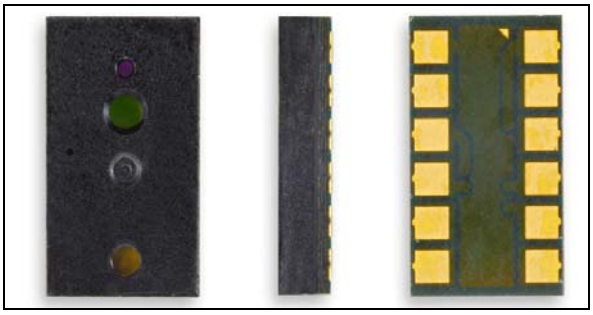
VL6180X

Proximity and ambient light sensing (ALS) module

Datasheet - production data



Features

- Three-in-one smart optical module
  - Proximity sensor
  - Ambient Light Sensor
  - VCSEL light source
- Fast, accurate distance ranging
  - Measures absolute range from 0 to above 10 cm
  - Independent of object reflectance
  - Ambient rejection
  - Crosstalk compensation for cover glass
- Gesture recognition
  - Distance and signal level can be used by host system to implement gesture recognition
  - Demo systems (implemented on Android smartphone platform) available.
- Ambient light sensor
  - High dynamic range
  - Accurate/sensitive in ultra-low light
  - Calibrated output value in lux
- Easy integration
  - Single reflowable component
  - No additional optics or gasket
  - Single power supply
  - I^2C interface for device control and data
- Two programmable GPIO
  - Window and thresholding functions for both ranging and ALS

Description

The VL6180X is the latest product based on ST's patented FlightSense™ technology. This is a ground-breaking technology allowing absolute distance to be measured independent of target reflectance. Instead of estimating the distance by measuring the amount of light reflected back from the object (which is significantly influenced by color and surface), the VL6180X precisely measures the time the light takes to travel to the nearest object and reflect back to the sensor (Time-of-Flight).

Combining an IR emitter, a range sensor and an ambient light sensor in a three-in-one ready-to-use reflowable package, the VL6180X is easy to integrate and saves the end-product maker long and costly optical and mechanical design optimizations.

The module is designed for ultra low power operation. Ranging and ALS measurements can be automatically performed at user defined intervals. Multiple threshold and interrupt schemes are supported to minimize host operations.

Host control and result reading is performed using an I^2C interface. Optional additional functions, such as measurement ready and threshold interrupts, are provided by two programmable GPIO pins.

Applications

- Smartphones/portable touchscreen devices
- Tablet/laptop/gaming devices
- Domestic appliances/industrial devices

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1 Functional description

This datasheet is applicable to the final VL6180X ROM code revision.

1.1 Technical specification

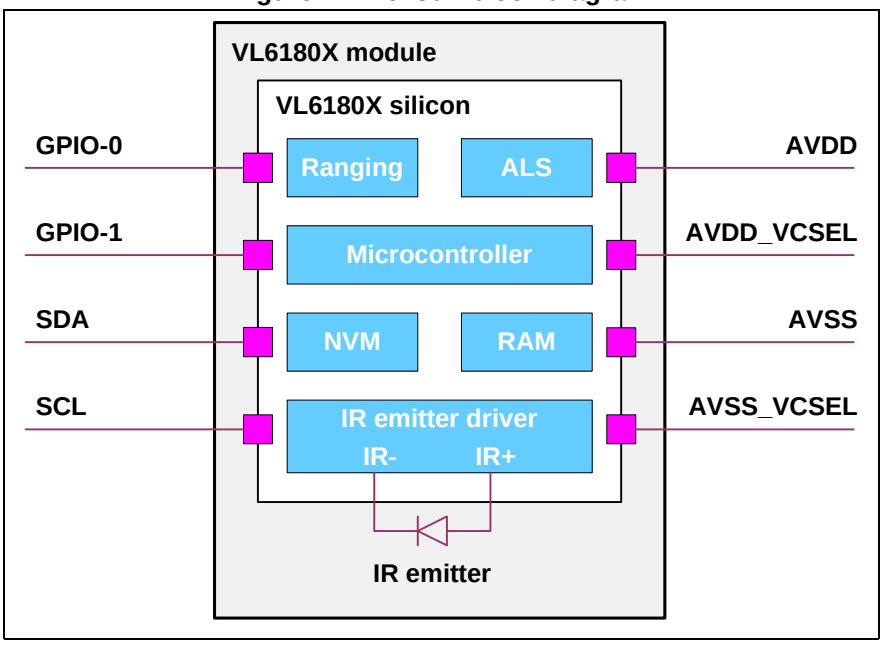
Table 1. Technical specification

Feature	Detail
Package	Optical LGA12
Size	4.8 x 2.8 x 1.0 mm
Ranging	0 to 100 mm(1)
Ambient light sensor	< 1 Lux up to 100 kLux(2) 16-bit output(3) 8 manual gain settings
Operating voltage: • Functional range • Optimum range(4)	 2.6 to 3.0 V 2.7 to 2.9 V
Operating temperature: • Functional range • Optimum range(4)	 -20 to 70°C -10 to 60°C
Typical power consumption	Hardware standby (GPIO0 = 0): < 1 µA Software standby: < 1 µA ALS: 300 µA Ranging: 1.7 mA (typical average)(5)
IR emitter	850 nm
I^2C	400 kHz serial bus Address: 0x29 (7-bit)

1. Ranging beyond 100 mm is possible with certain target reflectances and ambient conditions but not guaranteed
2. When used under a cover glass with 10% transmission in the visible spectrum
3. Digital output easily converted to Lux
4. Please refer to *Table 11.: Ranging specification*
5. Assumes 10 Hz sampling rate, 17% reflective target at 50 mm

1.2 System block diagram

Figure 1. VL6180X block diagram



1.3 Device pinout

Figure 2 shows the pinout of the VL6180X.

Figure 2. VL6180X pinout

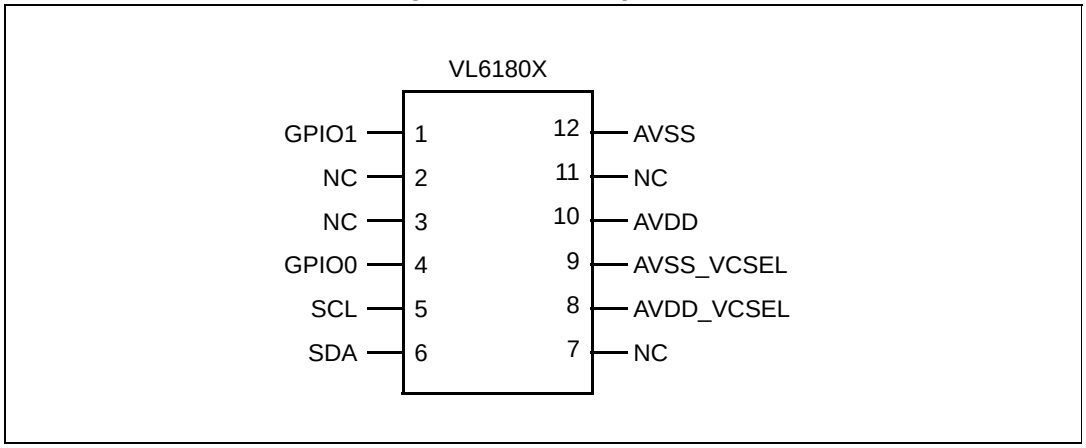


Table 2. VL6180X pin numbers and signal descriptions

Pin number	Signal name	Signal type	Signal description
1	GPIO1	Digital I/O	Interrupt output. Open-drain.
2	NC		No connect or ground
3	NC		No connect or ground

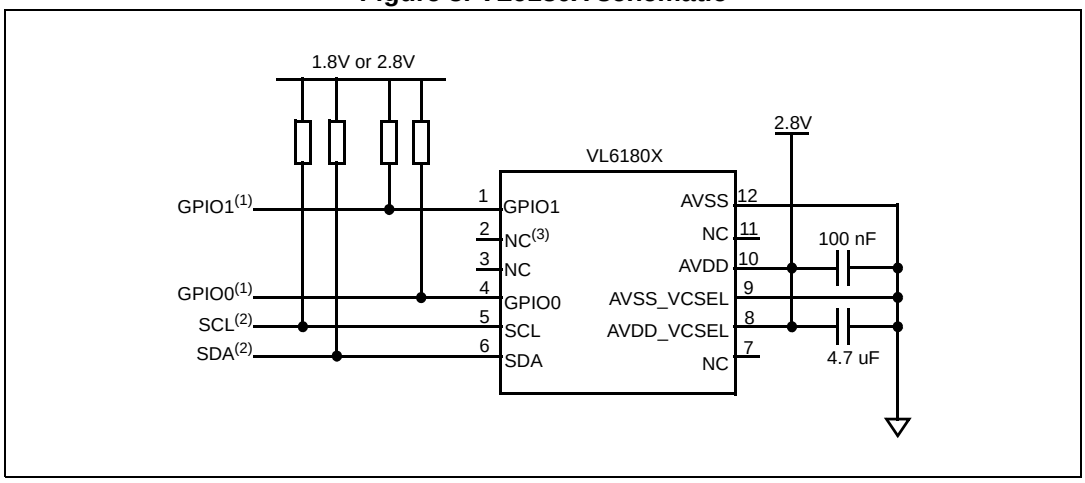
Table 2. VL6180X pin numbers and signal descriptions (continued)

Pin number	Signal name	Signal type	Signal description
4	GPIO0/CE	Digital I/O	Power-up default is chip enable (CE). It should be pulled high with a 47 kΩ resistor.
5	SCL	Digital input	I^2C serial clock
6	SDA	Digital I/O	I^2C serial data
7	NC		No connect or ground
8	AVDD_VCSEL	Supply	VCSEL power supply. 2.6 to 3.0 V
9	AVSS_VCSEL	Ground	VCSEL ground
10	AVDD	Supply	Digital/analog power supply. 2.6 to 3.0 V
11	NC		No connect or ground
12	AVSS	Ground	Digital/analog ground

1.4 Application schematic

Figure 3 shows the schematic of the VL6180X.

Figure 3. VL6180X schematic



1. Open drain. Recommend 47 kΩ
2. Open drain. Pull up resistors typically fitted once per I^2C bus at host
3. No connects can also be grounded if required

Note: Capacitors on AVDD and AVDD_VCSEL should be placed as close as possible to the supply pads.

1.5 Current consumption

The VL6180X is designed to be a low power device however the actual current drawn during ranging is dependent on the target reflectance and distance.

Table 3. Typical current consumption

Mode	Current	Conditions
Hardware standby	< 1 µA	Shutdown (GPIO0 = 0). No I^2C comms
Software standby	< 1 µA	After MCU boot. Device ready
ALS	300 µA	During integration
Ranging	1.7 mA	Average consumption during ranging(1)

1. 10 Hz sampling rate, 17% reflective target at 50 mm.

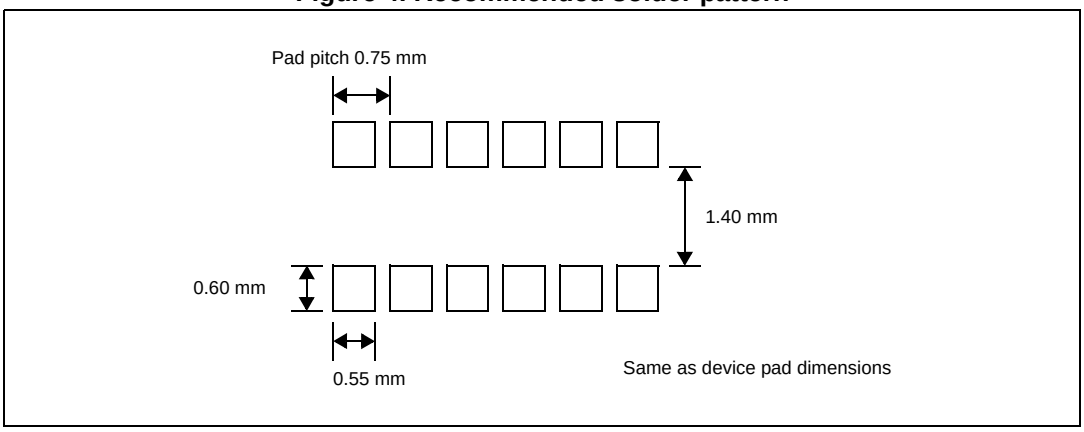
Table 4. Average current consumption

Power supply(1)	Current	Note
AVDD	14 mA	Average during active ranging
AVDD_VCSEL	8 mA(2)	Average during active ranging (33% duty cycle).

1. Normally, both supplies will be driven from a common source giving a peak instantaneous current demand of 38 mA.
2. Peak emitter current during ranging is 24 mA.

1.6 Recommended solder pad dimensions

Figure 4. Recommended solder pattern



1.7 Recommended reflow profile

The recommend reflow profile is shown in *Figure 5* and *Table 5*.

Figure 5. Recommended reflow profile

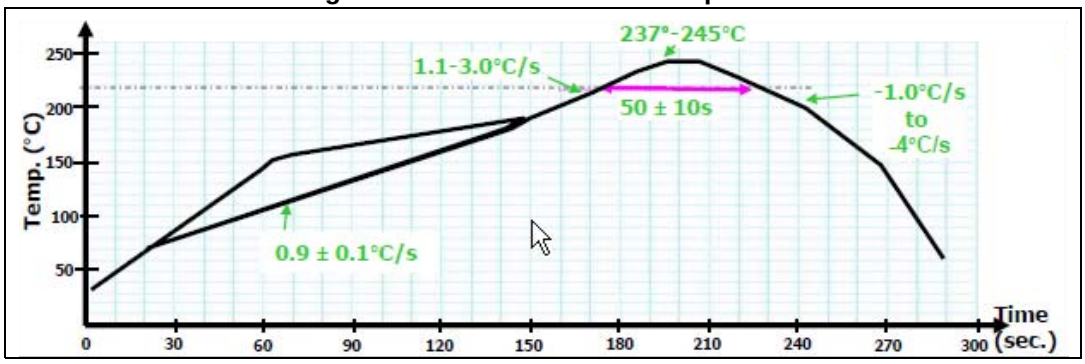


Table 5. Recommended reflow profile

Profile	Ramp to strike	
Temperature gradient in preheat	(T= 70 - 180°C):	0.9 +/- 0.1°C/s
Temperature gradient	(T= 200 - 225°C):	1.1 - 3.0°C/s
Peak temperature in reflow	237°C - 245°C	
Time above 220°C	50 +/- 10 seconds	
Temperature gradient in cooling	-1 to -4 °C/s (-6°C/s maximum)	
Time from 50 to 220°C	160 to 220 seconds	

Note: As the VL6180X package is not sealed, only a dry re-flow process should be used (such as convection re-flow). Vapor phase re-flow is not suitable for this type of optical component.

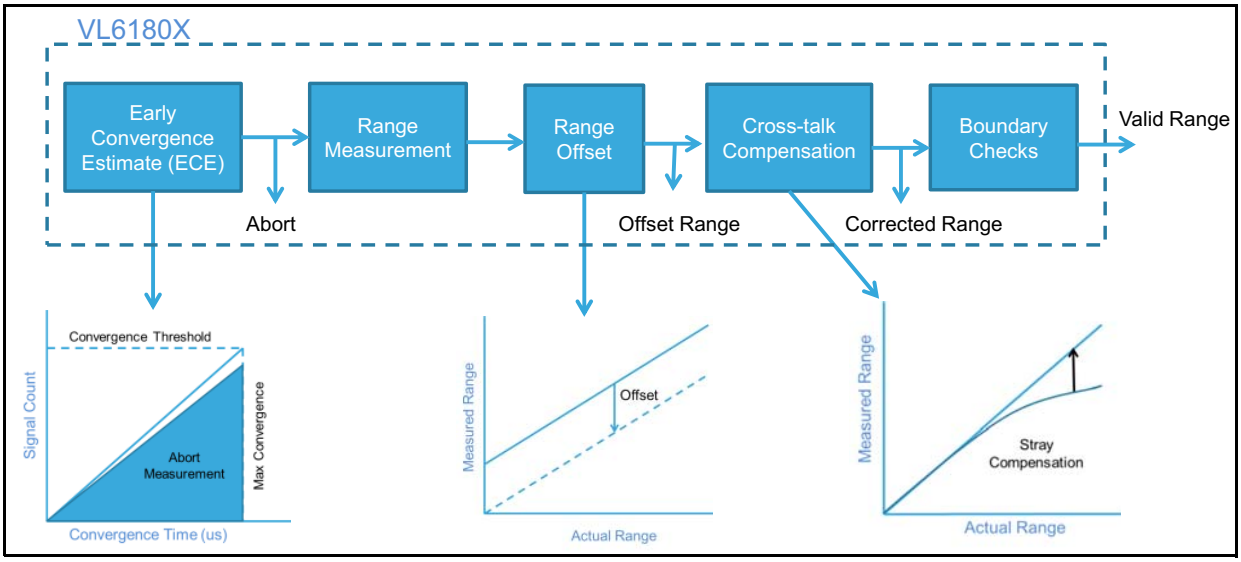
The VL6180X is an optical component and as such, it should be treated carefully. This would typically include using a 'no-wash' assembly process.

2 Operational description

2.1 Ranging

This section describes the operation of several features associated with the VL6180X. The VL6180X uses a simple pipe architecture to achieve a range measurement.

Figure 6. Ranging pipe architecture



2.1.1 Early convergence estimate (ECE)

VL6180X has a built in ECE feature. When enabled, the rate of convergence is automatically calculated 0.5 ms after the start of each measurement. If the return count is below the ECE threshold the measurement is aborted. This minimizes power consumption and reduces red glow when there is no target.

The ECE threshold is calculated as follows:

*ECE threshold = convergence threshold / (max_convergence * 2 * 1.2)*

ECE is enabled by setting bit 0 of SYSRANGE__RANGE_CHECK_ENABLES (0x02D)

2.1.2 Range offset

The part-to-part range offset is calibrated during manufacture using a 17% reflective gray target at 50 mm. The calibrated offset is written to SYSRANGE__PART_TO_PART_RANGE_OFFSET (0x024). The device automatically applies the part-to-part offset to the range output after every measurement:

Raw Offset Range = Range Measurement + Offset

The raw offset range is stored in RESULT__RANGE_RAW (0x064)

2.1.3 Cross talk compensation

Cross talk refers to the signal return from the cover glass. Range error increases as the signal rate from the target decreases (low reflectance, far target). The actual range can be recovered by applying cross talk compensation. The magnitude of the cross talk is dependent on the thickness of glass, filter material and size of the air gap between the device and the glass. Cross talk compensation is only applied to targets with a raw range greater than the crosstalk_valid_height (default = 20 mm) to ensure that correction is not applied to near targets where the signal rate is decreasing.

In the final application, the cross talk compensation factor needs to be characterized on a number of units to assess the production variation. In most cases it should be possible to use a single cross talk compensation factor per product configuration.

The cross talk compensation factor is characterized using a 3% reflective target at 100 mm as follows:

*cross talk compensation factor = signal rate * (1- (raw range /100 mm))*

Write the cross talk compensation factor to
SYSRANGE__CROSSTALK_COMPENSATION_RATE (0x01E)

The device then automatically calculates the stray corrected range as follows:

*cross talk compensated range = raw range * ((signal rate)/(signal rate - cross talk compensation factor))*

2.1.4 Ignore threshold

The range ignore_threshold is used to ensure the device is not able to range on the glass. The signal rate must be above the ignore-threshold before a range measurement will be considered valid.

*ignore_threshold (Mcps) = straylight_factor (Mcps) * 1.2*

Furthermore, ignore_valid_height can be specified such that only near targets are qualified. Thus, Range_ignore is only applied if:

(return_rate > ignore_threshold) && (raw_range < ignore_valid_height)

To enable range ignore, set bit 1 in SYSRANGE__RANGE_CHECK_ENABLES (0x02D)

2.1.5 SNR limit threshold

In high ambient conditions range accuracy can be impaired. The SNR limit is used to invalidate range measurements where the ambient:signal ratio is too high.

The ambient:signal ratio limit is usually set to around 4:1:

SYSRANGE__MAX_AMBIENT_LEVEL_MULT = 64 (4.4 format)

If *ambient_counts > return_counts * MAX_AMBIENT_LEVEL_MULT* then range measurement is abandoned

To enable SNR, set bit 4 in SYSRANGE__RANGE_CHECK_ENABLES (0x02D)

2.2 Ambient light sensor (ALS)

The VL6180X is capable of measuring the ambient light level over a wide dynamic range. This section describes the operation of the main features associated with the VL6180X ALS.

2.2.1 Field of view

The field of view of the ALS is +/- 42 degrees in both X and Y.

2.2.2 Range of measurable light level

Table 6 shows the range of measurable light.

Table 6. ALS dynamic range(1)

Analogue gain setting	Actual gain values	Dynamic range (no glass)		Dynamic range (10% transmissive glass)	
		Min. (Lux)(2)	Max. (Lux)	Minimum (Lux)	Maximum (Lux)
1	1.01	3.20	20800	32.0	>100,000
1.25	1.28	2.56	16640	25.6	>100,000
1.67	1.72	1.93	12530	19.3	>100,000
2.5	2.60	1.28	8320	12.8	83,200
5	5.21	0.64	4160	6.4	41,600
10	10.32	0.32	2080	3.2	20,800
20	20	0.16	1040	1.6	10,400
40	40	0.08	520	0.8	5,200

1. ALS lux resolution = 0.32 lux/count
2. Minimum of 10 counts

2.2.3 ALS Count to lux conversion

The output from the ambient light sensor is a 16-bit register (result__als_val [0x50]). The count output is proportional to the light level. The ALS must be calibrated before a conversion to a lux value can be made. The factory calibrated ALS lux resolution is 0.32 lux/count (without glass). This value will require re-calibration in the final system where cover glass is used.

2.2.4 Integration period

The integration period is the time over which a single ALS measurement is made. The default integration period is 100ms.

2.2.5 ALS gain selection

As shown in *Table 6.: ALS dynamic range*, eight analog gain settings are available which can be selected manually depending on the range and resolution required.

3 Electrical characteristics

3.1 Absolute maximum ratings

Table 7. Absolute maximum ratings

Parameter	Min.	Typ.	Max.	Unit
AVDD	-0.5	-	3.6	V
AVDD_VCSEL	-0.5	-	3.6	V
SCL, SDA, GPIO0 and GPIO1	-0.5	-	3.6	V

Note: Stresses above those listed in Table 7. 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. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

3.2 Normal operating conditions

Table 8. Normal operating conditions

Parameter	Min.	Typ.	Max.	Unit
Voltage (AVDD and AVDD_VCSEL)				
Voltage (optimum operating)	2.7	2.8	2.9	V
Voltage (functional operating)	2.6	2.8	3.0	V
Temperature				
Temperature (optimum operating)	-10		+60	°C
Temperature (functional operating)	-20	-	+70	°C
Temperature (test)	+21	-	+25	°C
Temperature (storage)	-40	-	+85	°C

3.3 Current consumption

Table 9. Current consumption(1)

Parameter	Min.	Typ.	Max.	Unit
Hardware Standby	-	-	1	µA
Software Standby	-	-	1	µA
ALS operation	-	300	350	µA

1. Measured at room temperature (23°C)

3.4 Electrical characteristics

Table 10. Digital I/O electrical characteristics

Symbol	Parameter	Minimum	Typical	Maximum	Unit
CMOS digital I/O (SDA, SCL, GPIO0 and GPIO1)					
V_{IL}	Low level input voltage	-0.5	-	0.6	V
V_{IH}	High level input voltage	1.12	-	AVDD+0.5	V
V_{OL}	Low level output voltage (8mA load)	-	-	0.4	V
V_{OH}	High level output voltage (8mA load)	AVDD-0.4	-	-	V
I_{IL}	Low level input current	-	-	-10	µA
I_{IH}	High level input current	-	-	10	µA

4 Performance specification

4.1 Proximity ranging (0 to 100mm)

The following table specifies ranging performance up to 100mm. These results are derived from characterization of both typical and corner samples (representative of worst case process conditions).

Unless specified otherwise, all results were performed at room temperature (23°C), nominal voltage (2.8V) and in the dark. Results are based on the average of 100 measurements for a 17% reflective target @ 50mm.

Table 11. Ranging specification

Parameter	Min.	Typ.	Max.	Unit
Noise(1)	-	-	2.0	mm
Range offset error(2)	-	-	13	mm
Temperature dependent drift (3)	-	9	15	mm
Voltage dependent drift (4)	-	3	5	mm
Convergence time (5)	-	-	15	ms

1. Maximum standard deviation of 100 measurements
2. Maximum offset drift after 3 reflow cycles. This error can be removed by re-calibration in the final system
3. Tested over optimum operating temperature range (see *Table 8.: Normal operating conditions*)
4. Tested over optimum operating voltage range (see *Table 8.: Normal operating conditions*)
5. Based on a 3% reflective target @ 100 mm

4.1.1 Max range vs. ambient light level

The data shown in this section is worst case data ***for reference only.***

Table 12 shows the worst case maximum range achievable under different ambient light conditions.

Table 12. Worst case max range vs. ambient 0 to 100mm(1)(2)

Target reflectance	In the dark(3)	Worst case indoor light (1 kLux diffuse halogen)	High ambient light (5 kLux diffuse halogen)	Unit
3%	> 100	> 80	> 40	mm
5%	> 100	> 90	> 45	mm
17%	> 100	> 100	> 60	mm
88%	> 100	> 100	> 70	mm

1. Tested in an integrating sphere (repeatable lab test, not representative of real world ambient light) at 1 kLux and 5 kLux (halogen light source) using 80 x 80 mm targets. Due to high IR content, 5 kLux halogen light approximates to 10 kLux to 15 kLux natural sunlight.
2. SNR limit of 0.1 applied. Note: maximum range could be increased by reducing the SNR limit to 0.06
3. Also applicable to lighting conditions with low IR content e.g typical office fluorescent lighting

4.2 ALS performance

The following table specifies ALS performance. These results are derived from characterization of typical samples (without cover glass). Unless specified otherwise, all tests were performed at room temperature (23°C), nominal voltage (2.8V) and using a halogen light source.

Table 13. ALS performance

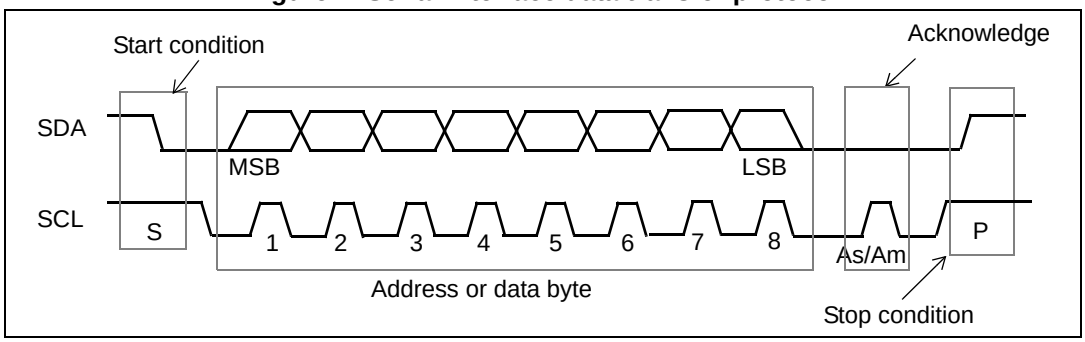
Parameter	Min.	Typ.	Max.	Unit
ALS sensitivity(1)	0.28	0.32	0.36	Lux/count
Angular response(2)	-	42	-	degrees
Spectral response	-	photopic	-	-
Dynamic Range(3)	0.002	-	20971	Lux
Linearity error (1 to 300 lux)(4)	-	-	5	%
Linearity error (300 to 7500 lux)(4)	-	-	10	%
Gain error (@ gain 20)	-	-	1	%
Gain error (gains 1 to 10)	-	-	7	%

1. 535nm LED @ 1 kLux. Measured @ gain 20.
2. Half angle. 40% transmission.
3. Minimum of one count at gain 40 and 400 ms ALS integration time.
4. Test conditions: -10°C to +60°C; analog gains 1 to 20

5 I²C control interface

The VL6180X is controlled over an I²C interface. The default I²C address is 0x29 (7-bit). This section describes the I²C protocol.

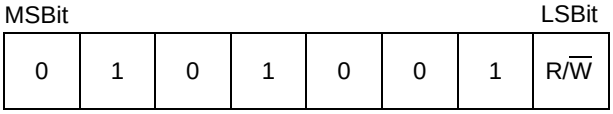
Figure 7. Serial interface data transfer protocol



Information is packed in 8-bit packets (bytes) always followed by an acknowledge bit, As for sensor acknowledge and Am for master acknowledge. 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.

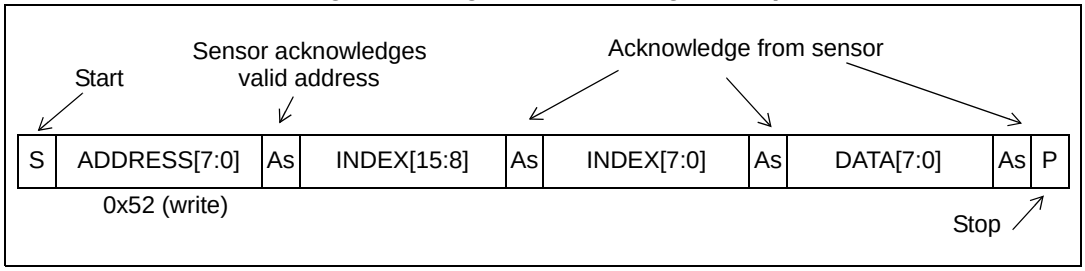
A message contains a series of bytes preceded by a start condition and followed by either a stop or repeated start (another start condition but without a preceding stop condition) followed by another message. The first byte contains the device address (0x52) and also specifies the data direction. If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

Figure 8. I²C device address



All serial interface communications with the sensor must begin with a start condition. The sensor 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 and third bytes received provide a 16-bit index which points to one of the internal 8-bit registers.

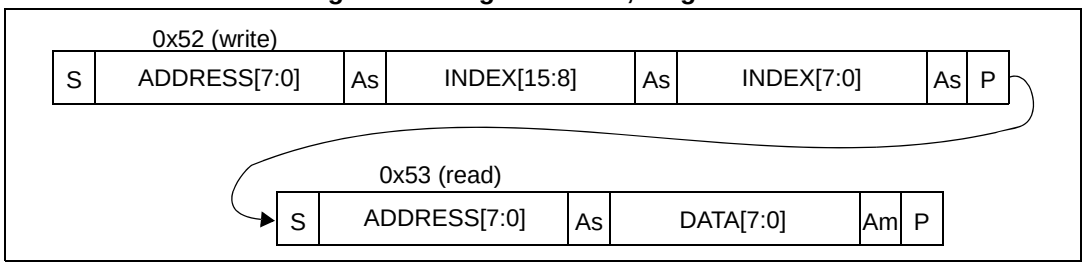
Figure 9. Single location, single write)



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.

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.

Figure 10. Single location, single read



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

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.

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.

Figure 11. Multiple location write

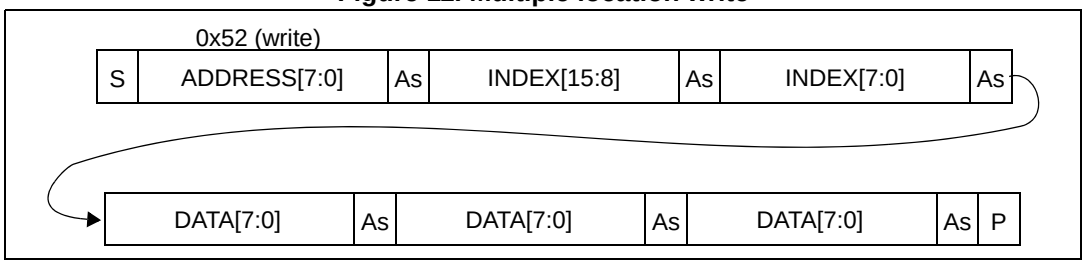
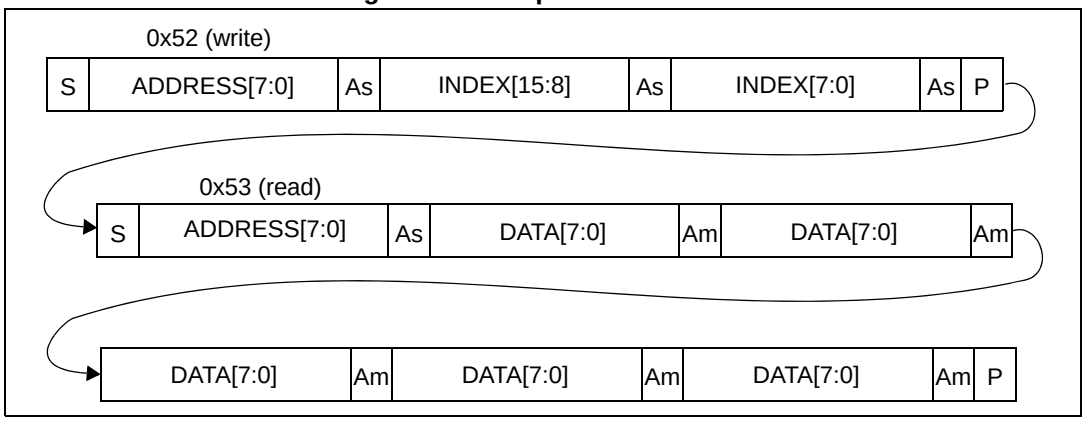


Figure 12. Multiple location read



6 Device registers

6.1 Register formats

Table 14 gives a summary of data formats used in the register map and *Table 15* gives a summary of the device registers.

Table 14. Register formats

Format	Description
9.7	9 integer bits + 7 fractional bits (stored over 2 bytes) For example, the value 4.2 is multiplied by 128, rounded and stored as 537 decimal. To decode, divide 537 by 128 = 4.19.

Table 15. Register summary

Offset	Register name	Reference
0x000	IDENTIFICATION__MODEL_ID	*Section 6.2.1 on page 25*
0x001	IDENTIFICATION__MODEL_REV_MAJOR	*Section 6.2.2 on page 25*
0x002	IDENTIFICATION__MODEL_REV_MINOR	*Section 6.2.3 on page 25*
0x003	IDENTIFICATION__MODULE_REV_MAJOR	*Section 6.2.4 on page 26*
0x004	IDENTIFICATION__MODULE_REV_MINOR	*Section 6.2.5 on page 26*
0x006	IDENTIFICATION__DATE_HI	*Section 6.2.6 on page 26*
0x007	IDENTIFICATION__DATE_LO	*Section 6.2.7 on page 27*
0x008:0x009	IDENTIFICATION__TIME	*Section 6.2.8 on page 27*
0x010	SYSTEM__MODE_GPIO0	*Section 6.2.9 on page 28*
0x011	SYSTEM__MODE_GPIO1	*Section 6.2.10 on page 29*
0x012	SYSTEM__HISTORY_CTRL	*Section 6.2.11 on page 30*
0x014	SYSTEM__INTERRUPT_CONFIG_GPIO	*Section 6.2.12 on page 31*
0x015	SYSTEM__INTERRUPT_CLEAR	*Section 6.2.13 on page 31*
0x016	SYSTEM__FRESH_OUT_OF_RESET	*Section 6.2.14 on page 32*
0x017	SYSTEM__GROUPED_PARAMETER_HOLD	*Section 6.2.15 on page 32*
0x018	SYSRANGE__START	*Section 6.2.16 on page 33*
0x019	SYSRANGE__THRESH_HIGH	*Section 6.2.17 on page 33*
0x01A	SYSRANGE__THRESH_LOW	*Section 6.2.18 on page 34*
0x01B	SYSRANGE__INTERMEASUREMENT_PERIOD	*Section 6.2.19 on page 34*
0x01C	SYSRANGE__MAX_CONVERGENCE_TIME	*Section 6.2.20 on page 34*
0x01E	SYSRANGE__CROSSTALK_COMPENSATION_RATE	*Section 6.2.21 on page 35*
0x021	SYSRANGE__CROSSTALK_VALID_HEIGHT	*Section 6.2.22 on page 35*
0x022	SYSRANGE__EARLY_CONVERGENCE_ESTIMATE	*Section 6.2.23 on page 35*
0x024	SYSRANGE__PART_TO_PART_RANGE_OFFSET	*Section 6.2.24 on page 36*

Table 15. Register summary (continued)

Offset	Register name	Reference
0x025	SYSRANGE__RANGE_IGNORE_VALID_HEIGHT	Section 6.2.25 on page 36
0x026	SYSRANGE__RANGE_IGNORE_THRESHOLD	Section 6.2.26 on page 36
0x02C	SYSRANGE__MAX_AMBIENT_LEVEL_MULT	Section 6.2.27 on page 37
0x02D	SYSRANGE__RANGE_CHECK_ENABLES	Section 6.2.27 on page 37
0x02E	SYSRANGE__VHV_RECALIBRATE	Section 6.2.29 on page 38
0x031	SYSRANGE__VHV_REPEAT_RATE	Section 6.2.30 on page 38
0x038	SYSALS__START	Section 6.2.31 on page 39
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0x2A3	INTERLEAVED_MODE__ENABLE	Section 6.2.56 on page 51

6.2 Register descriptions

6.2.1 IDENTIFICATION__MODEL_ID

7	6	5	4	3	2	1	0
identification__model_id							
R/W							

Address: 0x000

Type: R/W

Reset: 0xB4

Description:

[7:0]	identification__model_id: Device model identification number. 0xB4 = VL6180X

6.2.2 IDENTIFICATION__MODEL_REV_MAJOR

7	6	5	4	3	2	1	0
RESERVED					identification__model_rev_major		
R					R/W		

Address: 0x001

Type: R/W

Reset: 0x1

Description:

[2:0]	identification__model_rev_major: Revision identifier of the Device for major change.

6.2.3 IDENTIFICATION__MODEL_REV_MINOR

7	6	5	4	3	2	1	0
RESERVED					identification__model_rev_minor		
R					R/W		

Address: 0x002

Type: R/W

Reset: 0x3, register default overwritten at boot-up by NVM contents.

Description:

[2:0]	identification__model_rev_minor: Revision identifier of the Device for minor change. IDENTIFICATION__MODEL_REV_MINOR = 3 for latest ROM revision

6.2.4 IDENTIFICATION__MODULE_REV_MAJOR

7	6	5	4	3	2	1	0
RESERVED					identification__module_rev_major		
R					R/W		

Address: 0x003

Type: R/W

Reset: 0x1, register default overwritten at boot-up by NVM contents.

Description:

[2:0]	identification__module_rev_major: Revision identifier of the Module Package for major change. Used to store NVM content version. Contact ST for current information.

6.2.5 IDENTIFICATION__MODULE_REV_MINOR

7	6	5	4	3	2	1	0
RESERVED					identification__module_rev_minor		
R					R/W		

Address: 0x004

Type: R/W

Reset: 0x2

Description:

[2:0]	identification__module_rev_minor: Revision identifier of the Module Package for minor change. Used to store NVM content version. Contact ST for current information.

6.2.6 IDENTIFICATION__DATE_HI

7	6	5	4	3	2	1	0
identification__year				identification__month			
R/W				R/W			

Address: 0x006

Type: R/W

Reset: 0xYY, register default overwritten at boot-up by NVM contents.

Description: Part of the register set that can be used to uniquely identify a module.

[7:4]	identification__year: Last digit of manufacturing year (bits[3:0]).
[3:0]	identification__month: Manufacturing month (bits[3:0]).

6.2.7 IDENTIFICATION__DATE_LO

7	6	5	4	3	2	1	0
identification__day					identification__phase		
R/W					R/W		

Address: 0x007

Type: R/W

Reset: 0xYY, register default overwritten at boot-up by NVM contents.

Description: Part of the register set that can be used to uniquely identify a module.

[7:3]	identification__day: Manufacturing day (bits[4:0]).
[2:0]	identification__phase: Manufacturing phase identification (bits[2:0]).

6.2.8 IDENTIFICATION__TIME

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
identification__time															
R/W															

Address: 0x008:0x009

Type: R/W

Reset: 0xYYYY, register default overwritten at boot-up by NVM contents.

Description: Part of the register set that can be used to uniquely identify a module.

[15:0]	identification__time: Time since midnight (in seconds) = register_value * 2

6.2.9 SYSTEM__MODE_GPIO0

7	6	5	4	3	2	1	0
RESERVED	system__gpio0_is_xshutdown	system__gpio0_polarity	system__gpio0_select				RESERVED
R	R/W	R/W	R/W				R/W

Address: 0x010

Type: R/W

Reset: 0x60

Description:

[6]	system__gpio0_is_xshutdown: Priority mode - when enabled, other bits of the register are ignored. GPIO0 is main XSHUTDOWN input. 0: Disabled 1: Enabled - GPIO0 is main XSHUTDOWN input.
[5]	system__gpio0_polarity: Signal Polarity Selection. 0: Active-low 1: Active-high
[4:1]	system__gpio0_select: Functional configuration options. 0000: OFF (Hi-Z) 1000: GPIO Interrupt output
[0]	Reserved. Write 0.

6.2.10 SYSTEM__MODE_GPIO1

7	6	5	4	3	2	1	0
RESERVED		system__gpio1_polarity	system__gpio1_select				RESERVED
R		R/W	R/W				R/W

Address: 0x011

Type: R/W

Reset: 0x20

Description:

[5]	system__gpio1_polarity: Signal Polarity Selection. 0: Active-low 1: Active-high
[4:1]	system__gpio1_select: Functional configuration options. 0000: OFF (Hi-Z) 1000: GPIO Interrupt output
[0]	Reserved. Write 0.

6.2.11 SYSTEM__HISTORY_CTRL

7	6	5	4	3	2	1	0
RESERVED					system__history_buffer_clear	system__history_buffer_mode	system__history_buffer_enable
R					R/W	R/W	R/W

Address: 0x012

Type: R/W

Reset: 0x0

Description:

[2]	system__history_buffer_clear: User-command to clear history (FW will auto-clear this bit when clear has completed). 0: Disabled 1: Clear all history buffers
[1]	system__history_buffer_mode: Select mode buffer results for: 0: Ranging (stores the last 8 ranging values (8-bit) 1: ALS (stores the last 8 ALS values (16-bit)
[0]	system__history_buffer_enable: Enable History buffering. 0: Disabled 1: Enabled

6.2.12 SYSTEM__INTERRUPT_CONFIG_GPIO

7	6	5	4	3	2	1	0
RESERVED		als_int_mode			range_int_mode		
R		R/W			R/W		

Address: 0x014

Type: R/W

Reset: 0x0

Description:

[5:3]	als_int_mode: Interrupt mode source for ALS readings: 0: Disabled 1: Level Low (value < thresh_low) 2: Level High (value > thresh_high) 3: Out Of Window (value < thresh_low OR value > thresh_high) 4: New sample ready
[2:0]	range_int_mode: Interrupt mode source for Range readings: 0: Disabled 1: Level Low (value < thresh_low) 2: Level High (value > thresh_high) 3: Out Of Window (value < thresh_low OR value > thresh_high) 4: New sample ready

6.2.13 SYSTEM__INTERRUPT_CLEAR

7	6	5	4	3	2	1	0
RESERVED					int_clear_sig		
R					R/W		

Address: 0x015

Type: R/W

Reset: 0x0

Description:

[2:0]	int_clear_sig: Interrupt clear bits Writing a 1 to each bit will clear the intended interrupt note that the int is only cleared upon the write command itself. Bit [0] - Clear Range Int Bit [1] - Clear ALS Int Bit [2] - Clear Error Int.

6.2.14 SYSTEM__FRESH_OUT_OF_RESET

7	6	5	4	3	2	1	0
RESERVED							fresh_out_of_reset
R							R/W

Address: 0x016

Type: R/W

Reset: 0x1

Description:

[0]	fresh_out_of_reset: Fresh out of reset bit, default of 1, user can set this to 0 after initial boot and can therefore use this to check for a reset condition

6.2.15 SYSTEM__GROUPED_PARAMETER_HOLD

7	6	5	4	3	2	1	0
RESERVED							grouped_parameter_hold
R							R/W

Address: 0x017

Type: R/W

Reset: 0x0

Description:

[0]	grouped_parameter_hold: Flag set over I^2C to indicate that data is being updated 0: Data is stable - FW is safe to copy 1: Data being updated - FW not safe to copy Usage: set to 0x01 first, write any of the registers listed below, then set to 0x00 so that the settings are used by the firmware at the start of the next measurement. SYSTEM__INTERRUPT_CONFIG_GPIO SYSRANGE__THRESH_HIGH SYSRANGE__THRESH_LOW SYSALS__INTEGRATION_PERIOD SYSALS__ANALOGUE_GAIN SYSALS__THRESH_HIGH SYSALS__THRESH_LOW

6.2.16 SYSRANGE__START

7	6	5	4	3	2	1	0
RESERVED						sysrange__mode_select	sysrange__startstop
R						R/W	R/W

Address: 0x018

Type: R/W

Reset: 0x0

Description:

[1]	sysrange__mode_select: Device Mode select 0: Ranging Mode Single-Shot 1: Ranging Mode Continuous
[0]	sysrange__startstop: StartStop trigger based on current mode and system configuration of device_ready. FW clears register automatically. Setting this bit to 1 in single-shot mode starts a single measurement. Setting this bit to 1 in continuous mode will either start continuous operation (if stopped) or halt continuous operation (if started). This bit is auto-cleared in both modes of operation.

6.2.17 SYSRANGE__THRESH_HIGH

7	6	5	4	3	2	1	0
sysrange__thresh_high							
R/W							

Address: 0x019

Type: R/W

Reset: 0xFF

Description:

[7:0]	sysrange__thresh_high: High Threshold value for ranging comparison. Range 1-254mm.

6.2.18 SYSRANGE__THRESH_LOW

7	6	5	4	3	2	1	0
sysrange__thresh_low							
R/W							

Address: 0x01A

Type: R/W

Reset: 0x0

Description:

[7:0]	sysrange__thresh_low: Low Threshold value for ranging comparison. Range 1-254mm.

6.2.19 SYSRANGE__INTERMEASUREMENT_PERIOD

7	6	5	4	3	2	1	0
sysrange__intermeasurement_period							
R/W							

Address: 0x01B

Type: R/W

Reset: 0xFF

Description:

[7:0]	sysrange__intermeasurement_period: Time delay between measurements in Ranging continuous mode. Range 0-2.55s (1 code = 10ms).

6.2.20 SYSRANGE__MAX_CONVERGENCE_TIME

7	6	5	4	3	2	1	0
RESERVED		sysrange__max_convergence_time					
R		R/W					

Address: 0x01C

Type: R/W

Reset: 0x31

Description:

[5:0]	sysrange__max_convergence_time: Maximum time to run measurement in Ranging modes. Range 1 - 63 ms (1 code = 1 ms); Measurement aborted when limit reached to aid power reduction. For example, 0x01 = 1ms, 0x0a = 10ms.

6.2.21 SYSRANGE__CROSSTALK_COMPENSATION_RATE

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sysrange__crosstalk_compensation_rate															
R/W															

Address: 0x01E

Type: R/W

Reset: 0x0

Description:

[15:0]	sysrange__crosstalk_compensation_rate: User-controlled crosstalk compensation (stray count rate) due to phone housing. (Mcps, 9.7 format)

6.2.22 SYSRANGE__CROSSTALK_VALID_HEIGHT

7	6	5	4	3	2	1	0
sysrange__crosstalk_valid_height							
R/W							

Address: 0x021

Type: R/W

Reset: 0x14

Description:

[7:0]	sysrange__crosstalk_valid_height: User controlled crosstalk compensation. Minimum range value in mm to qualify for crosstalk compensation.

6.2.23 SYSRANGE__EARLY_CONVERGENCE_ESTIMATE

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sysrange__early_convergence_estimate															
R/W															

Address: 0x022

Type: R/W

Reset: 0x0

Description:

[15:0]	FW carries out an estimate of convergence rate 0.5ms (changed for cut 1.1) into each new range measurement. If convergence rate is below user input value, the operation aborts to save power. The unit of the threshold is VCSEL counts.

6.2.24 SYSRANGE__PART_TO_PART_RANGE_OFFSET

7	6	5	4	3	2	1	0
sysrange__part_to_part_range_offset							
R/W							

Address: 0x024

Type: R/W

Reset: 0xYY, register default overwritten at boot-up by NVM contents.

Description:

[7:0]	sysrange__part_to_part_range_offset: 2s complement.

6.2.25 SYSRANGE__RANGE_IGNORE_VALID_HEIGHT

7	6	5	4	3	2	1	0
sysrange__range_ignore_valid_height							
R/W							

Address: 0x025

Type: R/W

Reset: 0x0, register default overwritten at boot-up by NVM contents.

Description:

[7:0]	sysrange__range_ignore_valid_height: Range below which ignore threshold is applied. Aim is to ignore the cover glass i.e. low signal rate at near distance. Should not be applied to low reflectance target at far distance. Range in mm.

6.2.26 SYSRANGE__RANGE_IGNORE_THRESHOLD

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sysrange__range_ignore_threshold															
R/W															

Address: 0x026

Type: R/W

Reset: 0x0

Description:

[15:0]	sysrange__range_ignore_threshold: User input min threshold signal return rate count value on RETURN array. Used to filter out ranging due to phone housing when there is no target above the device. Mcps 9.7 format

6.2.27 SYSRANGE__MAX_AMBIENT_LEVEL_MULT

7	6	5	4	3	2	1	0
sysrange__max_ambient_level_mult							
R/W							

Address: 0x02C

Type: R/W

Reset: 0xA0, register default overwritten at boot-up by NVM contents.

Description:

[7:0]	sysrange__max_ambient_level_mult: User input value to multiply rtn VCSEL counts for AMB:VCSEL ratio check. If amb counts > VCSEL count * mult then abandon measurement due to high ambient. 4.4 format.

6.2.28 SYSRANGE__RANGE_CHECK_ENABLES

7	6	5	4	3	2	1	0
RESERVED			sysrange__signal_to_noise_enable	0	0	sysrange__range_ignore_enable	sysrange__early_convergence_enable
R			R/W	R/W	R	R/W	R/W

Address: 0x02D

Type: R/W

Reset: 0x11, register default overwritten at boot-up by NVM contents.

Description:

[4]	sysrange__signal_to_noise_enable: Measurement enable/disable
[1]	sysrange__range_ignore_enable: Measurement enable/disable
[0]	sysrange__early_convergence_enable: Measurement enable/disable

6.2.29 SYSRANGE__VHV_RECALIBRATE

7	6	5	4	3	2	1	0
RESERVED						sysrange__vhv_status	sysrange__vhv_recalibrate
R						R/W	R/W

Address: 0x02E

Type: R/W

Reset: 0x0

Description:

[1]	sysrange__vhv_status: FW controlled status bit showing when FW has completed auto-vhv process. 0: FW has finished autoVHV operation 1: During autoVHV operation
[0]	sysrange__vhv_recalibrate: User-Controlled enable bit to force FW to carry out recalibration of the VHV setting for sensor array. FW clears bit after operation carried out. 0: Disabled 1: Manual trigger for VHV recalibration. Can only be called when ALS and ranging are in STOP mode

6.2.30 SYSRANGE__VHV_REPEAT_RATE

7	6	5	4	3	2	1	0
sysrange__vhv_repeate_rate							
R/W							

Address: 0x031

Type: R/W

Reset: 0x0

Description:

[7:0]	sysrange__vhv_repeate_rate: User entered repeat rate of auto VHV task (0 = off, 255 = after every 255 measurements)

6.2.31 SYSALS__START

7	6	5	4	3	2	1	0
RESERVED						sysals__mode_select	sysals__startstop
R						R/W	R/W

Address: 0x038

Type: R/W

Reset: 0x0

Description:

[1]	sysals__mode_select: Device Mode select 0: ALS Mode Single-Shot 1: ALS Mode Continuous
[0]	sysals__startstop: Start/Stop trigger based on current mode and system configuration of device_ready. FW clears register automatically. Setting this bit to 1 in single-shot mode starts a single measurement. Setting this bit to 1 in continuous mode will either start continuous operation (if stopped) or halt continuous operation (if started). This bit is auto-cleared in both modes of operation. See *6.2.56: INTERLEAVED_MODE__ENABLE* for combined ALS and Range operation.

6.2.32 SYSALS__THRESH_HIGH

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sysals__thresh_high															
R/W															

Address: 0x03A

Type: R/W

Reset: 0xFFFF

Description:

[15:0]	sysals__thresh_high: High Threshold value for ALS comparison. Range 1-65534 codes.

6.2.33 SYSALS__THRESH_LOW

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sysals__thresh_low															
R/W															

Address: 0x03C

Type: R/W

Reset: 0x0

Description:

[15:0]	sysals__thresh_low: Low Threshold value for ALS comparison. Range 1-65534 codes.

6.2.34 SYSALS__INTERMEASUREMENT_PERIOD

7	6	5	4	3	2	1	0
sysals__intermeasurement_period							
R/W							

Address: 0x03E

Type: R/W

Reset: 0xFF

Description:

[7:0]	sysals__intermeasurement_period: Time delay between measurements in ALS continuous mode. Range 0-2.55s (1 code = 10ms).

6.2.35 SYSALS__ANALOGUE_GAIN

7	6	5	4	3	2	1	0
RESERVED					sysals__analogue_gain_light		
R					R/W		

Address: 0x03F

Type: R/W

Reset: 0x06

Description:

[2:0]	sysals__analogue_gain_light: ALS analogue gain (light channel) 0: ALS Gain = 20 1: ALS Gain = 10 2: ALS Gain = 5.0 3: ALS Gain = 2.5 4: ALS Gain = 1.67 5: ALS Gain = 1.25 6: ALS Gain = 1.0 7: ALS Gain = 40 Controls the “light” channel gain.

6.2.36 SYSALS__INTEGRATION_PERIOD

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RESERVED							sysals__integration_period								
R							R/W								

Address: 0x040

Type: R/W

Reset: 0x0

Description:

[8:0]	sysals__integration_period: Integration period for ALS mode, 1 code = 1ms (min=0=1ms, max=499=500ms). Recommend multiples of 50ms to reduce error due to 50/60Hz flicker

6.2.37 RESULT__RANGE_STATUS

7	6	5	4	3	2	1	0
result__range_error_code				result__range_min_threshold_hit	result__range_max_threshold_hit	result__range_measurement_ready	result__range_device_ready
R				R	R	R	R

Address: 0x04D

Type: R

Reset: 0x1

Description:

[7:4]	result__range_error_code: Specific error codes 0000: No error 0001: VCSEL Continuity Test 0010: VCSEL Watchdog Test 0011: VCSEL Watchdog 0100: PLL1 Lock 0101: PLL2 Lock 0110: Early Convergence Estimate 0111: Max Convergence 1000: No Target Ignore 1001: Not used 1010: Not used 1011: Max Signal To Noise Ratio 1100: Raw Ranging Algo Underflow 1101: Raw Ranging Algo Overflow 1110: Ranging Algo Underflow 1111: Ranging Algo Overflow
[3]	result__range_min_threshold_hit: Range Min threshold. When set high the latest range measurement was lower than or equal to the user input SYSRANGE__THRESH_LOW.
[2]	result__range_max_threshold_hit: Range Max Threshold. When set high the latest range measurement was greater than or equal to the user input SYSRANGE__THRESH_HIGH.
[1]	result__range_measurement_ready: **Legacy register - DO NOT USE**
[0]	result__range_device_ready: Device Ready. When set to 1, indicates the device mode and configuration can be changed and a new start command will be accepted. When 0, indicates the device is busy. Any new start commands will be ignored until device is ready. (RO).

6.2.38 RESULT__ALS_STATUS

7	6	5	4	3	2	1	0
result__als_error_code				result__als_min_threshold_hit	result__als_max_threshold_hit	result__als_measurement_ready	result__als_device_ready
R				R	R	R	R

Address: 0x04E

Type: R

Reset: 0x1

Description:

[7:4]	result__als_error_code: Specific error and debug codes 0000: No error 0001: Overflow error 0002: Underflow error
[3]	result__als_min_threshold_hit: Range Min threshold. When set high the latest range measurement was lower than or equal to the user input SYSALS__THRESH_LOW.
[2]	result__als_max_threshold_hit: Range Max Threshold. When set high the latest range measurement was greater than or equal to the user input SYSALS__THRESH_HIGH.
[1]	result__als_measurement_ready: **Legacy register - DO NOT USE**
[0]	result__als_device_ready: Device Ready. When set to 1, indicates the device mode and configuration can be changed and a new start command will be accepted. When 0 indicates the device is busy. Any new start commands will be ignored until device is ready. (RO).

6.2.39 RESULT__INTERRUPT_STATUS_GPIO

7	6	5	4	3	2	1	0
result_int_error_gpio		result_int_als_gpio			result_int_range_gpio		
R		R			R		

Address: 0x04F

Type: R

Reset: 0x0

Description:

[7:6]	result_int_error_gpio: Interrupt bits for Error: 0: No error reported 1: Laser Safety Error 2: PLL error (either PLL1 or PLL2)
[5:3]	result_int_als_gpio: Interrupt bits for ALS: 0: No threshold events reported 1: Level Low threshold event 2: Level High threshold event 3: Out Of Window threshold event 4: New Sample Ready threshold event
[2:0]	result_int_range_gpio: Interrupt bits for Range: 0: No threshold events reported 1: Level Low threshold event 2: Level High threshold event 3: Out Of Window threshold event 4: New Sample Ready threshold event

6.2.40 RESULT__ALS_VAL

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__als_ambient_light															
R															

Address: 0x050

Type: R

Reset: 0x0

Description:

[15:0]	result__als_ambient_light: 16 Bit ALS count output value. Lux value depends on Gain and integration settings and calibrated lux/count setting.

6.2.41 RESULT__HISTORY_BUFFER_x

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RESULT__HISTORY_BUFFER_0	result__history_buffer_0															
RESULT__HISTORY_BUFFER_1	result__history_buffer_1															
RESULT__HISTORY_BUFFER_2	result__history_buffer_2															
RESULT__HISTORY_BUFFER_3	result__history_buffer_3															
RESULT__HISTORY_BUFFER_4	result__history_buffer_4															
RESULT__HISTORY_BUFFER_5	result__history_buffer_5															
RESULT__HISTORY_BUFFER_6	result__history_buffer_6															
RESULT__HISTORY_BUFFER_7	result__history_buffer_7															
	R															

Address: 0x052 + x * 0x2 (x=0 to 7)

Type: R

Reset: 0x0

Description: See also *6.2.11: SYSTEM__HISTORY_CTRL*

RESULT__HISTORY_BUFFER_0: [15:0]	result__history_buffer_0: Range/ALS result value. Range mode; Bits[15:8] range_val_latest; Bits[7:0] range_val_d1; ALS mode; Bits[15:0] als_val_latest
RESULT__HISTORY_BUFFER_1: [15:0]	result__history_buffer_1: Range/ALS result value. Range mode; Bits[15:8] range_val_d2; Bits[7:0] range_val_d3; ALS mode; Bits[15:0] als_val_d1
RESULT__HISTORY_BUFFER_2: [15:0]	result__history_buffer_2: Range/ALS result value. Range mode; Bits[15:8] range_val_d4; Bits[7:0] range_val_d5; ALS mode; Bits[15:0] als_val_d2
RESULT__HISTORY_BUFFER_3: [15:0]	result__history_buffer_3: Range/ALS result value. Range mode; Bits[15:8] range_val_d6; Bits[7:0] range_val_d7; ALS mode; Bits[15:0] als_val_d3
RESULT__HISTORY_BUFFER_4: [15:0]	result__history_buffer_4: Range/ALS result value. Range mode; Bits[15:8] range_val_d8; Bits[7:0] range_val_d9; ALS mode; Bits[15:0] als_val_d4
RESULT__HISTORY_BUFFER_5: [15:0]	result__history_buffer_5: Range/ALS result value. Range mode; Bits[15:8] range_val_d10; Bits[7:0] range_val_d11; ALS mode; Bits[15:0] als_val_d5
RESULT__HISTORY_BUFFER_6: [15:0]	result__history_buffer_6: Range/ALS result value. Range mode; Bits[15:8] range_val_d12; Bits[7:0] range_val_d13; ALS mode; Bits[15:0] als_val_d6
RESULT__HISTORY_BUFFER_7: [15:0]	result__history_buffer_7: Range/ALS result value. Range mode; Bits[15:8] range_val_d14; Bits[7:0] range_val_d15; ALS mode; Bits[15:0] als_val_d7

6.2.42 RESULT__RANGE_VAL

7	6	5	4	3	2	1	0
result__range_val							
R							

Address: 0x062

Type: R

Reset: 0x0

Description:

[7:0]	result__range_val: Final range result value presented to the user for use. Unit is in mm.

6.2.43 RESULT__RANGE_RAW

7	6	5	4	3	2	1	0
result__range_raw							
R							

Address: 0x064

Type: R

Reset: 0x0

Description:

[7:0]	result__range_raw: Raw Range result value with offset applied (no cross talk compensation applied).

6.2.44 RESULT__RANGE_RETURN_RATE

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__range_return_rate															
R															

Address: 0x066

Type: R

Reset: 0x0

Description:

[15:0]	result__range_return_rate: sensor count rate of signal returns - Mcps 9.7 format

6.2.45 RESULT__RANGE_REFERENCE_RATE

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__range_reference_rate															
R															

Address: 0x068

Type: R

Reset: 0x0

Description:

[15:0]	result__range_reference_rate: sensor count rate of reference signal returns. Computed from RETURN_SIGNAL_COUNT / RETURN_CONV_TIME. Mcps 9.7 format

6.2.46 RESULT__RANGE_RETURN_SIGNAL_COUNT

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__range_return_signal_count																															
R																															

Address: 0x06C

Type: R

Reset: 0x0

Description:

[31:0]	result__range_return_signal_count: sensor count output value attributed to signal on the Return array

6.2.47 RESULT__RANGE_REFERENCE_SIGNAL_COUNT

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__range_reference_signal_count																															
R																															

Address: 0x070

Type: R

Reset: 0x0

Description:

[31:0]	result__range_reference_signal_count: sensor count output value attributed to signal on the Reference array

6.2.48 RESULT__RANGE_RETURN_AMB_COUNT

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__range_return_amb_count																															
R																															

Address: 0x074

Type: R

Reset: 0x0

Description:

[31:0]	result__range_return_amb_count: sensor count output value attributed to signal on the Return array

6.2.49 RESULT__RANGE_REFERENCE_AMB_COUNT

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__range_reference_amb_count																															
R																															

Address: 0x078

Type: R

Reset: 0x0

Description:

[31:0]	result__range_reference_amb_count: sensor count output value attributed to signal on the Reference array

6.2.50 RESULT__RANGE_RETURN_CONV_TIME

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__range_return_conv_time																															
R																															

Address: 0x07C

Type: R

Reset: 0x0

Description:

[31:0]	result__range_return_conv_time: sensor count output value attributed to signal on the Return array

6.2.51 RESULT__RANGE_REFERENCE_CONV_TIME

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
result__range_reference_conv_time																															
R																															

Address: 0x080

Type: R

Reset: 0x0

Description:

[31:0]	result__range_reference_conv_time: sensor count output value attributed to signal on the Reference array

6.2.52 READOUT__AVERAGING_SAMPLE_PERIOD

7	6	5	4	3	2	1	0
readout__averaging_sample_period							
R/W							

Address: 0x10A

Type: R/W

Reset: 0x30

Description:

[7:0]	readout__averaging_sample_period: The internal readout averaging sample period can be adjusted from 0 to 255. Increasing the sampling period decreases noise but reduces the effective max convergence time and increases power consumption: Effective max_convergence_time = max_convergence - sampling_period. Each unit corresponds to around 90 us additional processing time. The default value is 48 which equates to around 4.3 ms.

6.2.53 FIRMWARE__BOOTUP

7	6	5	4	3	2	1	0
RESERVED							firmware__bootup
R							R/W

Address: 0x119

Type: R/W

Reset: 0x1

Description:

[0]	firmware__bootup: FW must set bit once initial boot has been completed.

6.2.54 FIRMWARE__RESULT_SCALER

7	6	5	4	3	2	1	0
RESERVED				firmware__als_result_scaler			
R				R/W			

Address: 0x120

Type: R/W

Reset: 0x1

Description:

[3:0]	firmware__als_result_scaler: Bits [3:0] analogue gain 1 to 16x

6.2.55 I2C_SLAVE__DEVICE_ADDRESS

7	6	5	4	3	2	1	0
RESERVED	super_i2c_slave__device_address						
R	R/W						

Address: 0x212

Type: R/W

Reset: 0x29

Description:

[6:0]	super_i2c_slave__device_address: User programmable I^2C address (7-bit). Device address can be re-designated after power-up.

6.2.56 INTERLEAVED_MODE__ENABLE

7	6	5	4	3	2	1	0
tied_mode__enable							
R/W							

Address: 0x2A3

Type: R/W

Reset: 0x0

Description:

[7:0]	Interleaved mode enable: Write 0x1 to this register to select ALS+Range interleaved mode. Use SYSALS__START and SYSALS__INTERMEASUREMENT_PERIOD to control this mode. A range measurement is automatically performed immediately after each ALS measurement.

7 Outline drawing

Figure 13. Outline drawing (page 1/2)

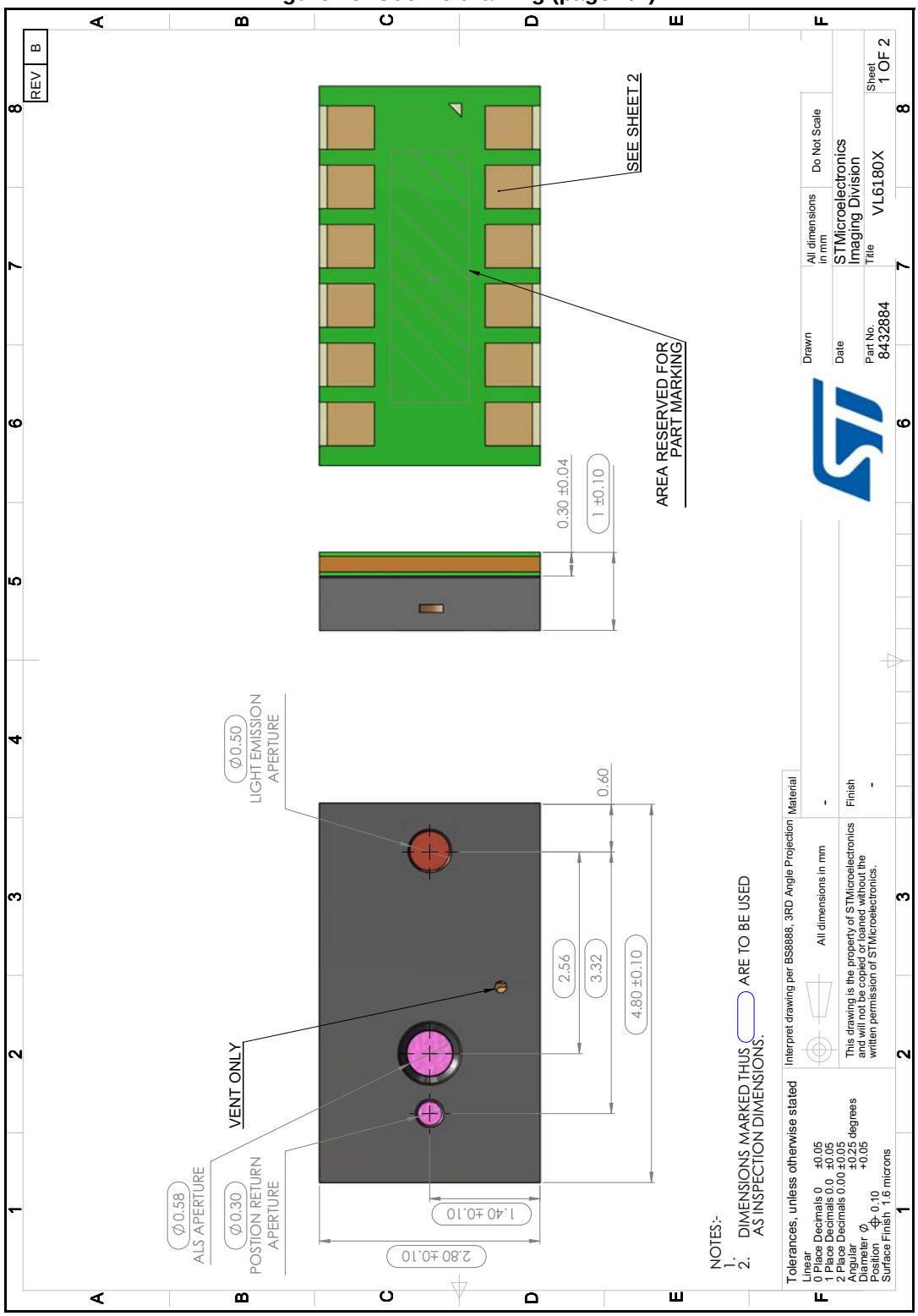
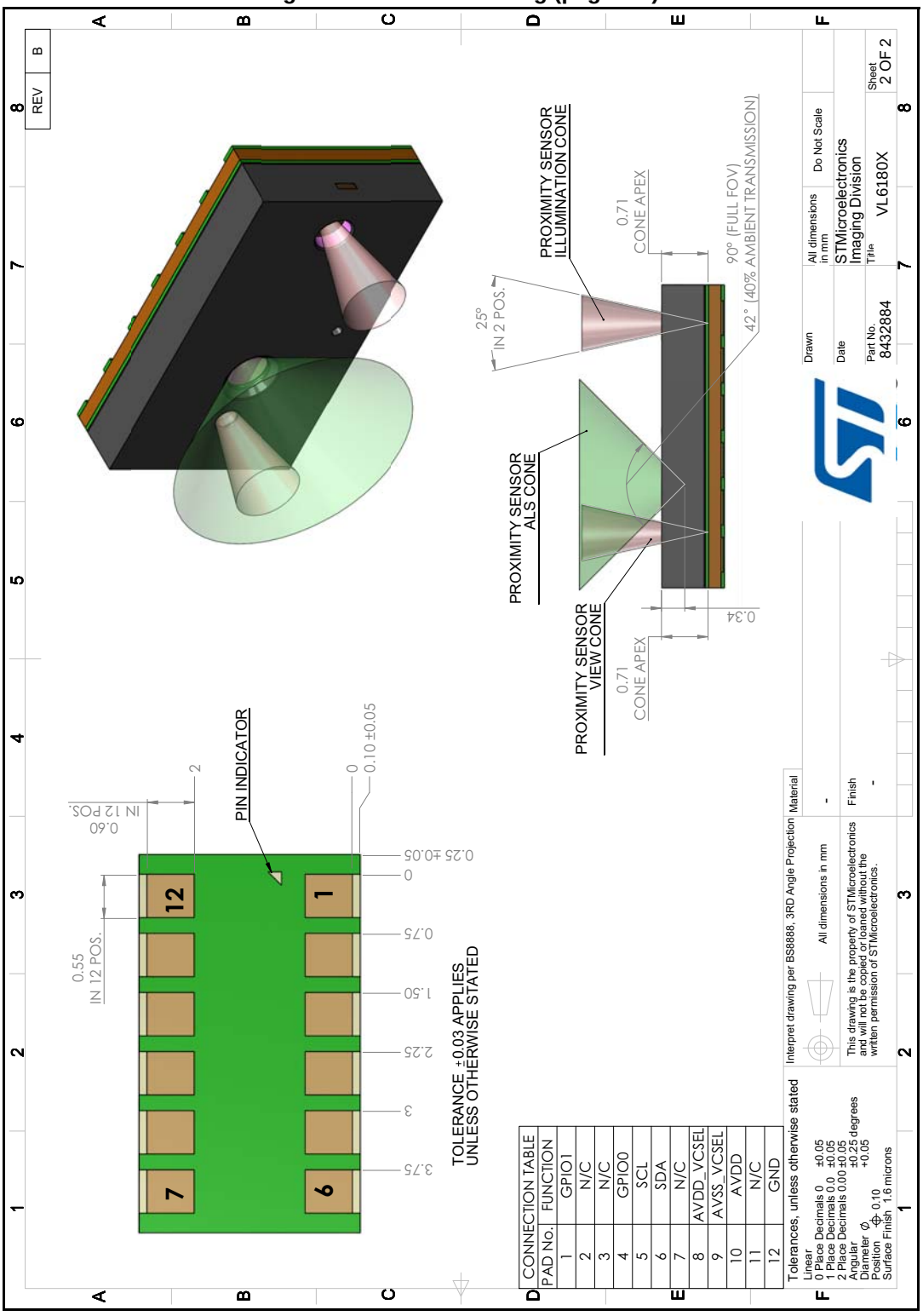


Figure 14. Outline drawing (page 2/2)



8 Laser safety considerations

The VL6180X 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 60825-1:2007. The laser output will remain within Class 1 limits as long as the STMicroelectronics recommended device settings are used and the operating conditions specified in this datasheet are respected. 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.

Figure 15. Class 1 laser product label

9 Ordering information

VL6180X is currently available in the following format. More detailed information is available on request.

Table 16. Delivery format

Order code	Description
VL6180XV0NR/1	Tape and reel (5000 units in a reel)

9.1 Traceability and identification

Latest ROM revision can be identified as follows:

0x002 IDENTIFICATION__MODEL_REV_MINOR = 3

The minimum information required for traceability is the content of the following registers:

0x006 - IDENTIFICATION__DATE_HI

0x007 - IDENTIFICATION__DATE_LO

0x008 - IDENTIFICATION__TIME (16-bit)

0x00A - IDENTIFICATION__CODE

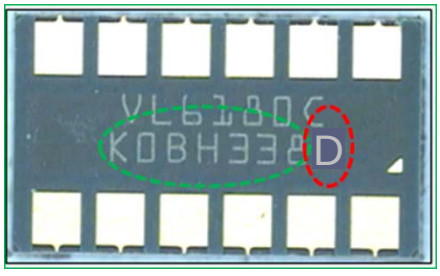
With this information, the module can be uniquely identified.

Preferably, all the IDENTIFICATION register contents should be provided for traceability.

9.2 Part marking

Devices are marked on the underside as shown below. 1st line is the product ID. 2nd line is the manufacturing info. (circled in green) and latest ROM revision circled in red.

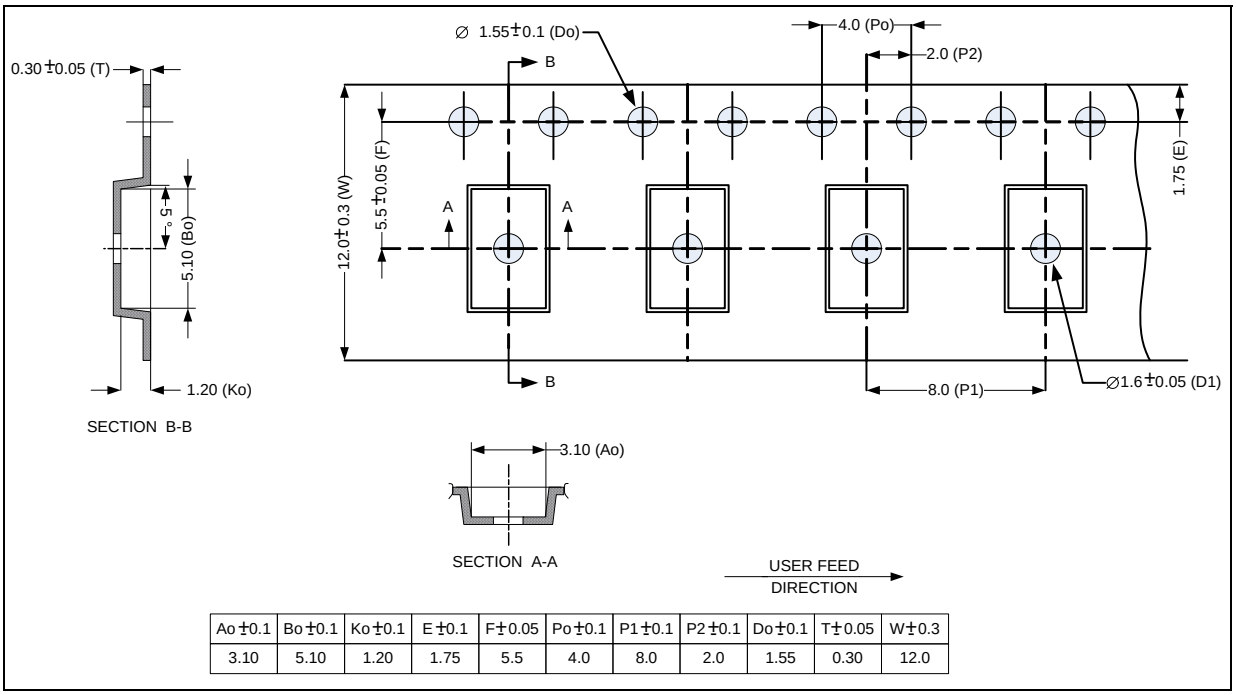
Figure 16. Part marking



9.3 Packaging

The VL6180X is available in tape and reel packaging as shown in *Figure 17.*

Figure 17. Tape and reel packaging

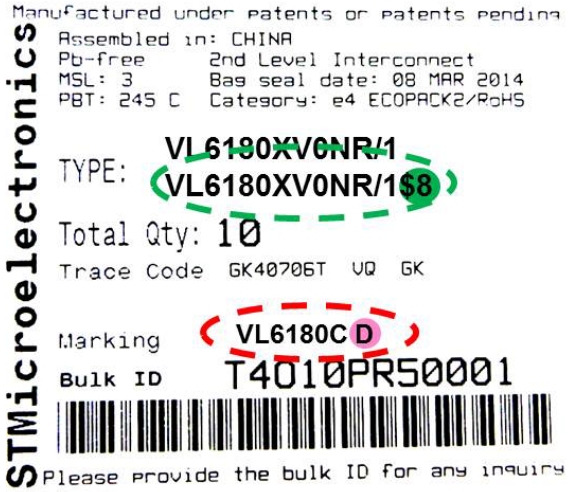


Ao±0.1	Bo±0.1	Ko±0.1	E±0.1	F±0.05	Po±0.1	P1±0.1	P2±0.1	Do±0.1	T±0.05	W±0.3
3.10	5.10	1.20	1.75	5.5	4.0	8.0	2.0	1.55	0.30	12.0

9.3.1 Package labeling

The labeling on the packing carton is shown in *Figure 18.* The latest ROM revision is indicated alongside the order code (shaded green) and also after the product marking (shaded pink).

Figure 18. Package labeling



9.4 Storage

The VL6180X is a MSL 3 package.

Table 17. Storage conditions

Level	Floor Life (out of bag) at Factory Ambient <30°C/60% RH
3	1 Week

After this limit, dry bake to be done; 3 hours at 125°C.

9.5 ROHS compliance

The VL6180X is Ecopack2 compliant as per ST definition.

Devices which are ROHS compliant even with use of ROHS exemption(s) and free of Halogenated flame retardant are named ECOPACK2 devices with the following definition:

- ROHS compliant even with use of ROHS exemption(s)
- 500 ppm maximum of Antimony as oxide or organic compound in each organic assy Materials (glue, substrate, mod compounds, housing...). Antimony in ceramic parts, in glass and in solder alloy is not restricted.
- 900 ppm maximum Bromine + Chlorine in each organic ass materials (glue, substrate, mold compounds, housing...)

These values are referring to maximum total content not to extractable ions content. Purchasing specification of assembly materials can impose lower values for technical reasons.

ECOPACK2 devices are of course fully compliant to ST banned and declarable substances specification and for example cannot contain red Phosphorus flame retardant.

10 ECOPACK®

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*.
ECOPACK® is an ST trademark.

11 Revision history

Table 18. Document revision history

Date	Revision	Changes
23-Sep-2013	1	Initial release.
30-Jan-2014	1.1	General update for latest ROM revision: *Section 1.1: Technical specification* updated *Section 1.4: Application schematic* updated *Section 1.5: Current consumption* updated Notes added to *Figure 5.: Recommended reflow profile* *Section 2.2: Ambient light sensor (ALS)* updated. *Section 3.1: Absolute maximum ratings* added *Section 3.2: Normal operating conditions* extended *Section 4: Performance specification* added Revised outline drawing added to *Section 7: Outline drawing* Class 1 laser product label added to *Section 7: Outline drawing* *Section 9: Ordering information* added information relating to device marking and package labeling
02-Apr-2014	1.2	Updates to the following sections: *Section 1.5: Current consumption* *Section 3.2: Normal operating conditions* *Section 3.4: Electrical characteristics* *Section 4.1: Proximity ranging (0 to 100mm)* Added *Section 4.2: ALS performance* Corrected error codes in.*Section 6.2.38: RESULT__ALS_STATUS* Updated *Section 6.2.20: SYSRANGE__MAX_CONVERGENCE_TIME* Product code changed to VL6180X
09-Apr-14	2	Add documentation reference number (026171) Update Disclaimer
15-May-14	3	ALS linearity spec updated in *Section 4.2: ALS performance* Updated some detail in *Table 1.: Technical specification* Added comment to *Section 1.3: Device pinout* stating that pins labeled ‘no connect’ can optionally be connected to ground Added test condition to *Section 3.3: Current consumption* Errata corrections in *6.2.8*, *6.2.35* and *6.2.54* *Section 7: Outline drawing* updated (no dimensional changes) Dry bake conditions updated in *Section 9.4: Storage*

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