output | Interrupt output. Open drain output. |
| 8 | DNC | Digital input | Do Not Connect, must be left floating. |
| 9 | SDA | Digital input/output | I2C serial data |
| 10 | SCL | Digital input | I2C serial clock input |
| 11 | AVDD | Supply | Supply, to be connected to main supply |
| 12 | GND4 | Ground | To be connected to main ground |

|  |  |  |  |
| --- | --- | --- | --- |
| **插脚数** | **信号名称** | **信号类型** | **信号描述** |
| 一 | AVDDVCSEL | 供应 | 连接到主电源的垂直腔面发射激光器电源 |
| 2 | AVSSVCSEL | 地面 | 垂直腔面发射激光器地，连接到主地 |
| 3 | GND | 地面 | 连接到主接地 |
| 四 | GND2 | 地面 | 连接到主接地 |
| 5 | XSHUT | 数字输入 | Xshutdown引脚，低电平有效 |
| 6 | GND3 | 地面 | 连接到主接地 |
| 七 | GPIO1 | 数字输出 | 中断输出。开漏输出。 |
| 8 | 昼夜能力(Day-Night Capability) | 数字输入 | 不连接，必须保持浮动。 |
| 9 | 国家药品监督管理局 | 数字输入/输出 | I2C串行数据 |
| 10 | SCL | 数字输入 | I2C串行时钟输入 |
| 11 | AVDD | 供应 | 电源，连接到主电源 |
| 12 | GND4 | 地面 | 连接到主接地 |

[*Figure 3*](#_bookmark9) shows the application schematic of the VL53L0X.

[*Figure 3*](#_bookmark9) 显示了VL53L0X的应用示意图。

#### Figure 3. VL53L0X schematic

#### 图3。VL53L0X原理图



,29''

$9''

5

7

9

10

8

1

11

2

3

4

6

12

100Q)

4.7)

+267

;6+87 $9''9&6(/

\*3,21 $9''

6'$ $9669&6(/

6&/ \*1'

'1& \*1'2

\*1'3

**9/53/0;** \*1'4



,29''

$9''

5

7

9

10

8

1

11

2

3

4

6

12

100Q)

4.7)

+267

;6+87 $9''9&6(/

\*3,21 $9''

6'$ $9669&6(/

6&/ \*1'

'1& \*1'2

\*1'3

**9/53/0;** \*1'4

*Note: Capacitors on external supply AVDD should be placed as close as possible to the AVDDVCSEL and AVSSVCSEL module pins.*

*注:外部电源AVDD上的电容应尽可能靠近AVDDVCSEL和AVSSVCSEL模块引脚。*

*Note: External pull-up resistors values can be found in I2C-bus specification. Pull-up are typically fitted only once per bus, near the host.*

*注:外部上拉电阻值可以在I2C总线规范中找到。主机附近的每条总线通常只安装一次上拉。*

*Recommended values for pull-up resistors for an AVDD of 2.8V and 400KHz I2C clock*

*2.8V和400千赫I2C时钟的AVDD上拉电阻推荐值*

*would be 1.5k to 2k Ohms.*

*将是1.5k到2k欧姆。*

*Note: XSHUT pin must always be driven to avoid leakage current. Pull-up is needed if the host state is not known.*

*注意:XSHUT引脚必须始终被驱动，以避免漏电流。如果主机状态未知，则需要上拉。*

*XSHUT is needed to use HW standby mode (no I2C comm).*

*需要XSHUT来使用硬件待机模式(无I2C通信)。*

*Note: XSHUT and GPIO1 pull up recommended values are 10k Ohms Note: GPIO1 to be left unconnected if not used*

*注:XSHUT和GPIO1上拉推荐值为10k欧姆注:如果不使用，GPIO1保持不连接*

## System functional description

## 系统功能描述

[*Figure 4*](#_bookmark12) shows the system level functional description. The host customer application is controlling the VL53L0X device using an API (Application Programming Interface).

[*Figure 4*](#_bookmark12) 显示了系统级功能描述。主机客户应用程序正在使用应用编程接口控制VL53L0X设备。

The API is exposing to the customer application a set of high level functions that allows control of the VL53L0X Firmware (FW) like initialization/calibration, ranging Start/Stop, choice of accuracy, choice of ranging mode.

该应用编程接口向客户应用程序公开了一组高级功能，允许控制VL53L0X固件(FW)，如初始化/校准、测距启动/停止、精度选择、测距模式选择。

The API is a turnkey solution, it consists of a set of C functions which enables fast development of end user applications, without the complication of direct multiple register access. The API is structured in a way that it can be compiled on any kind of platform through a well isolated platform layer.

该应用编程接口是一个交钥匙解决方案，它由一组C函数组成，能够快速开发最终用户应用程序，而无需复杂的直接多寄存器访问。该应用编程接口的结构使得它可以通过隔离良好的平台层在任何类型的平台上编译。

The API package allows the user to take full benefit of VL53L0X capabilities.

应用编程接口包允许用户充分利用VL53L0X的功能。

A detailed description of the API is available in the VL53L0X API User Manual (separate document, DocID029105).

在VL53L0X应用编程接口用户手册(单独的文档，文档029105)中提供了该应用编程接口的详细描述。

VL53L0X FW fully manages the hardware (HW) register accesses.

VL53L0X FW完全管理硬件(HW)寄存器访问。

[*Section 2.2: Firmware state machine description*](#_bookmark13) details the Firmware state machine.

[*Section 2.2: Firmware state machine description*](#_bookmark13) 详细说明固件状态机。

#### Figure 4. VL53L0X system functional description

#### 图4。VL53L0X系统功能描述

,2&

+DUGZDUH

)LUPZDUH

9/53/0;

$3,

&XVWRPHU

$SSOLFDWLRQ

**9/53/0;**

**+267**

,2&

+DUGZDUH

)LUPZDUH

9/53/0;

$3,

&XVWRPHU

$SSOLFDWLRQ

**9/53/0;**

**+267**

## Firmware state machine description

## 固件状态机描述

[*Figure 5*](#_bookmark14) shows the Firmware state machine.

[*Figure 5*](#_bookmark14) 显示了固件状态机。

#### Figure 5. Firmware state machine

,QWHU-PHDVXUHPHQW SHULRG QRW FRPSOHWHG

6WDQGE\

1H[W VWDUW VWDUWV DXWRPDWLFDOO\ DIWHU WKH ODVW KDV ILQLVKHG

,QWHU-0HDV

5DQJH 0HDV

5DQJH 0HDV

5DQJH 0HDV

**6LQJOH**

**&RQWLQXRXV**

**&RQWLQXRXV 7LPHG**

+RVW LQLWLDWHV 67$57

5DQJH 0RGH

$XWRPDWLF PRYH WR 6: VWDQGE\

6Z 6WDQGE\

+RVW LQLWLDWHV 6723

)Z ,QLWLDO %RRW

+RVW ORZHUV ;6+87

+RVW UDLVHV ;6+87

+Z 6WDQGE\

+RVW UHPRYHV $9''

+RVW DSSOLHV $9''

3RZHU 2II

#### 图5。固件状态机

,QWHU-PHDVXUHPHQW SHULRG QRW FRPSOHWHG

6WDQGE\

1H[W VWDUW VWDUWV DXWRPDWLFDOO\ DIWHU WKH ODVW KDV ILQLVKHG

,QWHU-0HDV

5DQJH 0HDV

5DQJH 0HDV

5DQJH 0HDV

**6LQJOH**

**&RQWLQXRXV**

**&RQWLQXRXV 7LPHG**

+RVW LQLWLDWHV 67$57

5DQJH 0RGH

$XWRPDWLF PRYH WR 6: VWDQGE\

6Z 6WDQGE\

+RVW LQLWLDWHV 6723

)Z ,QLWLDO %RRW

+RVW ORZHUV ;6+87

+RVW UDLVHV ;6+87

+Z 6WDQGE\

+RVW UHPRYHV $9''

+RVW DSSOLHV $9''

3RZHU 2II

## Customer manufacturing calibration flow

## 客户制造校准流程

[*Figure 6*](#_bookmark16) shows the recommended calibration flow that should be applied at customer level, at factory, once only. This flow takes into account all parameters (cover glass, temperature & voltage) from the application.

[*Figure 6*](#_bookmark16) 显示了建议的校准流程，该流程应仅在客户层面、工厂应用一次。该流程考虑了应用中的所有参数(盖板玻璃、温度和电压)。

#### Figure 6. Customer manufacturing calibration flow

DĂŶƵĨĂĐƚƵƌŝŶŐ

ĐĂůŝďƌĂƚŝŽŶ ĨůŽǁ

Ύ ͗ dŝŵŝŶŐƐ ĂƌĞ ŐŝǀĞŶ ĨŽƌ ŝŶĨŽƌŵĂƚŝŽŶ ŽŶůǇ͕ ƚŚĞǇ ĐĂŶ ǀĂƌǇ ĚĞƉĞŶĚŝŶŐ ŽŶ ƚŚĞ ,ŽƐƚ ĐĂƉĂďŝůŝƚŝĞƐ

^WADƐ ĐĂůŝďƌĂƚŝŽŶ ;ΕϭϬŵƐΎͿ

DĞǀŝĐĞ ŝŶŝƚŝĂůŝǌĂƚŝŽŶ ĂŶĚ ƐĞƚƚŝŶŐƐ

;ΕϰϬŵƐΎͿ

CĂůŝďƌĂƚŝŽŶ ƐƚĞƉ ƚŽ ďĞ ƌĞƉĞĂƚĞĚ ǁŝƚŚ х ϴ ĚĞŐƌĞĞC ƚĞŵƉĞƌĂƚƵƌĞ ĐŚĂŶŐĞ͘

/ŶŝƚŝĂů ĐĂůŝďƌĂƚŝŽŶ Ͳ ƌĞƋƵŝƌĞĚ ŽŶůǇ ŽŶĐĞ͕ ŚŽƐƚ ƚŽ ƐƚŽƌĞ ǀĂůƵĞƐ͘

/ŶŝƚŝĂůŝƐĂƚŝŽŶ Ͳ

ƚŽ ďĞ ĐĂůůĞĚ ŽŶĐĞ ĂĨƚĞƌ ĚĞǀŝĐĞ ƌĞƐĞƚ

#### 图6。客户制造校准流程

DĂŶƵĨĂĐƚƵƌŝŶŐ

ĐĂůŝďƌĂƚŝŽŶ ĨůŽǁ

Ύ ͗ dŝŵŝŶŐƐ ĂƌĞ ŐŝǀĞŶ ĨŽƌ ŝŶĨŽƌŵĂƚŝŽŶ ŽŶůǇ͕ ƚŚĞǇ ĐĂŶ ǀĂƌǇ ĚĞƉĞŶĚŝŶŐ ŽŶ ƚŚĞ ,ŽƐƚ ĐĂƉĂďŝůŝƚŝĞƐ

^WADƐ ĐĂůŝďƌĂƚŝŽŶ ;ΕϭϬŵƐΎͿ

DĞǀŝĐĞ ŝŶŝƚŝĂůŝǌĂƚŝŽŶ ĂŶĚ ƐĞƚƚŝŶŐƐ

;ΕϰϬŵƐΎͿ

CĂůŝďƌĂƚŝŽŶ ƐƚĞƉ ƚŽ ďĞ ƌĞƉĞĂƚĞĚ ǁŝƚŚ х ϴ ĚĞŐƌĞĞC ƚĞŵƉĞƌĂƚƵƌĞ ĐŚĂŶŐĞ͘

/ŶŝƚŝĂů ĐĂůŝďƌĂƚŝŽŶ Ͳ ƌĞƋƵŝƌĞĚ ŽŶůǇ ŽŶĐĞ͕ ŚŽƐƚ ƚŽ ƐƚŽƌĞ ǀĂůƵĞƐ͘

/ŶŝƚŝĂůŝƐĂƚŝŽŶ Ͳ

ƚŽ ďĞ ĐĂůůĞĚ ŽŶĐĞ ĂĨƚĞƌ ĚĞǀŝĐĞ ƌĞƐĞƚ

|  |  |
| --- | --- |
| dĞŵƉĞƌĂƚƵƌĞ ĐĂůŝďƌĂƚŝŽŶ ;ΕϰϬŵƐΎͿ | |
|  |  |
| KĨĨƐĞƚ ĐĂůŝďƌĂƚŝŽŶ ;ΕϯϬϬŵƐΎͿ | |
|  |  |
| CƌŽƐƐdĂůŬ ĐĂůŝďƌĂƚŝŽŶ ;ΕϭƐĞĐΎͿ | |

|  |  |
| --- | --- |
| dğŵɖğƌăƚƶƌğđăůŝďƌăƚŝžŷ;εϰϭŵɛύͿ | |
|  |  |
| kĩĩɛğƚđăůŝďƌăƚŝžŷ;εϯϭϭŵɛύͿ | |
|  |  |
| cƌžɛɛdăůŭđăůŝďƌăƚŝžŷ;εϭɛğđύͿ | |

### SPAD and temperature calibration

### SPAD和温度校准

In order to optimize the dynamic of the system, the reference SPADs have to be calibrated. Reference SPAD calibration needs to be done only once during the initial manufacturing calibration, the calibration data should then be stored on the Host.

为了优化系统的动态特性，必须校准参考SPADs。在初始制造校准过程中，参考SPAD校准只需进行一次，校准数据应存储在主机上。

Temperature calibration is the calibration of two parameters (VHV and phase cal) which are temperature dependent. These two parameters are used to set the device sensitivity.

温度校准是对与温度相关的两个参数(VHV和相位校准)的校准。这两个参数用于设置设备灵敏度。

Calibration should be performed during initial manufacturing calibration, it must be performed again when temperature varies more than 8degC compared to the initial

校准应在初始制造校准期间进行，当温度与初始温度相比变化超过8℃时，必须再次进行校准

calibration temperature.

校准温度。

For more details on SPAD and temperature calibration please refer to the VL53L0X API User Manual.

有关SPAD和温度校准的更多详细信息，请参考VL53L0X应用编程接口用户手册。

### Ranging offset calibration

### 测距偏移校准

Ranging offset can be characterized by the mean offset, which is the centering of the measurement versus the real distance.

测距偏移可以通过平均偏移来表征，平均偏移是测量相对于实际距离的中心。

Offset calibration should be performed at factory for optimal performances (recommended at 10cm). The offset calibration should take into account:

偏移校准应在工厂进行，以获得最佳性能(建议在10厘米处)。失调校准应考虑:

* + - * Supply voltage and temperature
      * 电源电压和温度
      * Protective cover glass above VL53L0X module
      * VL53L0X模块上方的保护盖玻璃

#### Figure 7. Range offset

**p2p\_offset calibration**

**Actual Range**

**Measured range**

#### 图7。范围偏移

**p2p\_offset calibration**

**Actual Range**

**Measured range**

### Cross-talk calibration

### 串扰校准

Cross-talk is defined as the signal return from the cover glass. The magnitude of the cross- talk depends on the type of glass and air gap. Cross-talk results in a range error which is proportional to the ratio of the cross-talk to the signal return from the target.

串扰被定义为从盖板玻璃返回的信号。串扰的大小取决于玻璃的类型和气隙。串扰会导致距离误差，该误差与串扰与从目标返回的信号之比成正比。

#### Figure 8. Cross-talk compensation



**cross-talk compensation**

**Actual Range**

**Measured range**

#### 图8。串扰补偿



**cross-talk compensation**

**Actual Range**

**Measured range**

Full offset and cross-talk calibration procedure is described in the VL53L0X API User Manual.

VL53L0X应用编程接口用户手册中描述了全偏移和串扰校准程序。

## Ranging operating modes

## 测距工作模式

There are 3 ranging modes available in the API:

API中有3种测距模式:

1. Single ranging
2. 单一测距

Ranging is performed only once after the API function is called. System returns to SW standby automatically.

调用API函数后，测距只执行一次。系统自动返回软件待机状态。

1. Continuous ranging
2. 连续测距

Ranging is performed in a continuous way after the API function is called. As soon as the measurement is finished, another one is started without delay.

调用API函数后，以连续方式执行测距。测量一结束，立即开始另一次测量。

User has to stop the ranging to return to SW standby. The last measurement is completed before stopping.

用户必须停止测距才能返回软件待机状态。停止前完成最后一次测量。

1. Timed ranging
2. 定时测距

Ranging is performed in a continuous way after the API function is called. When a measurement is finished, another one is started after a user defined delay.

调用API函数后，以连续方式执行测距。测量完成后，在用户定义的延迟后，将开始另一次测量。

This delay (inter-measurement period) can be defined through the API. User has to stop the ranging to return to SW standby.

这个延迟(测量间隔期)可以通过应用编程接口来定义。用户必须停止测距才能返回软件待机状态。

If the stop request comes during a range measurement, the measurement is completed before stopping. If it happens during an inter-measurement period, the range measurement stops immediately.

如果在距离测量过程中出现停止请求，测量将在停止前完成。如果在测量间隔期间发生，距离测量会立即停止。

## Ranging profiles

## 测距剖面

There are 4 different ranging profiles available via API example code. Customers can create their own ranging profile dependent on their use case performance requirements.

通过应用编程接口示例代码，有4种不同的测距配置文件可供使用。客户可以根据他们的用例性能需求创建自己的范围配置文件。

For more details please refer to the VL53L0X API User Manual.

更多详情请参考VL53L0X应用编程接口用户手册。

1. Default mode
2. 默认模式
3. High speed
4. 高速的
5. High accuracy
6. 高准确度
7. Long range
8. 远程

## Ranging profile phases

## 测距剖面相位

Each range profile consists of 3 consecutive phases:

每个距离剖面由3个连续的阶段组成:

* Initialization and load calibration data
* 初始化和加载校准数据
* Ranging
* 排列
* Digital housekeeping
* 数字管家

#### Figure 9. Typical initialization / ranging / housekeeping phases

DŝŐŝƚĂů ŚŽƵƐĞŬĞĞƉŝŶŐ

ZĂŶŐĞ ŵĞĂƐƵƌĞŵĞŶƚ ;ΕϮϯŵƐΎͿ

ZĂŶŐŝŶŐ

ZĂŶŐĞ ƐĞƚ ƵƉ ;ΕϴŵƐΎͿ

>ŽĂĚ ĐĂůŝďƌĂƚŝŽŶ ĚĂƚĂ ;ΕϭŵƐΎͿ

/ŶĐůƵĚĞƐ ;^Ğƚ^WADCĂůŝďƌĂƚŝŽŶ͕

^ĞƚdĞŵƉCĂůŝďƌĂƚŝŽŶ͕

^ĞƚKĨĨƐĞƚCĂůŝďƌĂƚŝŽŶ Θ

^ĞƚCƌŽƐƐͲƚĂůŬsĂůƵĞͿ

DĞǀŝĐĞ ŝŶŝƚŝĂůŝǌĂƚŝŽŶ ĂŶĚ ƐĞƚƚŝŶŐƐ

;ΕϰϬŵƐΎͿ

/ŶŝƚŝĂůŝǌĂƚŝŽŶ ĂŶĚ CĂůŝďƌĂƚŝŽŶ

;ƚŽ ďĞ ĐĂůůĞĚ ĂĨƚĞƌ ĚĞǀŝĐĞ ƌĞƐĞƚͿ

DŝŐŝƚĂů ƉƌŽĐĞƐƐŝŶŐ ;ΕϬ͘ϴŵƐΎͿ

#### 图9。典型的初始化/测距/内务处理阶段

DŝŐŝƚĂů ŚŽƵƐĞŬĞĞƉŝŶŐ

ZĂŶŐĞ ŵĞĂƐƵƌĞŵĞŶƚ ;ΕϮϯŵƐΎͿ

ZĂŶŐŝŶŐ

ZĂŶŐĞ ƐĞƚ ƵƉ ;ΕϴŵƐΎͿ

>ŽĂĚ ĐĂůŝďƌĂƚŝŽŶ ĚĂƚĂ ;ΕϭŵƐΎͿ

/ŶĐůƵĚĞƐ ;^Ğƚ^WADCĂůŝďƌĂƚŝŽŶ͕

^ĞƚdĞŵƉCĂůŝďƌĂƚŝŽŶ͕

^ĞƚKĨĨƐĞƚCĂůŝďƌĂƚŝŽŶ Θ

^ĞƚCƌŽƐƐͲƚĂůŬsĂůƵĞͿ

DĞǀŝĐĞ ŝŶŝƚŝĂůŝǌĂƚŝŽŶ ĂŶĚ ƐĞƚƚŝŶŐƐ

;ΕϰϬŵƐΎͿ

/ŶŝƚŝĂůŝǌĂƚŝŽŶ ĂŶĚ CĂůŝďƌĂƚŝŽŶ

;ƚŽ ďĞ ĐĂůůĞĚ ĂĨƚĞƌ ĚĞǀŝĐĞ ƌĞƐĞƚͿ

DŝŐŝƚĂů ƉƌŽĐĞƐƐŝŶŐ ;ΕϬ͘ϴŵƐΎͿ

Ύ ͗ dŝŵŝŶŐƐ ĂƌĞ ŐŝǀĞŶ ĨŽƌ ŝŶĨŽƌŵĂƚŝŽŶ ŽŶůǇ͕ ƚŚĞǇ ĐĂŶ ǀĂƌǇ ĚĞƉĞŶĚŝŶŐ ŽŶ ƚŚĞ ,ŽƐƚ ĐĂƉĂďŝůŝƚŝĞƐ

Ύ ͗ dŝŵŝŶŐƐ ĂƌĞ ŐŝǀĞŶ ĨŽƌ ŝŶĨŽƌŵĂƚŝŽŶ ŽŶůǇ͕ ƚŚĞǇ ĐĂŶ ǀĂƌǇ ĚĞƉĞŶĚŝŶŐ ŽŶ ƚŚĞ ,ŽƐƚ ĐĂƉĂďŝůŝƚŝĞƐ

### Initialization and load calibration data phase

### 初始化和加载校准数据阶段

Initialization and calibration phase is performed before the first ranging or after a device reset, see [*Figure 9*](#_bookmark25).

初始化和校准阶段在第一次测距之前或设备复位之后执行，请参见[*Figure 9*](#_bookmark25)

The user may then have to repeat the temperature calibration phase in a periodic way, depending on the use case.

根据使用情况，用户可能需要定期重复温度校准阶段。

For more details on the calibration functions please refer to the VL53L0X API User Manual.

有关校准功能的更多详细信息，请参考VL53L0X应用编程接口用户手册。

### Ranging phase

### 测距阶段

The ranging phase consists of a range setup then range measurement.

测距阶段包括测距设置和测距测量。

During the ranging operation, several VCSEL infrared pulses are emitted, then reflected back by the target object, and detected by the receiving array. The photo detector used inside VL53L0X is using advanced ultra-fast SPAD technology (Single Photon Avalanche Diodes), protected by several patents.

在测距操作期间，发射几个垂直腔面发射激光器红外脉冲，然后由目标物体反射回来，并由接收阵列检测。VL53L0X内部使用的光电探测器采用先进的超快SPAD技术(单光子雪崩二极管)，受多项专利保护。

The typical timing budget for a range is 33ms (init/ranging/housekeeping), see [*Figure 12*](#_bookmark36), with the actual range measurement taking 23ms, see [*Figure 9*](#_bookmark25). The minimum range measurement period is 8ms.

一个范围的典型时序预算为33毫秒(初始化/测距/内务处理)，参见[*Figure 12*](#_bookmark36)[*Figure 9*](#_bookmark25)

*Note: The minimum range timing budget is 20ms. Maximum is 5 seconds. The longer the timing budget, the higher the accuracy and the ranging distance capability.*

*注:最小距离计时预算为20毫秒。最长为5秒。定时预算越长，精度和测距能力越高。*

### Digital housekeeping

### 数字管家

Digital processing (housekeeping) is the last operation inside the ranging sequence that computes, validates or rejects a ranging measurement. Part of this processing is performed internally while the other part is executed on the Host by the API.

数字处理(内务处理)是测距序列中计算、验证或拒绝测距测量的最后一个操作。该处理的一部分在内部执行，而另一部分由应用编程接口在主机上执行。

At the end of the digital processing, the ranging distance is computed by VL53L0X itself. If the distance could not be measured (weak signal, no target…), a corresponding error code is provided.

在数字处理结束时，测距距离由VL53L0X自己计算。如果无法测量距离(信号弱，无目标…)，则提供相应的错误代码。

The following functions are performed on the device itself:

以下功能在设备本身上执行:

* + - * Signal value check (weak signal)
      * 信号值检查(弱信号)
      * Offset correction
      * 偏移校正
      * Cross-talk correction (in case of cover glass)
      * 串扰校正(在盖玻片的情况下)
      * Final ranging value computation While the API performs the following:
      * 最终测距值计算当应用编程接口执行以下操作时:
      * Return Ignore Threshold RIT check (Signal check versus cross talk)
      * 返回忽略阈值RIT检查(信号检查与串扰)
      * Sigma check (accuracy condition)
      * 适马检查(准确度条件)
      * Final ranging state computation
      * 最终测距状态计算

If the user wants to enhance the ranging accuracy, some extra processing (not part of the API) can be carried out by the host, for example, rolling average, hysteresis or any kind of filtering.

如果用户想要提高测距精度，主机可以执行一些额外的处理(不是应用编程接口的一部分)，例如滚动平均、滞后或任何类型的滤波。

## Getting the data: interrupt or polling

## 获取数据:中断或轮询

User can get the final data using a polling or an interrupt mechanism.

用户可以使用轮询或中断机制获取最终数据。

Polling mode: user has to check the status of the ongoing measurement by polling an API function.

轮询模式:用户必须通过轮询API函数来检查正在进行的测量的状态。

Interrupt mode: An interrupt pin (GPIO1) sends an interrupt to the host when a new measurement is available.

中断模式:当新的测量可用时，中断引脚(GPIO1)向主机发送中断。

The description of these 2 modes is available in the VL53L0X API User Manual.

这两种模式的描述可在VL53L0X API用户手册中找到。

## Device programming and control

## 设备编程和控制

Device physical control interface is I2C, described in [*Section 3: Control interface*](#_bookmark37).

设备物理控制接口是I2C，如中所述[*Section 3: Control interface*](#_bookmark37)

A software layer (API) is provided to control the device. The API is described in the VL53L0X API User Manual.

提供软件层(API)来控制设备。该应用编程接口在VL53L0X应用编程接口用户手册中有所描述。

## Power sequence

## 电源序列

### Power up and boot sequence

### 通电和引导顺序

There are two options available for device power up/boot.

设备加电/启动有两种选择。

**Option 1**: XSHUT pin connected and controlled from host.

选项1:通过主机连接和控制XSHUT引脚。

This option helps to optimize power consumption as the VL53L0X can be completely powered off when not used, and then woken up through host GPIO (using XSHUT pin).

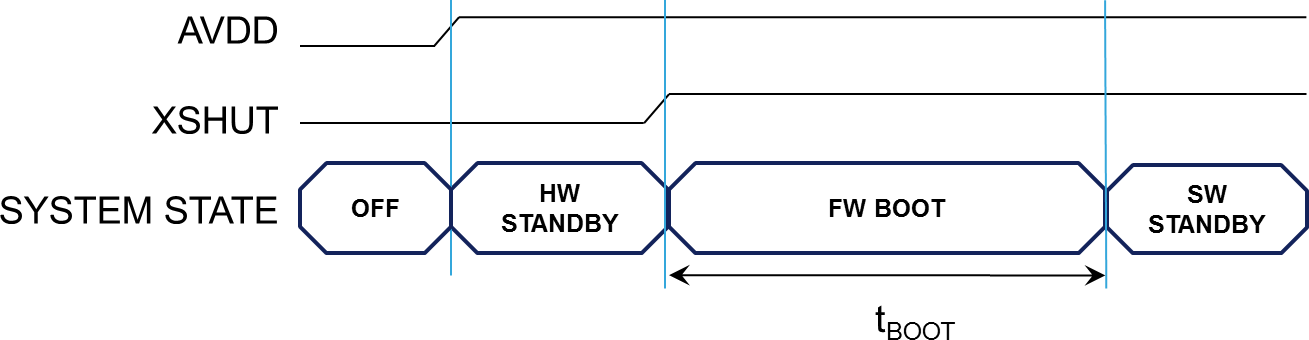
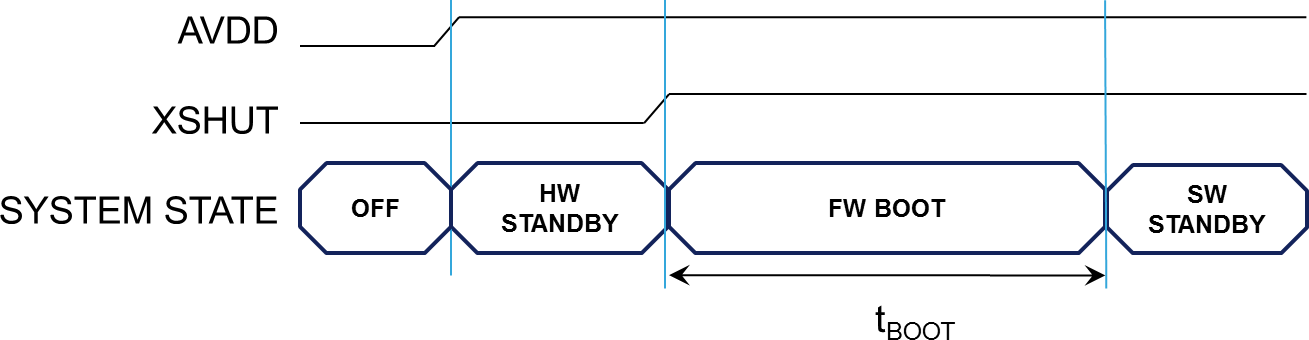
该选项有助于优化功耗，因为VL53L0X在不使用时可以完全断电，然后通过主机GPIO唤醒(使用XSHUT引脚)。

HW Standby mode is defined as the period when AVDD is present and XSHUT is low.

硬件待机模式定义为AVDD存在且XSHUT为低电平的时间段。

#### Figure 10. Power up and boot sequence

#### 图10。通电和引导顺序



tBOOT is 1.2ms max.

tBOOT最大1.2毫秒。

**Option 2**: XSHUT pin not controlled by host, and tied to AVDD through pull-up resistor.

选项2: XSHUT引脚不受主机控制，通过上拉电阻与AVDD相连。

In case XSHUT pin is not controlled, the power up sequence is presented in [*Figure 11*](#_bookmark34). In this case, the device is going automatically in SW STANDBY after FW BOOT, without entering HW STANDBY.

如果XSHUT引脚不受控制，上电顺序如所示[*Figure 11*](#_bookmark34)

#### Figure 11. Power up and boot sequence with XSHUT not controlled

#### 图11。XSHUT不受控制时的上电和引导顺序

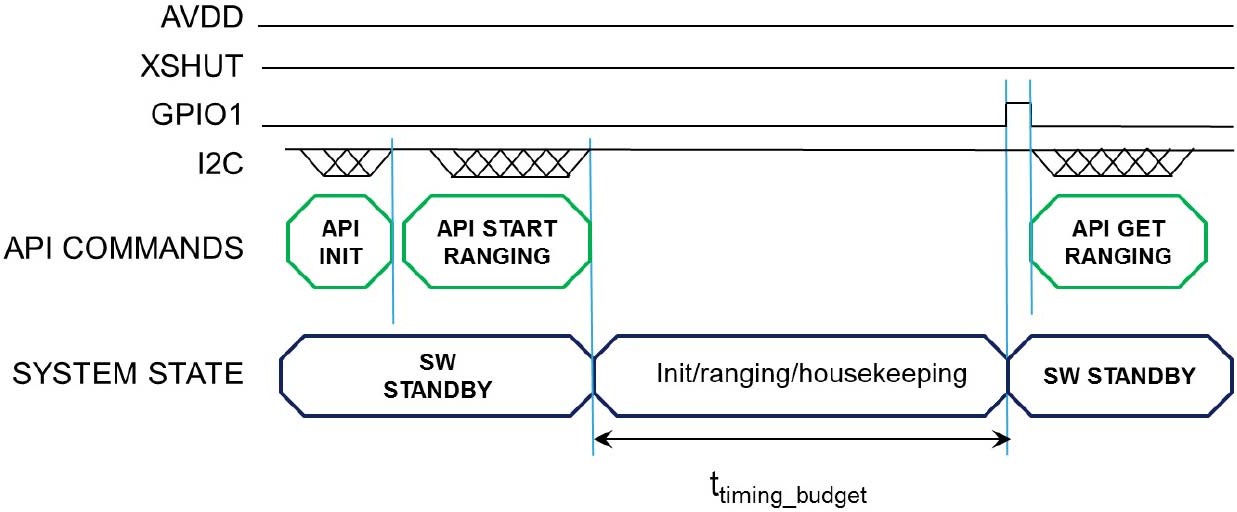
tBOOT is 1.2ms max.

tBOOT最大1.2毫秒。

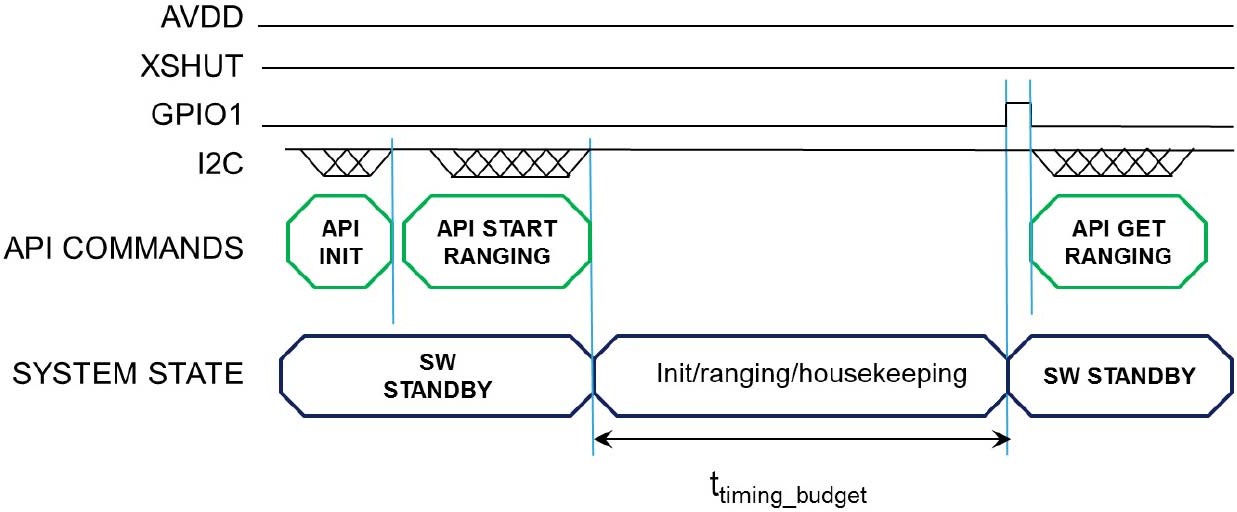
## Ranging sequence

## 测距序列

#### Figure 12. Ranging sequence



#### 图12。测距序列



ttiming\_budget is a parameter set by the user, using a dedicated API function. Default value is 33ms.

ttiming\_budget是用户使用专用的API函数设置的参数。默认值为33毫秒。

# Control interface

# 控制接口

This section specifies the control interface. The I2C interface uses two signals: serial data line (SDA) and serial clock line (SCL). Each device connected to the bus is using a unique address and a simple master / slave relationships exists.

本节指定控制接口。I2C接口使用两个信号:串行数据线(SDA)和串行时钟线(SCL)。连接到总线的每个设备都使用唯一的地址，并且存在简单的主/从关系。

Both SDA and SCL lines are connected to a positive supply voltage using pull-up resistors located on the host. Lines are only actively driven low. A high condition occurs when lines are floating and the pull-up resistors pull lines up. When no data is transmitted both lines are high.

SDA和SCL线都通过主机上的上拉电阻连接到正电源电压。线路仅被主动拉低。当线路浮动且上拉电阻将线路上拉时，出现高电平状态。当没有数据传输时，两条线路都为高电平。

Clock signal (SCL) generation is performed by the master device. The master device initiates data transfer. The I2C bus on the VL53L0X has a maximum speed of 400 kbits/s and uses a device address of 0x52.

时钟信号(SCL)生成由主设备执行。主设备启动数据传输。VL53L0X上的I2C总线的最大速度为400千位/秒，使用的设备地址为0x52。

#### Figure 13. Data transfer protocol



Address or data byte

Ac/Am

P

8

7

5 6

4

2 3

1

S

LSB

MSB

#### 图13。数据传输协议



Address or data byte

Ac/Am

P

8

7

5 6

4

2 3

1

S

LSB

MSB

Stop condition

SCL

SDA

Acknowledge

Start condition

Stop condition

SCL

SDA

Acknowledge

Start condition

Information is packed in 8-bit packets (bytes) always followed by an acknowledge bit, Ac for VL53L0X acknowledge and Am for master acknowledge (host bus master). The internal data is produced by sampling SDA at a rising edge of SCL. The external data must be stable during the high period of SCL. The exceptions to this are start (S) or stop (P) conditions when SDA falls or rises respectively, while SCL is high.

信息封装在8位数据包(字节)中，后面总是跟着一个确认位，Ac表示VL53L0X确认，Am表示主机确认(主机总线主机)。内部数据是通过在SCL上升沿对SDA进行采样产生的。外部数据必须在SCL的高发期保持稳定。这种情况的例外是，当SDA分别下降或上升，而SCL高时，开始(S)或停止(P)条件。

A message contains a series of bytes preceded by a start condition and followed by either a stop or repeated start (another start condition but without a preceding stop condition) followed by another message. The first byte contains the device address (0x52) and also specifies the data direction. If the least significant bit is low (that is, 0x52) the message is a master write to the slave. If the lsb is set (that is, 0x53) then the message is a master read from the slave.

一条消息包含一系列字节，前面是开始条件，后面是停止或重复开始(另一个开始条件，但没有前面的停止条件)，后面是另一条消息。第一个字节包含设备地址(0x52)，还指定了数据方向。如果最低有效位为低(即0x52)，则该消息是主机对从机的写操作。如果lsb被置位(即0x53)，则该消息是从从机读取的主机信息。

#### Figure 14. VL53L0X I2C device address: 0x52

MSBit

LSBit

#### 图14。VL53L0X I2C设备地址:0x52

MSBit

LSBit

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | R/W |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 一 | 0 | 一 | 0 | 0 | 一 | 拆装 |

All serial interface communications with the camera module must begin with a start condition. The VL53L0X module acknowledges the receipt of a valid address by driving the SDA wire low. The state of the read/write bit (lsb of the address byte) is stored and the next byte of data, sampled from SDA, can be interpreted. During a write sequence the second byte received provide a 8-bit index which points to one of the internal 8-bit registers.

与摄像机模块的所有串行接口通信必须从启动条件开始。VL53L0X模块通过将SDA线拉低来确认收到有效地址。存储读/写位(地址字节的lsb)的状态，并可以解释从SDA采样的下一个数据字节。在写序列期间，接收到的第二个字节提供一个指向内部8位寄存器之一的8位索引。

#### Figure 15. VL53L0X data format (write)

Start

VL53L0X acknowledges valid address

Acknowledge from VL53L0X

0x52 (write)

Stop

#### 图15。VL53L0X数据格式(写)

Start

VL53L0X acknowledges valid address

Acknowledge from VL53L0X

0x52 (write)

Stop





|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S | ADDRESS[7:0] | Ac | INDEX[7:0] | Ac | DATA[7:0] | Ac | P |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S | 地址[7:0] | 锕 | 索引[7:0] | 锕 | 数据[7:0] | 锕 | P |



As data is received by the slave it is written bit by bit to a serial/parallel register. After each data byte has been received by the slave, an acknowledge is generated, the data is then stored in the internal register addressed by the current index.

从机接收到数据后，会一位一位地写入串行/并行寄存器。从机接收到每个数据字节后，会产生一个应答，然后将数据存储在由当前索引寻址的内部寄存器中。

During a read message, the contents of the register addressed by the current index is read out in the byte following the device address byte. The contents of this register are parallel loaded into the serial/parallel register and clocked out of the device by the falling edge of SCL.

在读取消息期间，由当前索引寻址的寄存器内容在器件地址字节之后的字节中读出。该寄存器的内容并行载入串行/并行寄存器，并在SCL下降沿从器件输出。

#### Figure 16. VL53L0X data format (read)



0x53 (read)

0x52 (write)

#### 图16。VL53L0X数据格式(读)



0x53 (read)

0x52 (write)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S | ADDRESS[7:0] | Ac | INDEX[7:0] | Ac | P |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S | 地址[7:0] | 锕 | 索引[7:0] | 锕 | P |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S | ADDRESS[7:0] | Ac | DATA[7:0] | Am | P |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S | 地址[7:0] | 锕 | 数据[7:0] | 是 | P |

At the end of each byte, in both read and write message sequences, an acknowledge is issued by the receiving device (that is, the VL53L0X for a write and the host for a read).

在每个字节的末尾，在读和写消息序列中，接收设备都会发出一个确认(即，VL53L0X用于写，主机用于读)。

A message can only be terminated by the bus master, either by issuing a stop condition or by a negative acknowledge (that is, **not** pulling the SDA line low) after reading a complete byte during a read operation.

一条消息只能由总线主控器终止，要么通过发出停止条件，要么通过在读操作期间读完一个完整字节后发出否定应答(即不将SDA线拉低)。

The interface also supports auto-increment indexing. After the first data byte has been transferred, the index is automatically incremented by 1. The master can therefore send data bytes continuously to the slave until the slave fails to provide an acknowledge or the master terminates the write communication with a stop condition. If the auto-increment feature is used the master does **not** have to send address indexes to accompany the data bytes.

该接口还支持自动增量索引。传输完第一个数据字节后，索引自动递增1。因此，主机可以连续向从机发送数据字节，直到从机无法提供应答或主机以停止条件终止写通信。如果使用自动递增功能，主机不必发送地址索引来伴随数据字节。

#### Figure 17. VL53L0X data format (sequential write)



0x52 (write)

#### 图17。VL53L0X数据格式(顺序写入)



0x52 (write)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S | ADDRESS[7:0] | Ac | INDEX[7:0] | Ac |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S | 地址[7:0] | 锕 | 索引[7:0] | 锕 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| DATA[7:0] | Ac | DATA[7:0] | Ac | DATA[7:0] | Ac | P |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 数据[7:0] | 锕 | 数据[7:0] | 锕 | 数据[7:0] | 锕 | P |

**Figure 18. VL53L0X data format (sequential read)**



0x53 (read)

0x52 (write)

**图18。VL53L0X数据格式(顺序读取)**



0x53 (read)

0x52 (write)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S | ADDRESS[7:0] | Ac | INDEX[7:0] | Ac | P |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S | 地址[7:0] | 锕 | 索引[7:0] | 锕 | P |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| S | ADDRESS[7:0] | Ac | DATA[7:0] | Am | DATA[7:0] | Am |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| S | 地址[7:0] | 锕 | 数据[7:0] | 是 | 数据[7:0] | 是 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| DATA[7:0] | Am | DATA[7:0] | Am | DATA[7:0] | Am | P |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 数据[7:0] | 是 | 数据[7:0] | 是 | 数据[7:0] | 是 | P |

## I2C interface - timing characteristics

## I2C界面定时特性

Timing characteristics are shown in [*Table 3*](#_bookmark45). Please refer to [*Figure 19*](#_bookmark46) for an explanation of the parameters used.

时序特性如所示[*Table 3*](#_bookmark45)[*Figure 19*](#_bookmark46)

Timings are given for all PVT conditions.

给出了所有PVT条件下的计时。

#### Table 3. I2C interface - timing characteristics

#### 表3。I2C界面定时特性

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Symbol** | **Parameter** | **Minimum** | **Typical** | **Maximum** | **Unit** |
| FI2C | Operating frequency (Standard and Fast mode) | 0 | - | 400(1) | kHz |
| tLOW | Clock pulse width low | 1.3 | - | - | s |
| tHIGH | Clock pulse width high | 0.6 | - | - | s |
| tSP | Pulse width of spikes which are suppressed by the input filter | - | - | 50 | ns |
| tBUF | Bus free time between transmissions | 1.3 | - | - | ms |
| tHD.STA | Start hold time | 0.26 | - | - | s |
| tSU.STA | Start set-up time | 0.26 | - | - | s |
| tHD.DAT | Data in hold time | 0 | - | 0.9 | s |
| tSU.DAT | Data in set-up time | 50 | - | - | ns |
| tR | SCL/SDA rise time | - | - | 120 | ns |
| tF | SCL/SDA fall time | - | - | 120 | ns |
| tSU.STO | Stop set-up time | 0.6 | - | - | s |
| Ci/o | Input/output capacitance (SDA) | - | - | 10 | pF |
| Cin | Input capacitance (SCL) | - | - | 4 | pF |
| CL | Load capacitance | - | 125 | 400 | pF |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **标志** | **参数** | **最低限度** | **典型的** | **最高的** | **单位** |
| FI2C | 工作频率(标准和快速模式) | 0 | - | 400(1) | 千赫 |
| tLOW | 时钟脉冲宽度低 | 1.3 | - | - | s |
| 大腿 | 时钟脉冲宽度高 | 0.6 | - | - | s |
| 一茶匙的量 | 输入滤波器抑制的尖峰脉冲宽度 | - | - | 50 | 纳秒 |
| tBUF | 传输之间的总线空闲时间 | 1.3 | - | - | 女士 |
| tHD。无线电台临时使用许可证 | 开始保持时间 | 0.26 | - | - | s |
| tSU。无线电台临时使用许可证 | 开始设置时间 | 0.26 | - | - | s |
| tHD。数据；数字录音带 | 保持时间内的数据 | 0 | - | 0.9 | s |
| tSU。数据；数字录音带 | 设置时间内的数据 | 50 | - | - | 纳秒 |
| tR | SCL/民主行动党上升时间 | - | - | 120 | 纳秒 |
| 法国南部（French Southern Territories的缩写） | SCL/民主行动党秋季会议 | - | - | 120 | 纳秒 |
| tSU。长期定货(standing order) | 停止设置时间 | 0.6 | - | - | s |
| Ci/o | 输入/输出电容 | - | - | 10 | 性能因素(Performance Factor) |
| Cin | 输入电容(SCL) | - | - | 四 | 性能因素(Performance Factor) |
| 化学发光 | 负载电容 | - | 125 | 400 | 性能因素(Performance Factor) |

* + 1. The maximum bus speed is also limited by the combination of 400pF load capacitance and pull-up resistor. Please refer to the I2C specification for further information.
    2. 最大总线速度也受到400pF负载电容和上拉电阻组合的限制。更多信息请参考I2C规范。

#### Figure 19. I2C timing characteristics

tSU.STO

tSU.STA

tSU.DAT

tHIGH

tHD.DAT

**SCL**

**SDA**

***stop***

***start***

***stop start***



**...**

tHD.STA

**V**

**VIH**

**IL**

tHD.STA

tF

tR

tLOW

tBUF

**VIH**

**... VIL**

#### 图19。I2C计时特性

tSU.STO

tSU.STA

tSU.DAT

tHIGH

tHD.DAT

**SCL**

**SDA**

***stop***

***start***

***stop start***



**...**

tHD.STA

**V**

**VIH**

**IL**

tHD.STA

tF

tR

tLOW

tBUF

**VIH**

**... VIL**

All timings are measured from either VIL or VIH.

所有计时都是从VIL或VIH开始测量的。

## I2C interface - reference registers

## I2C接口参考寄存器

The registers shown in the table below can be used to validate the user I2C interface.

下表所示的寄存器可用于验证用户I2C接口。

#### Table 4. Reference registers

#### 表4。参考寄存器

|  |  |
| --- | --- |
| **Address** | **(after fresh reset, without API loaded)** |
| 0xC0 | 0xEE |
| 0xC1 | 0xAA |
| 0xC2 | 0x10 |
| 0x51 | 0x0099 |
| 0x61 | 0x0000 |

|  |  |
| --- | --- |
| **地址** | **(重新设置后，未加载应用编程接口)** |
| 0xC0 | 0xEE |
| 0xC1 | 0xAA |
| 0xC2 | 0x10 |
| 0x51 | 0x0099 |
| 0x61 | 0x0000 |

*Note: I2C read/writes can be 8,16 or 32-bit. Multi-byte reads/writes are always addressed in ascending order with MSB first as shown in* [*Table 5.*](#_bookmark49)

*注意:I2C读/写可以是8位、16位或32位。多字节读/写总是以升序进行寻址，MSB优先，如所示*[*Table 5.*](#_bookmark49)

#### Table 5. 32-bit register example

#### 表5。32位寄存器示例

|  |  |
| --- | --- |
| **Register address** | **Byte** |
| Address | MSB |
| Address + 1 | .. |
| Address + 2 | .. |
| Address + 3 | LSB |

|  |  |
| --- | --- |
| **寄存器地址** | **字节** |
| 地址 | 最高有效位 |
| 地址+ 1 | .. |
| 地址+ 2 | .. |
| 地址+ 3 | 最低有效位 |

## Absolute maximum ratings

## 绝对最大额定值

**Table 6. Absolute maximum ratings**

**表6。绝对最大额定值**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Min.** | **Typ.** | **Max.** | **Unit** |
| AVDD | -0.5 | - | 3.6 | V |
| SCL, SDA, XSHUT and GPIO1 | -0.5 | - | 3.6 | V |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **参数** | **量滴** | **典型。** | **最大值** | **单位** |
| AVDD | -0.5 | - | 3.6 | V |
| SCL、民主行动党、XSHUT和GPIO1 | -0.5 | - | 3.6 | V |

*Note: Stresses above those listed in* [*Table 6.*](#_bookmark52) *may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specification is not implied.*

*注:应力高于中列出的应力*[*Table 6.*](#_bookmark52)

*Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

*长时间暴露在绝对最大额定值条件下可能会影响设备的可靠性。*

## Recommended operating conditions

## 推荐的操作条件

#### Table 7. Recommended operating conditions(1)

#### 表7。推荐的操作条件(1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | | **Min.** | **Typ.** | **Max.** | **Unit** |
| Voltage (AVDD) | | 2.6 | 2.8 | 3.5 | V |
| IO (IOVDD)(2) | Standard mode | 1.6 | 1.8 | 1.9 | V |
| 2V8 mode(3)(4) | 2.6 | 2.8 | 3.5 | V |
| Temperature (normal operating) | | -20 |  | +70 | °C |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **参数** | | **量滴** | **典型。** | **最大值** | **单位** |
| 电压(AVDD) | | 2.6 | 2.8 | 3.5 | V |
| 输入输出(IOVDD)(2) | 标准模式 | 1.6 | 1.8 | 1.9 | V |
| 2V8模式(3)(4) | 2.6 | 2.8 | 3.5 | V |
| 温度(正常运行) | | -20 |  | +70 | C |

* + 1. There are no power supply sequencing requirements. The I/Os may be high, low or floating when AVDD is applied. The I/Os are internally failsafe with no diode connecting them to AVDD
    2. 没有电源时序要求。当应用AVDD时，输入/输出可以是高电平、低电平或浮动电平。输入/输出是内部故障安全的，没有二极管将它们连接到AVDD
    3. XSHUT should be high level only when AVDD is on.
    4. 只有当AVDD开启时，XSHUT才应该是高电平。
    5. SDA, SCL, XSHUT and GPIO1 high levels have to be equal to AVDD in 2V8 mode.
    6. 在2V8模式下，SDA、SCL、XSHUT和GPIO1高电平必须等于AVDD。
    7. The default API mode is 1V8.
    8. 默认的API模式是1V8。

2V8 mode is programmable using device settings loaded by the API. For more details please refer to the VL53L0X API User Manual.

2V8模式可使用API加载的设备设置进行编程。更多详情请参考VL53L0X应用编程接口用户手册。

## ESD

## （同Esdras）[圣经]以斯拉记

VL53L0X is compliant with ESD values presented in[*Table 8*](#_bookmark56)

VL53L0X符合中所示的静电放电值[*Table 8*](#_bookmark56)

#### Table 8. ESD performances

#### 表8。静电放电性能

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Specification** | **Conditions** |
| Human Body Model | JS-001-2012 | +/- 2kV, 1500 Ohms, 100pF |
| Charged Device Model | JZSD22-C101 | +/- 500V |

|  |  |  |
| --- | --- | --- |
| **参数** | **规格** | **情况** |
| 人体模型 | JS-001-2012 | +/- 2kV，1500欧姆，100pF |
| 带电设备模型 | JZSD22-C101 | +/-500伏 |

**Table 9. Consumption at ambient temperature(1)**

**表9。环境温度下的消耗量(1)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Min.** | **Typ.** | **Max.** | **Unit** |
| HW STANDBY | 3 | 5 | 7 | uA |
| SW STANDBY (2V8 mode)(2) | 4 | 6 | 9 | uA |
| Timed ranging Inter measurement |  | 16 |  | uA |
| Active Ranging average consumption (including VCSEL) (3)(4) |  | 19 |  | mA |
| Average power consumption at 10Hz with 33ms ranging sequence |  |  | 20 | mW |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **参数** | **量滴** | **典型。** | **最大值** | **单位** |
| 硬件待机 | 3 | 5 | 七 | 美国联合航空公司 |
| 软件待机(2V8模式)(2) | 四 | 6 | 9 | 美国联合航空公司 |
| 定时测距间测量 |  | 16 |  | 美国联合航空公司 |
| 主动测距平均功耗(包括垂直腔面发射激光器)(3)(4) |  | 19 |  | 妈 |
| 10Hz时的平均功耗，33毫秒测距序列 |  |  | 20 | 毫瓦 |

* + 1. All current consumption values include silicon process variations. Temperature and Voltage are at nominal conditions (23degC and 2.8V).
    2. 所有电流消耗值都包括硅工艺变化。温度和电压处于标称状态(23摄氏度和2.8伏)。

All values include AVDD and AVDDVCSEL.

所有值包括AVDD和AVDDVCSEL。

* + 1. In standard mode (1V8), pull-ups have to be modified, then SW STANDBY consumption is increased by
    2. 在标准模式(1V8)下，必须修改上拉，然后软件待机功耗增加

+0.6uA.

+0.6uA。

* + 1. Active ranging is an average value, measured using default API settings (33ms timing budget).
    2. 主动测距是一个平均值，使用默认的应用编程接口设置(33毫秒定时预算)进行测量。
    3. Peak current (including VCSEL) can reach 40mA.
    4. 峰值电流(包括VCSEL)可达40mA。

#### Table 10. Digital I/O electrical characteristics

#### 表10。数字输入输出电气特性

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Symbol** | **Parameter** | **Minimum** | **Typical** | **Maximum** | **Unit** |
| **Interrupt pin (GPIO1)** | | | | | |
| VIL | Low level input voltage | - | - | 0.3 IOVDD | V |
| VIH | High level input voltage | 0.7 IOVDD | - | - | V |
| VOL | Low level output voltage (IOUT = 4 mA) | - | - | 0.4 | V |
| VOH | High level output voltage at (IOUT = 4 mA) | IOVDD- 0.4 | - | - | V |
| FGPIO | Operating frequency (CLOAD = 20 pF) | 0 | - | 108 | MHz |
| **I2C interface (SDA/SCL)** | | | | | |
| VIL | Low level input voltage | -0.5 | - | 0.6 | V |
| VIH | High level input voltage | 1.12 | - | IOVDD+0.5 | V |
| VOL | Low level output voltage (IOUT = 4 mA in Standard and Fast modes) | - | - | 0.4 | V |
| IIL/IH | Leakage current(1) | - | - | 10 | µA |
| Leakage current(2) | - | - | 0.15 | µA |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **标志** | **参数** | **最低限度** | **典型的** | **最高的** | **单位** |
| **中断引脚(GPIO1)** | | | | | |
| 垂直注入逻辑 | 低电平输入电压 | - | - | 0.3 IOVDD | V |
| VIH | 高电平输入电压 | 0.7 IOVDD | - | - | V |
| 卷（volume的缩写） | 低电平输出电压(IOUT = 4毫安) | - | - | 0.4 | V |
| VOH | 高电平输出电压(IOUT = 4毫安) | IOVDD- 0.4 | - | - | V |
| FGPIO | 工作频率(CLOAD = 20 pF) | 0 | - | 108 | 兆赫 |
| **I2C接口(民主行动党/SCL)** | | | | | |
| 垂直注入逻辑 | 低电平输入电压 | -0.5 | - | 0.6 | V |
| VIH | 高电平输入电压 | 1.12 | - | IOVDD+0.5 | V |
| 卷（volume的缩写） | 低电平输出电压(标准和快速模式下IOUT = 4毫安) | - | - | 0.4 | V |
| IIL/IH | 泄漏电流(1) | - | - | 10 | A |
| 漏电流(2) | - | - | 0.15 | A |

1. AVDD = 0 V
2. AVDD = 0 V
3. AVDD = 2.85 V; I/O voltage = 1.8 V
4. AVDD = 2.85V；输入/输出电压= 1.8伏

## Measurement conditions

## 测量条件

In all measurement tables in the document, it is considered that the full Field Of View (FOV) is covered.

在文件中的所有测量表中，都认为涵盖了整个视野(FOV)。

VL53L0X system FOV is 25degrees.

VL53L0X系统FOV是25度。

Reflectance targets are standard ones (Grey 17% N4.74 and White 88% N9.5 Munsell charts).

反射率目标是标准目标(灰色17% N4.74和白色88% N9.5芒塞尔图)。

Unless mentioned, device is controlled through the API using the default settings (refer to VL53L0X API User Manual for API settings description).

除非另有说明，设备是通过使用默认设置的应用编程接口来控制的(关于应用编程接口设置的描述，请参考VL53L0X应用编程接口用户手册)。

#### Figure 20. Typical ranging (default mode)

**API\_RangeValue (mm) vs. Actual Target Distance (mm)**

1200 Reflectance

grey17

white88

1100

1000

900

800

700

600

500

400

300

200

100

0

0 100 200 300 400 500 600 700 800 900 1000 1100 1200

Actual Target Distance (mm)

#### 图20。典型测距(默认模式)

**API\_RangeValue (mm) vs. Actual Target Distance (mm)**

1200 Reflectance

grey17

white88

1100

1000

900

800

700

600

500

400

300

200

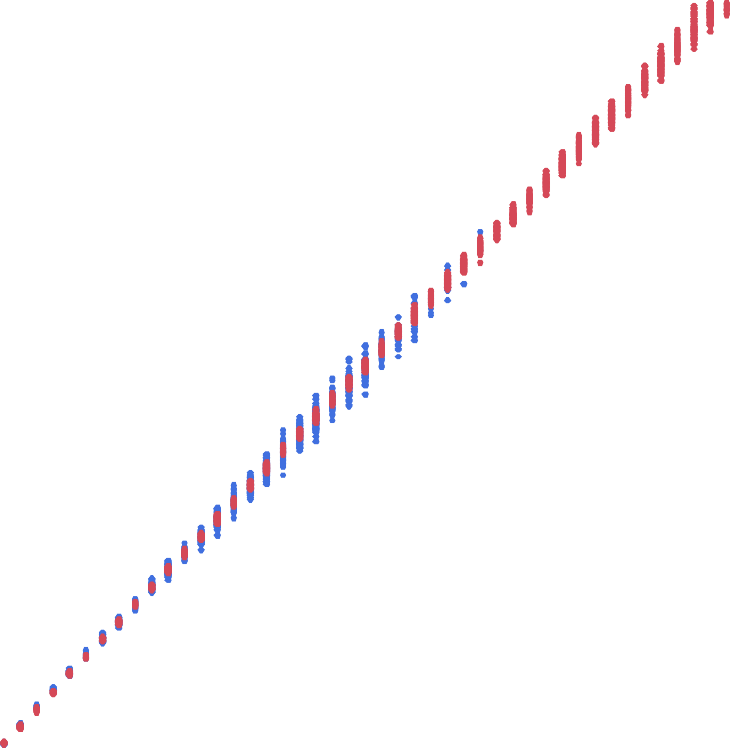
100

0

0 100 200 300 400 500 600 700 800 900 1000 1100 1200

Actual Target Distance (mm)

**Figure 21. Typical ranging - Long range mode**



**API\_RangeValue (mm) vs. Actual Target Distance (mm)**

Reflectance

grey17

2200 white88

2000

1800

1600

1400

1200

1000

800

600

400

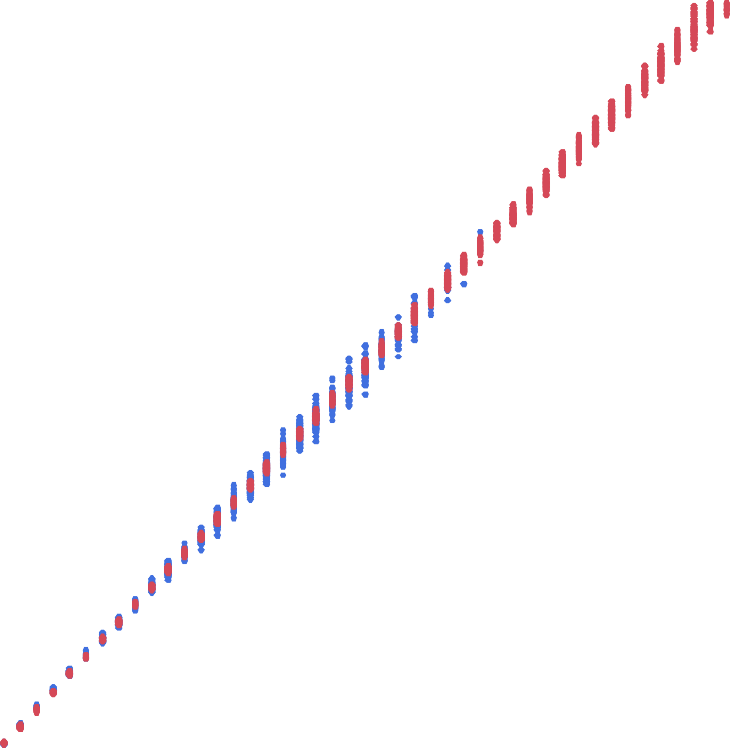
200

0

0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400

Actual Target Distance (mm)

**图21。典型测距-远程模式**



**API\_RangeValue (mm) vs. Actual Target Distance (mm)**

Reflectance

grey17

2200 white88

2000

1800

1600

1400

1200

1000

800

600

400

200

0

0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400

Actual Target Distance (mm)

## Max ranging distance

## 最大测距距离

[*Table 11*](#_bookmark66) presents the ranging specification for VL53L0X bare module, without cover glass, at room temperature (23degreesC) and with nominal voltage (2.8Volts).

[*Table 11*](#_bookmark66) 介绍了在室温(23摄氏度)和标称电压(2.8伏)下，不带盖板玻璃的VL53L0X裸模块的测距规格。

#### Table 11. Max ranging capabilities with 33ms timing budget

#### 表11。33毫秒定时预算的最大测距能力

|  |  |  |  |
| --- | --- | --- | --- |
| **Target reflectance level (Full FOV)** | **Conditions** | **Indoor (2)** | **Outdoor overcast (2)** |
| White Target (88%) | Typical | 200cm+ (1) | 80cm |
| Minimum | 120cm | 60cm |
| Grey Target (17%) | Typical | 80cm | 50cm |
| Minimum | 70cm | 40cm |

|  |  |  |  |
| --- | --- | --- | --- |
| **目标反射水平(全FOV)** | **情况** | **室内(2)** | **室外阴天(2)** |
| 白色目标(88%) | 典型的 | 200厘米+ (1) | 80厘米 |
| 最低限度 | 120厘米 | 60厘米 |
| 灰色目标(17%) | 典型的 | 80厘米 | 50厘米 |
| 最低限度 | 70厘米 | 40厘米 |

Note (1): using long range API profile

注(1):使用远程应用编程接口配置文件

* Indoor: no infrared
* 室内:无红外线
* Outdoor overcast corresponds to a parasitic noise of 10kcps/SPAD for VL53L0X module. For reference, this corresponds to a 1.2W/m² at 940nm, and is equivalent to 5kLux daylight, while ranging on a grey 17% chart at 40cm
* 室外阴天对应于VL53L0X模块10k PS/SPAD的寄生噪声。作为参考，这相当于940纳米处的1.2W/m，相当于5勒克司日光，而在40厘米处的灰色17%图表上的范围

Measurement conditions:

测量条件:

* Targets reflectance used : Grey (17%), White (88%)
* 使用的目标反射率:灰色(17%)，白色(88%)
* Nominal Voltage (2.8V) and Temperature (23degreesC)
* 标称电压(2.8V)和温度(23摄氏度)
* All distances are for a complete Field of View covered (FOV = 25degrees)
* 所有距离均为完整的覆盖视野(FOV = 25度)
* 33ms timing budget
* 33ms时序预算

All distances mentioned in this table are guaranteed for a minimum detection rate of 94% (up to 100%). Detection rate is the worst case percentage of measurements that will return a valid measurement when target is detected.

此表中提到的所有距离都保证最低检测率为94%(最高为100%)。检测率是检测到目标时返回有效测量值的测量值的最坏情况百分比。

## Ranging accuracy

## 测距精度

### Standard deviation

### 标准偏差

Ranging accuracy can be characterized by standard deviation. It includes Measure-to- Measure and Part-to-Part (silicon) dispersion.

测距精度可以用标准偏差来表征。它包括测量到测量和部分到部分(硅)分散。

#### Table 12. Ranging accuracy

#### 表12。测距精度

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Indoor (no infrared)** | | | **Outdoor** | | |
| **Target reflectance level (Full FOV)** | **Distance** | **33ms** | **66ms** | **Distance** | **33ms** | **66ms** |
| White Target (88%) | at 120cm | 4% | 3% | at 60cm | 7% | 6% |
| Grey Target (17%) | at 70cm | 7% | 6% | at 40cm | 12% | 9% |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **室内(无红外线)** | | | **户外的** | | |
| **目标反射水平(全FOV)** | **距离** | **33毫秒** | **66毫秒** | **距离** | **33毫秒** | **66毫秒** |
| 白色目标(88%) | 在120厘米处 | 4% | 3% | 在60厘米处 | 7% | 6% |
| 灰色目标(17%) | 在70厘米处 | 7% | 6% | 40厘米 | 12% | 9% |

Measurement conditions:

测量条件:

* Targets reflectance used: Grey (17%), White (88%)
* 使用的目标反射率:灰色(17%)，白色(88%)
* Offset correction done at 10cm from sensor.
* 在距离传感器10厘米处进行偏移校正。
* Indoor: no Infrared / Outdoor: eq. 5kLux equivalent sunlight (10kcps/SPAD)
* 室内:无红外线/室外:情商。5千瓦当量阳光(10kcps/SPAD)
* Nominal Voltage (2v8) and Temperature (23degreesC)
* 标称电压(2v8)和温度(23摄氏度)
* All distances are for a complete Field of View covered (FOV = 25degrees)
* 所有距离均为完整的覆盖视野(FOV = 25度)
* Detection rate is considered at 94% minimum
* 检测率最低为94%

### Range profile examples

### 范围概况示例

[*Table 13*](#_bookmark71) details typical performance for the four example ranging profiles, as per measurement conditions in [*Section 5.3: Ranging accuracy*](#_bookmark67).

[*Table 13*](#_bookmark71) 根据中的测量条件，详细说明了四种示例测距曲线的典型性能[*Section 5.3: Ranging accuracy*](#_bookmark67)

#### Table 13. Range profiles

#### 表13。范围配置文件

|  |  |  |  |
| --- | --- | --- | --- |
| **Range Profile** | **Range timing budget** | **Typical performance** | **Typical application** |
| Default mode | 30ms | 1.2m, accuracy as per  [*Table 12*](#_bookmark69) | standard |
| High accuracy | 200ms | 1.2m, accuracy < +/- 3% | precise measurement |
| Long range | 33ms | 2m, accuracy as per  [*Table 12*](#_bookmark69) | long ranging, only for dark conditions (no IR) |
| High speed | 20ms | 1.2m, accuracy +/- 5% | high speed where accuracy is not priority |

|  |  |  |  |
| --- | --- | --- | --- |
| **范围概况** | **距离计时预算** | **典型性能** | **典型应用** |
| 默认模式 | 30毫秒 | 1.2m，精度符合  [*Table 12*](#_bookmark69) | 标准 |
| 高准确度 | 200毫秒 | 1.2m，精度<+/- 3% | 精确测量 |
| 远程 | 33毫秒 | 2m，精度符合  [*Table 12*](#_bookmark69) | 长距离，仅适用于黑暗条件(无红外线) |
| 高速的 | 20毫秒 | 1.2m，精度+/- 5% | 精度不是重点的高速 |

### Ranging offset error

### 测距偏移误差

The table below shows how range offset may drift over distance, voltage and temperature.

下表显示了范围偏移如何随距离、电压和温度漂移。

Assumes offset calibrated at 10cm. See VL53L0X API User Manual for details on offset calibration.

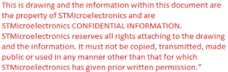
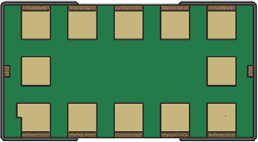
假设偏移量校准为10厘米。有关失调校准的详细信息，请参见VL53L0X应用编程接口用户手册。

#### Table 14. Ranging offset

#### 表14。测距偏移

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Nominal Conditions** | **Measure point** | **Typical offset from nominal** | **Maximum offset from nominal** |
| Ranging distance | Offset calibration at 10cm (“zero”) | White 120cm (indoor) Grey 70cm (indoor) White 60cm (outdoor) Grey 40cm (outdoor) |  | < 3% |
| Voltage drift | 2.8V | 2.6V to 3.5V | +/- 10mm | +/- 15mm |
| Temperature drift | 23°C | -20°C to +70°C | +/- 10mm | +/- 30mm |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **标称条件** | **测量点** | **标称值的典型偏移** | **标称值的最大偏移** |
| 测距距离 | 10厘米(“零”)处的偏移校准 | 白色120厘米(室内)灰色70厘米(室内)白色60厘米(室外)灰色40厘米(室外) |  | < 3% |
| 电压漂移 | 2.8V | 2.6V至3.5V | +/-10毫米 | ±15毫米 |
| 温度漂移 | 23摄氏度 | -20℃至+70℃ | +/-10毫米 | +/-30毫米 |



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**VL53L0X**

**Outline drawing**

**6**

**Outline drawing**

**Figure 22. Outline drawing (page 1/3)**

DocID029104 Rev 1

29/40

2.40 0.05

1.20

0.05

0.80

0.50

0.35 0.10

0.08

0

0.80

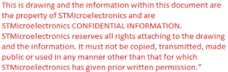
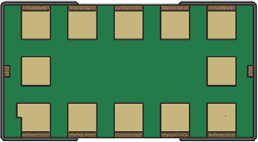
1.60

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7ROHUDQFHV, XQOHVV RWKHUZLVH VWDWHG

/LQHDU

1. 3ODFH 'HFLPDOV 0 0.05
2. 3ODFH 'HFLPDOV 0.0 0.05
3. 3ODFH 'HFLPDOV 0.00 0.05

,QWHUSUHW GUDZLQJ SHU %68888, 0DWHULDO

35' $QJOH 3URMHFWLRQ

'UDZQ

678$57 52%(57621 LQ PP

$OO GLPHQVLRQV

'R 1RW 6FDOH 6FDOH

20:1

)

$QJXODU 'LDPHWHU

0.25 GHJUHHV

+0.05

'DWH

)LQLVK

2 )(% 2016 ,PDJLQJ 'LYLVLRQ

670LFURHOHFWURQLFV

6XUIDFH )LQLVK 1.6 PLFURQV

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3DUW 1R.

7LWOH

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**VL53L0X**

**Outline drawing**

**6**

**Outline drawing**

**Figure 22. Outline drawing (page 1/3)**

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| 3 | \*1' |
| 4 | \*1'2 |
| 5 | ;6+87 |
| 6 | \*1'3 |
| 7 | \*3,21 |
| 8 | '1& |
| 9 | 6'$ |
| 10 | 6&/ |
| 11 | $9'' |
| 12 | \*1'4 |

|  |  |
| --- | --- |
| 一 | $9''9&6(/ |
| 2 | $9669&6(/ |
| 3 | \*1' |
| 四 | \*1'2 |
| 5 | ；6+87 |
| 6 | \*1'3 |
| 七 | \*3,21 |
| 8 | '1& |
| 9 | 6'$ |
| 10 | 6&/ |
| 11 | $9'' |
| 12 | \*1'4 |



**Outline drawing**

**VL53L0X**

**Figure 23. Outline drawing (page 2/3)**

30/40

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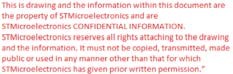
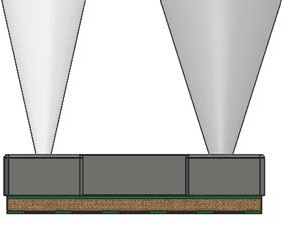
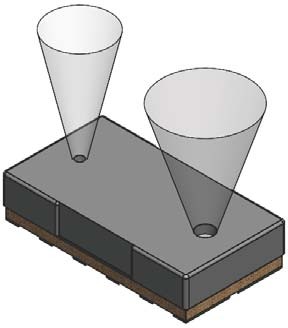
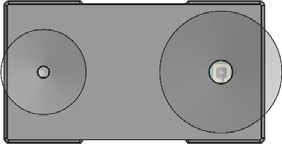
**Outline drawing**

**VL53L0X**

**Figure 23. Outline drawing (page 2/3)**

30/40

DocID029104 Rev 1



287/,1( '5$:,1\* 2 2) 3

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7LWOH 9/53/0; & /,1(5 02'8/( 6KHHW

3DUW 1R.

'000266747

3RVLWLRQ 0.10

6XUIDFH )LQLVK 1.6 PLFURQV

1

)

670LFURHOHFWURQLFV

2 )(% 2016 ,PDJLQJ 'LYLVLRQ

)LQLVK

'DWH

0.25 GHJUHHV

+0.05

$QJXODU 'LDPHWHU

'R 1RW 6FDOH 6FDOH

20:1

$OO GLPHQVLRQV

678$57 52%(57621 LQ PP

'UDZQ

,QWHUSUHW GUDZLQJ SHU %68888, 0DWHULDO

35' $QJOH 3URMHFWLRQ

7ROHUDQFHV, XQOHVV RWKHUZLVH VWDWHG

/LQHDU

1. 3ODFH 'HFLPDOV 0 0.05
2. 3ODFH 'HFLPDOV 0.0 0.05
3. 3ODFH 'HFLPDOV 0.00 0.05

)

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7+( 7:2 &21(6 6+2:1 21 7+,6 6+((7 5(35(6(17

92/80(6 ,172 :+,&+ 7+( 86(56' (48,30(17

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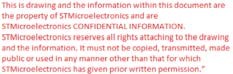
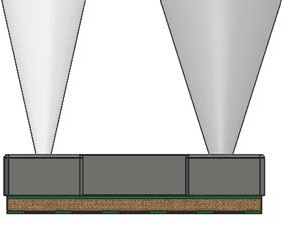
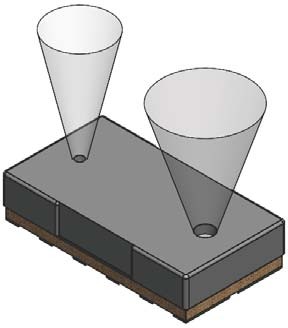
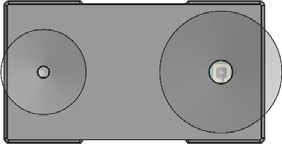
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287/,1( '5$:,1\* 2 2) 3

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7LWOH 9/53/0; & /,1(5 02'8/( 6KHHW

3DUW 1R.

'000266747

3RVLWLRQ 0.10

6XUIDFH )LQLVK 1.6 PLFURQV

1

)

670LFURHOHFWURQLFV

2 )(% 2016 ,PDJLQJ 'LYLVLRQ

)LQLVK

'DWH

0.25 GHJUHHV

+0.05

$QJXODU 'LDPHWHU

'R 1RW 6FDOH 6FDOH

20:1

$OO GLPHQVLRQV

678$57 52%(57621 LQ PP

'UDZQ

,QWHUSUHW GUDZLQJ SHU %68888, 0DWHULDO

35' $QJOH 3URMHFWLRQ

7ROHUDQFHV, XQOHVV RWKHUZLVH VWDWHG

/LQHDU

1. 3ODFH 'HFLPDOV 0 0.05
2. 3ODFH 'HFLPDOV 0.0 0.05
3. 3ODFH 'HFLPDOV 0.00 0.05

)

(;&/86,21 &21( '$7$:

7+( 7:2 &21(6 6+2:1 21 7+,6 6+((7 5(35(6(17

92/80(6 ,172 :+,&+ 7+( 86(56' (48,30(17

+286,1\* 6+28/' 127 (17(5.

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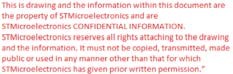
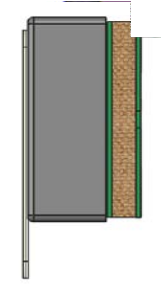
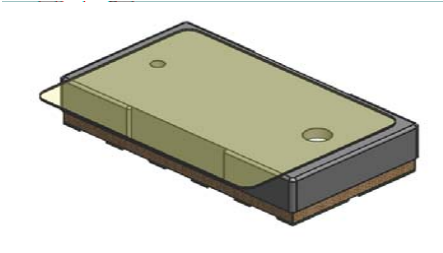
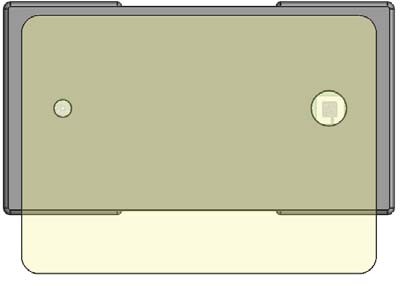
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287/,1( '5$:,1\* 3 2) 3

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7LWOH 9/53/0; & /,1(5 02'8/( 6KHHW

670LFURHOHFWURQLFV

,PDJLQJ 'LYLVLRQ

'DWH

2 )(% 2016

3DUW 1R.

'000266747

)LQLVK

0.25 GHJUHHV

+0.05

3RVLWLRQ 0.10

6XUIDFH )LQLVK 1.6 PLFURQV

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$QJXODU 'LDPHWHU

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'R 1RW 6FDOH 6FDOH

30:1

$OO GLPHQVLRQV

678$57 52%(57621 LQ PP

'UDZQ

,QWHUSUHW GUDZLQJ SHU %68888, 0DWHULDO

35' $QJOH 3URMHFWLRQ

7ROHUDQFHV, XQOHVV RWKHUZLVH VWDWHG

/LQHDU

1. 3ODFH 'HFLPDOV 0 0.05
2. 3ODFH 'HFLPDOV 0.0 0.05
3. 3ODFH 'HFLPDOV 0.00 0.05

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**VL53L0X**

**Outline drawing**

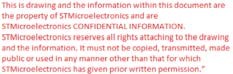
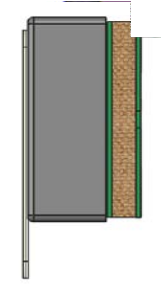
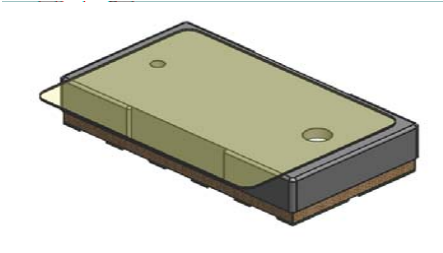
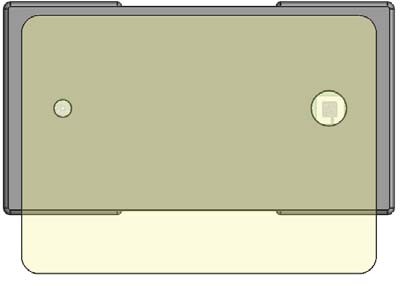
**Figure 24. Outline drawing - with liner (page 3/3)**

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31/40

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287/,1( '5$:,1\* 3 2) 3

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7LWOH 9/53/0; & /,1(5 02'8/( 6KHHW

670LFURHOHFWURQLFV

,PDJLQJ 'LYLVLRQ

'DWH

2 )(% 2016

3DUW 1R.

'000266747

)LQLVK

0.25 GHJUHHV

+0.05

3RVLWLRQ 0.10

6XUIDFH )LQLVK 1.6 PLFURQV

1

$QJXODU 'LDPHWHU

)

'R 1RW 6FDOH 6FDOH

30:1

$OO GLPHQVLRQV

678$57 52%(57621 LQ PP

'UDZQ

,QWHUSUHW GUDZLQJ SHU %68888, 0DWHULDO

35' $QJOH 3URMHFWLRQ

7ROHUDQFHV, XQOHVV RWKHUZLVH VWDWHG

/LQHDU

1. 3ODFH 'HFLPDOV 0 0.05
2. 3ODFH 'HFLPDOV 0.0 0.05
3. 3ODFH 'HFLPDOV 0.00 0.05

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**VL53L0X**

**Outline drawing**

**Figure 24. Outline drawing - with liner (page 3/3)**

DocID029104 Rev 1

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0.15 0.15

The VL53L0X contains a laser emitter and corresponding drive circuitry. The laser output is designed to remain within Class 1 laser safety limits under all reasonably foreseeable conditions including single faults in compliance with IEC 60825-1:2014 (third edition).

VL53L0X包含一个激光发射器和相应的驱动电路。激光输出设计为在所有合理可预见的条件下保持在1级激光安全限值内，包括符合IEC 60825-1:2014标准(第三版)的单一故障。

The laser output will remain within Class 1 limits as long as the STMicroelectronics recommended device settings (API settings) are used and the operating conditions specified are respected.

只要使用意法半导体推荐的设备设置(应用编程接口设置)并遵守规定的操作条件，激光输出将保持在1级限制内。

The laser output power must not be increased by any means and no optics should be used with the intention of focusing the laser beam.

激光输出功率不得以任何方式增加，不得使用任何光学器件聚焦激光束。

**Caution:** Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

警告:使用除此处规定之外的控制或调整或程序执行可能会导致危险的辐射暴露。

#### Figure 25. Class 1 laser product label

#### 图25。1类激光产品标签





# Packaging and labeling

# 包装和标签

## Product marking

## 产品标记

A 2-line product marking is applied on the backside of the module (i.e. on the substrate). The first line is the silicon product code, and the second line, the internal tracking code.

模块背面(即基板上)贴有双线产品标记。第一行是硅产品代码，第二行是内部跟踪代码。

#### Figure 26. Example of marking

#### 图26。标记示例



## Inner box labeling

## 内盒标签

The labeling follows the ST standard packing acceptance specification. The following information will be on the inner box label:

标签遵循ST标准包装验收规范。内盒标签上会有以下信息:

* + - assembly site
    - 装配现场
    - sales type
    - 销售类型
    - quantity
    - 量
    - trace code
    - 跟踪代码
    - marking
    - 标记
    - bulk ID number
    - 批量身份证号码

## Packing

## 包装

At customer / subcontractor level, it is recommended to mount theVL53L0X in a clean environment to avoid foreign material deposition.

在客户/分包商层面，建议在清洁的环境中安装theVL53L0X，以避免异物沉积。

To help avoid any foreign material contamination at phone assembly level the modules will be shipped in a tape and reel format with a protective liner. The packaging will be vacuum- sealed and include a desiccant.

为了帮助避免电话组件层面的任何异物污染，模块将以带保护衬垫的胶带和卷轴形式运输。包装将被真空密封，并包括干燥剂。

The liner is compliant with reflow at 260°C. It must be removed during assembly of the customer device, just before mounting the cover glass.

衬垫符合260℃回流的要求。在客户设备组装期间，就在安装盖板玻璃之前，必须将其移除。

### 8.3.1 Tape outline drawings

### 8.3.1胶带外形图

#### Figure 27. Tape outline drawing

Pin 1



#### 图27。胶带外形图

Pin 1



## Pb-free solder reflow process



## 无铅回流焊工艺



[*Figure 28*](#_bookmark89) and [*Table 15*](#_bookmark88) shows the recommended and maximum values for the solder profile.

[*Figure 28*](#_bookmark89) 和[*Table 15*](#_bookmark88)

Customers will have to tune the reflow profile depending on the PCB, solder paste and material used.

客户必须根据印刷电路板、焊膏和所用材料调整回流曲线。

We expect customers to follow the “recommended” reflow profile, which is specifically tuned for VL53L0X package.

我们希望客户遵循“推荐的”回流曲线，该曲线专门针对VL53L0X封装进行了调整。

For any reason if a customer must perform a reflow profile which is different from “recommended” one (especially peak >240°C), this new profile must be qualified by the customer at its own risk. In any case, the profile have to be within the “maximum” profile limit described in [*Table 15*](#_bookmark88).

出于任何原因，如果客户必须执行不同于“推荐”的回流曲线(尤其是峰值温度> 240°C)，客户必须自行承担风险对新曲线进行鉴定。在任何情况下，配置文件都必须在中描述的“最大”配置文件限制内[*Table 15*](#_bookmark88)

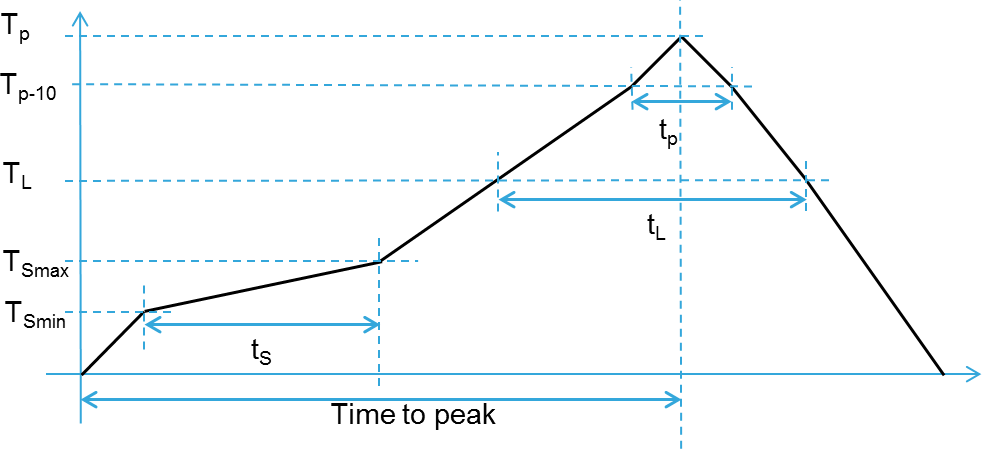
#### Table 15. Recommended solder profile

#### 表15。推荐的焊料轮廓

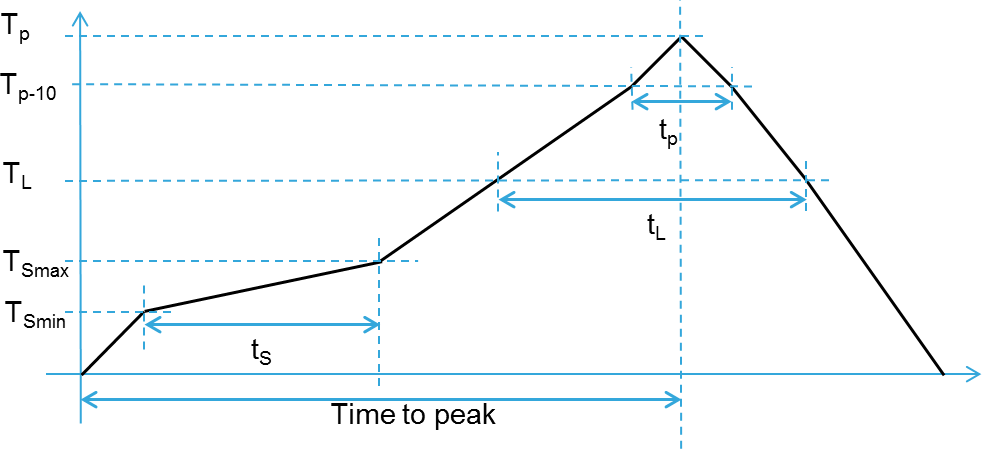
|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Recommended** | **Maximum** | **Units** |
| Minimum temperature (TS min) | 130 | 150 | °C |
| Maximum temperature (TS max) | 200 | 200 | °C |
| Time ts (TS min to TS max) | 90-110 | 60 - 120 | seconds |
| Temperature (TL) | 217 | 217 | °C |
| Time (tL) | 55-65 | 55 - 65 | seconds |
| Ramp up | +2 | +3 | °C/second |
| Temperature (Tp-10) | - | 250 | °C |
| Time (tp-10) | - | 10 | seconds |
| Ramp up | - | +3 | °C/second |
| Peak temperature (Tp) | 240 | 260 max | °C |
| Time to peak | 300 | 300 | seconds |
| Ramp down (peak to TL) | -4 | -6 | °C/second |

|  |  |  |  |
| --- | --- | --- | --- |
| **因素** | **被推荐的** | **最高的** | **单位** |
| 最低温度(最低温度) | 130 | 150 | C |
| 最高温度(最大温度) | 200 | 200 | C |
| 时间ts (ts最小值到TS最大值) | 90-110 | 60 - 120 | 秒 |
| 温度 | 217 | 217 | C |
| 时间(tL) | 55-65 | 55 - 65 | 秒 |
| 扩大生产 | +2 | +3 | c/秒 |
| 温度(Tp-10) | - | 250 | C |
| 时间(tp-10) | - | 10 | 秒 |
| 扩大生产 | - | +3 | c/秒 |
| 峰值温度(Tp) | 240 | 最大260 | C |
| 高峰时间 | 300 | 300 | 秒 |
| 斜坡下降(峰值至t1) | -4 | -6 | c/秒 |

**Figure 28. Solder profile**



**图28。焊料轮廓**



*Note: Temperature mentioned in* [*Table 15*](#_bookmark88) *is measured at the top of VL53L0X package.*

*注:中提到的温度*[*Table 15*](#_bookmark88)

*Note: The component should be limited to a maximum of 3 passes through this solder profile.*

*注意:该元件最多只能有3次通过该焊料剖面。*

## Handling and storage precautions

## 搬运和储存注意事项

### Shock precaution

### 防震措施

Proximity sensor modules house numerous internal components that are susceptible to shock damage. If a unit is subject to excessive shock, is dropped onto the floor, or a tray/reel of units is dropped onto the floor, it must be rejected, even if no apparent damage is visible.

接近传感器模块容纳了许多易受冲击损坏的内部部件。如果设备受到过度冲击，掉落到地板上，或者设备托盘/卷轴掉落到地板上，即使没有明显的损坏，也必须拒收。

### Part handling

### 零件处理

Handling must be done with non-marring ESD safe carbon, plastic, or Teflon tweezers. Ranging module are susceptible to damage or contamination. A clean assembly process is advised at customer after un-taping the parts, and until a protective cover glass is mounted.

必须使用防静电碳、塑料或聚四氟乙烯镊子进行处理。测距模块容易受到损坏或污染。在拆开零件的胶带之后，直到安装了保护盖玻璃之前，建议客户进行清洁的组装过程。

### Compression force

### 压力

A maximum compressive load of 25N shall be applied on the module.

模块上应施加25N的最大压缩载荷。

### Moisture sensitivity level

### 水分敏感水平

Moisture sensitivity is level 3 (MSL) as described in IPC/JEDEC JSTD-020-C

湿度敏感度为3级(MSL)，如IPC/JEDEC JSTD-020-C中所述

## Storage temperature conditions

## 储存温度条件

#### Table 16. Recommended storage conditions

#### 表16。推荐的储存条件

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Min.** | **Typ.** | **Max.** | **Unit** |
| Temperature (storage) | -40 |  | +85 | °C |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **参数** | **量滴** | **典型。** | **最大值** | **单位** |
| 温度(储存) | -40 |  | +85 | C |

**Table 17. Ordering information**

**表17。订购须知**

|  |  |  |
| --- | --- | --- |
| **Sales type** | **Package** | **Packing** |
| VL53L0CXV0DH/1 | Optical LGA12 with liner | Tape and reel |

|  |  |  |
| --- | --- | --- |
| **销售类型** | **包裹** | **包装** |
| VL53L0CXV0DH/1 | 带衬垫的光学LGA12 | 磁带和卷轴 |

# 10 Acronyms and abbreviations

# 10首字母缩略词和缩写

**Table 18. Acronyms and abbreviations**

**表18。首字母缩略词和缩写**

|  |  |
| --- | --- |
| **Acronym/ abbreviation** | **Definition** |
| ESD | Electrostatic discharge |
| I2C | Inter-integrated circuit (serial bus) |
| NVM | Non volatile memory |
| RIT | Return Ignore Threshold |
| SPAD | Single photon avalanche diode |
| VCSEL | Vertical cavity surface emitting laser |

|  |  |
| --- | --- |
| **缩写词** | **定义** |
| （同Esdras）[圣经]以斯拉记 | 静电放电 |
| I2C | 集成电路间(串行总线) |
| 非挥发性物质 | 非易失性存储器 |
| 罗切斯特理工学院 | 返回忽略阈值 |
| 危险信号 | 单光子雪崩二极管 |
| 垂直腔面发射激光器 | 垂直腔面发射激光器 |

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [*www.st.com*](http://www.st.com/).

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#### Table 19. Document revision history

#### 表19。文档修订历史

|  |  |  |
| --- | --- | --- |
| **Date** | **Revision** | **Changes** |
| 30-May-2016 | 1.0 | Initial release. |

|  |  |  |
| --- | --- | --- |
| **日期** | **修订本** | **变化** |
| 2016年5月30日 | 1.0 | 初次发布。 |

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