DT0032
Design tip

VL6180X cross talk compensation implementation

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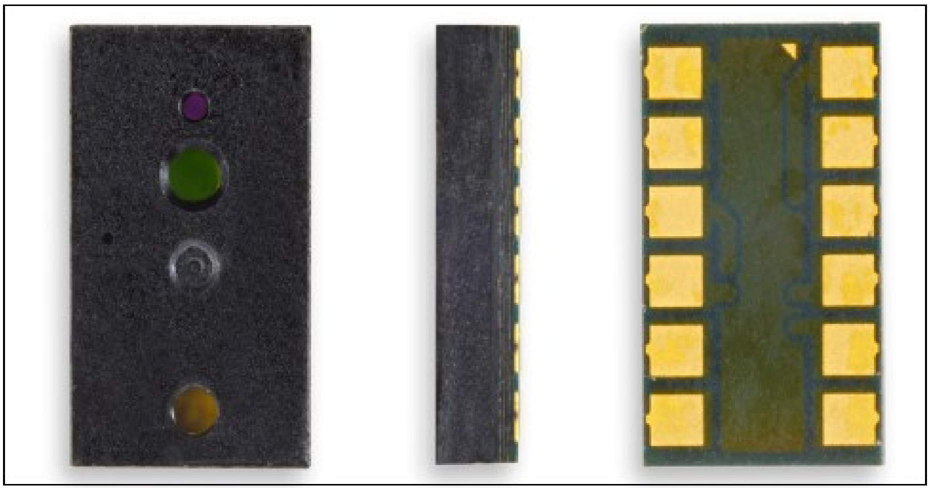
Main components	
VL6180X	Proximity and ambient light sensing (ALS) module

Purpose and benefits

The purpose of this document is to explain how to implement the cross talk compensation feature of the VL6180X.

It is assumed that customers who use this document can communicate with the VL6180X through I^2C and are now looking for more information on how to implement the cross talk compensation feature into their application code.

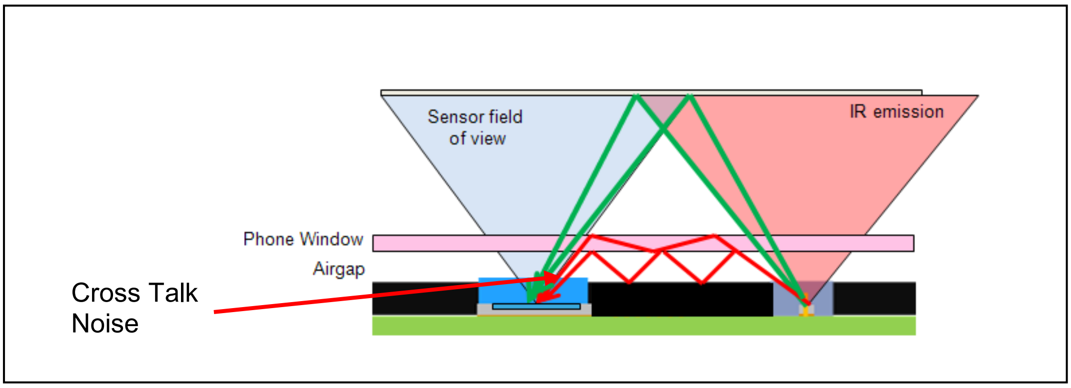
Figure 1. VL6180X device



Cross talk compensation overview

Cross talk compensation refers to a feature within the VL6180X that corrects the range reported by the VL6180X when there is a cover glass used on top of the device. This feature works by multiplying the results received by a factor to allow the device to report the correct range. It is important to note that cross talk compensation is only applicable for ranges greater than 20mm. Figure 2 shows picture of the cross talk noise that is referred to.

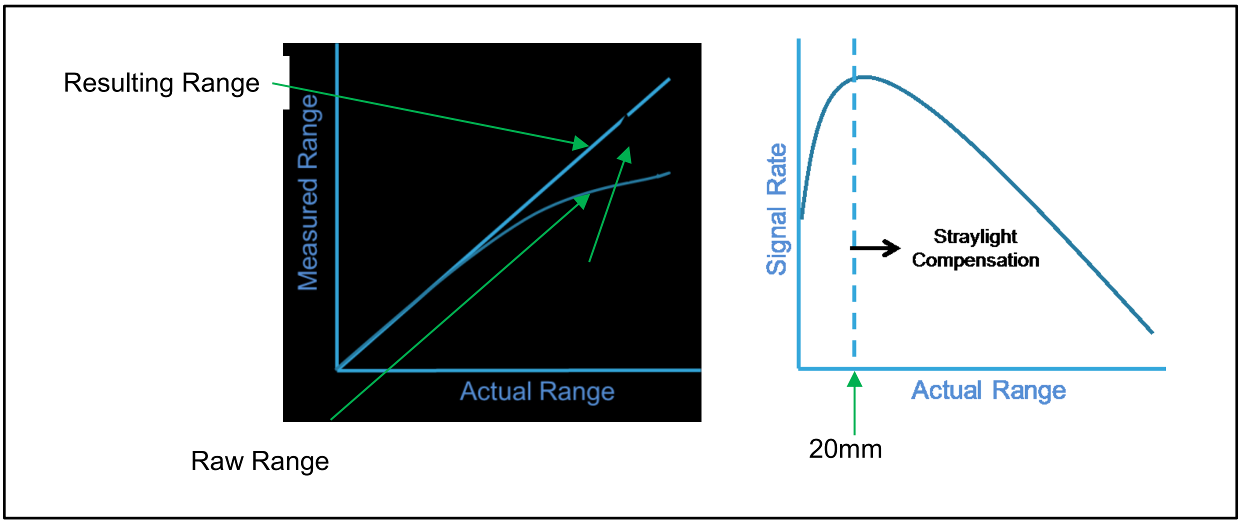
Figure 2. Cross talk noise



Cross talk compensation description

The cross talk compensation factor is a parameter set by the HOST system. In a normal production environment, this setting is characterized and then loaded at each boot up of the device. A simple diagram of how this compensation works is shown below in 3.

Figure 3. Cross talk compensation



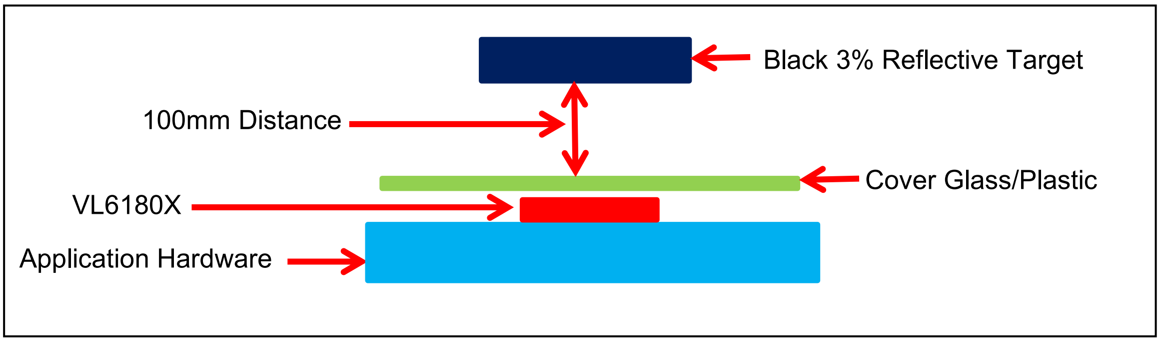
As shown above in the left hand image of 3, as the measured range increases, the actual range, which is comprised of the raw range reported by the VL6180X system, does not accurately report the distance of the target due to the extra noise introduced by cover glass. To compensate for this, the cross talk compensation factor labeled “Stray Compensation” on the left side of Figure 3 is applied to the raw range and the resulting range is the accurate distance of the object. Also, the return signal rate shown as “Signal Rate” on the right side of Figure 3, is at its peak as a target of below or around 20 mm. As the target is moved further away, the return signal rate decreases, which will allow the cross talk compensation to be applied correctly.

Calibrating the cross talk compensation

To apply the cross talk compensation factor in the VL6180X, the cross talk calibration must be completed. In a normal end application, this would be done by performing cross talk calibration on a production lot of the end user application devices. This will ensure that the average of the cross talk calibration factor is captured with all of the expected mechanical tolerances.

To perform cross talk calibration, a black 3% reflective target is placed at 100mm above the VL6180X device in the end application. This is shown in Figure 4.

Figure 4. Cross talk calibration setup



Then the HOST system will capture at least 10 measurements to ensure the average is representative of the cross talk in the system. The values then read from RESULT__RANGE_RAW Reg 0x0064 and also the RESULT__RANGE_RETURN_RATE Reg 0x0066 after each measurement is completed. These raw range measurements and the return signal rate are averaged to get average raw range and average return signal rate and are divided by 100mm to get a ratio or cross talk compensated factor. This value is multiplied by 128 and then written to the SYSRANGE__CROSSTALK_COMPENSATION_RATE, Reg 0x001E. Please note the signal return rate from Reg 0x0066 is stored in a 9.7 format. This is given below in Table 1.

Table 1. 9.7 Data format

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**

Cross talk compensation registers:

The following registers in Table 2 are used in the cross talk compensation operation.

Table 2. Overview of registers used in cross talk compensation

Register Name	Register Address	Description
SYSRANGE__CROSSTALK_COMPENSATION_RATE	**0x001E**	**This is the crosstalk compensation register. This is a 2byte register. The format is 9.7. See Table 1**Error! eference source not found. **for more information**
RESULT__RANGE_RAW	**0x0064**	**This is the raw range reported by the VL6180X before cross talk compensation is applied.**
RESULT__RANGE_RETURN_RATE	**0x0066**	**This is the return signal rate in Mcps 9.7 format. This register is 2bytes.**

The registers shown in Table 2 are a subset of what is used in normal operation of the VL6180X. The user is advised to refer to the datasheet for further information on how to set up GPIO modes, interrupt conditions, and other functions of the VL6180X.

Cross talk compensation implementation example

An example of how to implement the cross talk compensation, assuming the device is setup with a test setup as shown in Figure 4 above is described. The system takes 10 successive measurements for raw range. The equation shown below will give the cross talk compensation value to write to the SYSRANGE__CROSSTALK_COMPENSATION_RATE, Reg 0x001E.

Assuming a variable, *CROSST (unsigned 8 bit) RAW_R[9] is an array from 0 to 9, RTN_SIG_RATE[9] is an array from 0 to 9 (unsigned 16 bit), AVE_RAW_R (unsigned 8 bit) , AVE_SIG_RATE (unsigned 16 bit)*

To capture the values, it is beneficial to perform 10 single shot range measurements. The convergence time should be at least 20ms to ensure the VL6180X has enough time to provide a range measurement for the black 3% reflective target.

The values for the range are read from the RESULT__RANGE_RAW register address 0x0064. The values read from this register are 8 bit unsigned integers. The values read for the return signal rate are 16 bit unsigned and are read from RESULT__RANGE_RETURN_RATE Reg 0x0066 (high byte) Reg 0x0067 (low byte). Note that the return signal rate values are in 9.7 format which means they will be divided by 128 before they can be used.

If the values read from Reg 0x0064 were as follows: RAW_R[0] = 76, RAW_R[1] = 80, RAW_R[2] = 72, RAW_R[3] = 76, RAW_R[4] = 77, RAW_R[5] = 78, RAW_R[5] = 74, RAW_R[6] = 76, RAW_R[7] = 81, RAW_R[8] = 74, RAW_R[9] = 71.

AVE_RAW_R = (RAW_R[0] + RAW_R[1] … RAW_R[9]) / 10 = 83.5

If the values read from Reg 0x0066 (high byte) and 0x0067 (low byte) were as follows: RTN_SIG_RATE[0] = 267, RTN_SIG_RATE[1] = 260, RTN_SIG_RATE[2] = 270, RTN_SIG_RATE[3] = 285, RTN_SIG_RATE[4] = 258, RTN_SIG_RATE[5] = 281, RTN_SIG_RATE[6] = 283, RTN_SIG_RATE[7] = 261, RTN_SIG_RATE[8] = 263, RTN_SIG_RATE[9] = 265

AVE_SIG_RATE = [(RTN_SIG_RATE[0]+ RTN_SIG_RATE[1]… RTN_SIG_RATE[9]) / 128]/10 = 2.103

*CROSST = AVE_SIG_RATE * (1 – (AVE_RAW_R / 100)) = 2.103 * (1 – (83.5/100)) = 2.103 * (0.165) = 0.3469*

Then multiply CROSST by 128 to get 0x002C, and then write this value to SYSRANGE__CROSSTALK_COMPENSATION_RATE, Reg 0x001E (high byte) and Reg 0x001F (low byte).

Reg 0x001E = 0x00 and Reg 0x001F = 0x2C

Support material

Related design support material
MOB-EK2-180-03 Product/ system evaluation board
Documentation
Datasheet: VL6180X - Proximity and ambient light sensing (ALS) module

Revision history

Date	Version	Changes
23-Jun-2014	1	Initial release