OPT3101 – De-aliasing to extend the Distance Range

ASC-DC-MED-IMG

ABSTRACT

OPT3101 in default operating mode works with a modulation frequency of 10MHz, which has a un-aliased distance range of 15m. This document explains the de-alias mode operation using OPT3101 to extend the distance range from 15m to 75m using on chip de-aliasing feature.

Document History

Version	Date	Notes
1.0	08 June 2018	First release

Contents

1 De-aliasing Introduction

OPT3101 uses an indirect time of flight principle to measure the distance. OPT3101 system transmits 10MHz modulated optical signal with an external LED/LASER connected to the illumination driver output and receives the signal with an external photodiode connected to the AFE input. OPT3101 measures the phase of the received signal.

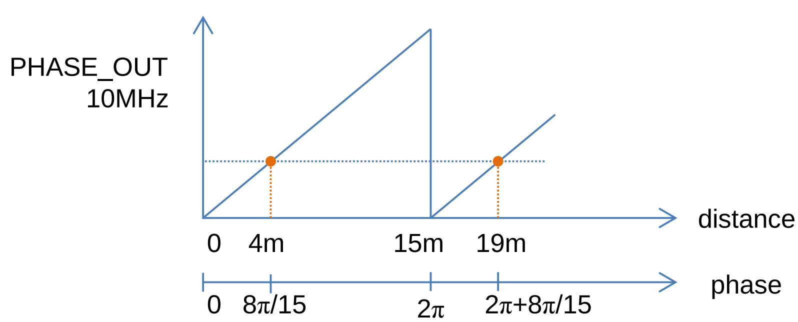

Figure 1. Phase vs Distance using 10MHz modulation frequency

For distances which can have a delay more than one time period, the phase wraps around 2π and becomes indistinguishable from distances separated by multiples of un-aliased distance. Un-aliased distance with a modulation frequency of f_{MOD} is given by (1).

$$\text{Unaliased distance} = \frac{c}{2 \times f_{MOD}} \qquad (1)$$

Where c is the speed of light = 299792458 m/s

To extend the un-aliased range, OPT3101 can use a second frequency of 12MHz and do a second measurement. Using the phase from 10MHz and 12MHz, the un-aliased distance range can be extended to 75m as shown in Figure 2.

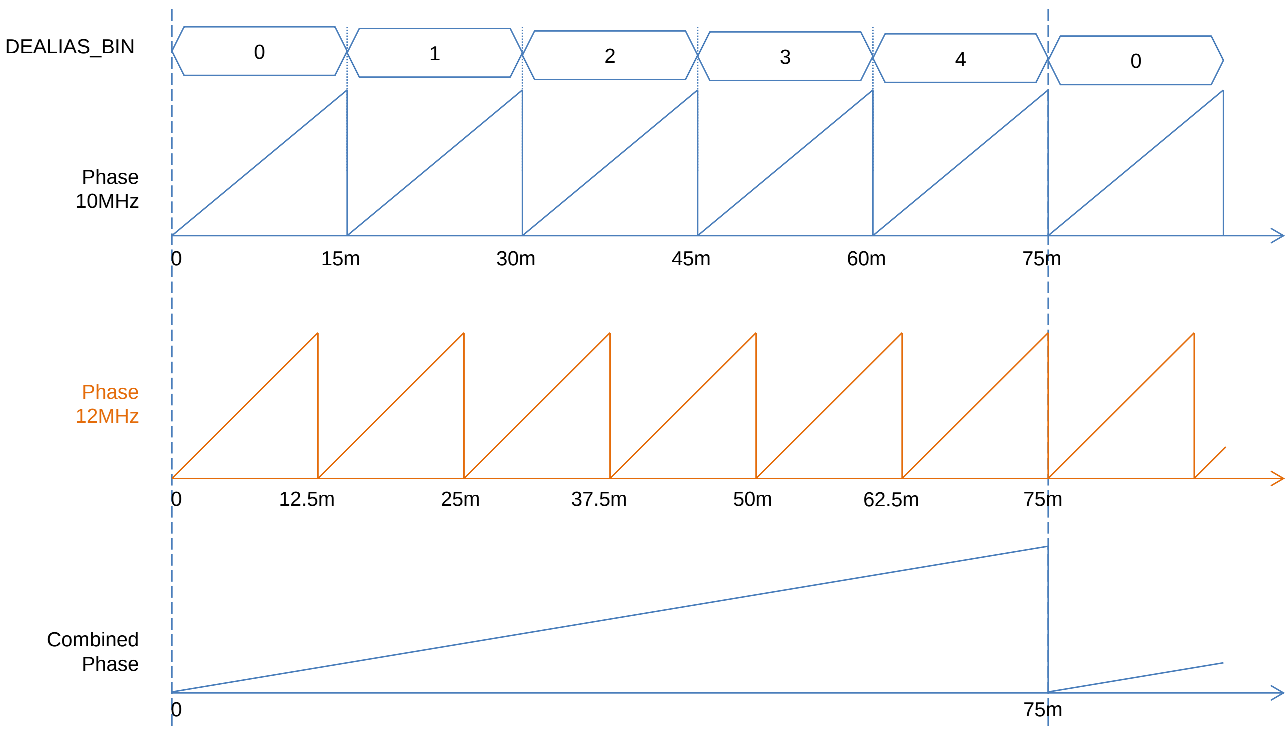

Figure 2. Phase vs Distance using 10MHz modulation frequency

2 Sequencer Setting to Enable De-alias Measurement

For de-aliasing two samples with different modulation frequencies should be captured. OPT3101 supports two modulation frequencies 10MHz and 12MHz. Using the on chip sequencer, alternate samples can be switched between 10MHz and 12MHz modulation frequencies automatically. On chip depth engine can combine the output from both the modulation frequencies and produce an output in PHASE_OUT register. There is also an option to read DEALIAS_BIN and the phase of 10MHz, which then can be combined in the host to get the de-aliased distance. Details on the phase output are discussed in section 3.

Table 1 lists the register settings required for operating the device in de-alias mode using the on chip sequencer. These register settings should be written in addition to the register settings required for the device normal operation mode.

Table 1: Sequencer settings to enable de-aliased measurement

PARAMETER	VALUE	DESCRIPTION
Sequencer Interrupt Signal		
TG_SEQ_INT_START	9850	Set the sequencer interrupt at the end of the last averaged sub-frame after data ready is available
TG_SEQ_INT_END	9858	
TG_SEQ_INT_MASK_START	NUM_AVG_SUB_FRAMES	
TG_SEQ_INT_MASK_END	NUM_AVG_SUB_FRAMES	
Sequencer Commands		
COMMAND0	0x100 #	Set to fo = 10MHz
COMMAND1	0x102	Set to fo to de-alias frequency Writes ‘1’ to EN_DEALIAS_MEAS register
COMMAND2	0x400	Go to Command0
2nd Modulation Frequency Settings		
NCR_CONFIG	1	1 – Selects the 2nd modulation frequency of 12MHz
GIVE_DEALIAS_DATA	1	0 - DEALIAS_BIN and PHASE_OUT should be combined off-chip to get combined phase. 1 - PHASE_OUT will have combined phase from de-alias measurement.
Sequencer Enable		
ENABLE_SEQUENCER	1	Enable the sequencer. Sequencer Enable should be only be changed while TG_EN = 0. Before changing this register disable TG (TG_EN = 0), modify this register and then enable TG (TG_EN = 1)
ENABLE_PROCESSOR_VALUES	1	Enable processor values to control the STATUS_OUT register bits.

3 Output

With GIVE_DEALIAS_DATA='1', PHASE_OUT register will have the de-aliased phase output. De-aliased phase readout from PHASE_OUT can be converted to distance using Equation (2). In this scenario, output resolution = 2.4397 mm/LSB.

$$\text{Dealiased Distance} = \frac{\text{PHASE\_OUT}}{2^{16}} \times \frac{c}{2f_{MOD}} \times \frac{64}{6} \quad (2)$$

Where

f_{MOD} = 10MHz

c = Speed of Light = 299792458 m/s

With GIVE_DEALIAS_DATA='0', DEALIAS_BIN and PHASE_OUT should be combined outside the chip to get the de-aliased distance as shown in Equation (**3**) and (**4**). In this scenario, output resolution = 0.2287 mm/LSB.

$$\text{Dealiased Phase} = \text{DEALIAS\_BIN} \times 2^{16} \times \frac{\text{FREQ\_COUNT\_READ\_REG}}{16384} + \text{PHASE\_OVER\_FLOW} \times 2^{16} + \text{PHASE\_OUT} \quad (3)$$

$$\text{Dealiased Distance} = \text{Dealiased Phase} \times \frac{c}{2f_{MOD}} \quad (4)$$

Where
f_{MOD} = 10MHz
c = Speed of Light = 299792458 m/s

4 Calibration

Crosstalk and phase offset calibration should be done for both the modulation frequencies 10MHz and 12MHz. Follow the same calibration procedure as reported in calibration user guide *sbau310* for the 12MHz crosstalk and phase offset calibration.

For the calibration, the sequencer mode should be disabled (ENABLE_SEQUENCER = 0, ENABLE_PROCESSOR_VALUES = 0). For de-alias frequency (12MHz) measure crosstalk (internal, illumination) and phase offset by setting the device into this frequency by writing the registers listed in Table 2.

Table 2: Register setting to set the device into 12MHz frequency mode

Register	Value	Description
OVERRIDE_CLKGEN_REG	1	Setting this register 1 allows user to independently control DEALIAS_FREQ, DEALIAS_EN
DEALIAS_EN	1	Enable de-alias CLK generation
DEALIAS_FREQ	1	Change Modulation CLK to 12MHz (10MHz*6/5)

4.1 Crosstalk

De-alias frequency doesn't have separate crosstalk registers. Crosstalk registers of the main modulation frequency of 10MHz are scaled to obtain the crosstalk values for 12MHz modulation frequency. From the measured crosstalk data of de-alias frequency 12MHz (I_2, Q_2) and crosstalk of default frequency 10MHz (I_1, Q_1) compute the crosstalk scaling coefficients α, β using the equation below.

$$I_2+jQ_2=(I_1+jQ_1)\times(\alpha+j\beta)$$
$$I_2=\alpha I_1-\beta Q_1 \quad (5)$$
$$Q_2=\alpha Q_1+\beta I_1$$

Compute the crosstalk scaling coefficient for both internal crosstalk (α0, β0) and illumination crosstalk (α1, β1) using the above equations and respective crosstalk values. These crosstalk scaling coefficients should be written to the registers listed in Table 3.

Table 3: Crosstalk scaling coefficients for De-alias Frequency

Register	Value	Description
ALPHA0_DEAL_SCALE	α0*16	Internal crosstalk scaling for de-alias frequency. Range: -32 to 31
BETA0_DEAL_SCALE	β0*16	
ALPHA1_DEAL_SCAL	α1*16	Illumination crosstalk scaling for de-alias frequency. Range: -32 to 31
BETA1_DEAL_SCALE	β1*16	

4.2 Phase Offset

Measure the phase offset for the de-alias frequency of 12MHz and write to the following registers.

Table 4: Phase Offset Registers for De-alias Frequency

Register	Value	Description
PHASE2_OFFSET_HDR0_TX0		Phase offset for de-alias frequency, illumination current = L, TX channel=0
PHASE2_OFFSET_HDR1_TX0		Phase offset for de-alias frequency, illumination current = H, TX channel=0