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| Phio Usage |
| A short introduction to phio options |
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| **10/15/2018** |

1. Introduction

The VL53L1 Linux Driver delivery comes with a daemon (for IPP histograms’ related source code part which we don’t intend to disclose to our customers) and an example of user space application named “phio” (historically stands for photonic I/O) to call driver functions through ioctl or sysfs paths.

This phio application was not aiming to be a delivery itself but today it is currently used for tests and some FAE applications. That raises the need for a bit of documentation about it.

1. Parameters and settings

With the phio application, most of the time, the option used alone stands for “getting” the current value of the setting related to that option. For instance to get the current measurement timing budget you shall type

sudo ./phio –t

To change the timing budget value you have to add ‘=’ sign followed by the new value to set. For instance to set timing budget to 20 ms (i.e. 20 000µsec) you shall type

sudo ./phio –t=20000

Please note settings are actually applied to the device by the linux driver only when the ranging is started.

As a consequence, all setting parameters preceding the ‘-s’ will be applied before the actual start of measurements.

Typical example of a histogram based 10 values ranging measurement with a timing budget of 17 ms and a default ROI (full field of view):

sudo ./phio -O -m=1 –t=17000 -s -Z=10 –S

note the –S stops the ranging

* 1. Linux device selection

By default, stmvl531l1 linux driver’s installation creates the device called /dev/stmvl53l1\_ranging which is corresponding to the device number 0

In case of multiple devices connected to the host you can select the device to be used through phio with the –d option

[-d --dev dev\_no] dev\_no shall be set at first arg

sudo ./phio –d <number>

* 1. Tuning parameters

The tuning parameters can be displayed and modified thanks to phio   
Store the tuning params [key, value] tuplets in a text formatted file

sudo ./phio –g <destination\_file>

Modify the value for a specific tuning param

sudo ./phio -N "<key> <value>"

Update several tuning params [key, value] tuplets taken from a text formatted file

sudo ./phio –G <input\_params\_file>

Some keys can’t be actually modified by the user and driver may return device i/o error -4 in such case

When it occurs it ends up with the following message in phio:

[Eio] perform\_tuning\_ioctl -1 Input/output error [device i/o error is -4]

* 1. Manipulating Dmax parameters

Set Dmax reflectance:

sudo ./phio -A=5

Set Dmax mode:

sudo ./phio -B=2

Please refer to user manual for further explanation about Dmax

1. Calibration
   1. Reference Spad Management

Performs reference spad management calibration. See user manual for further explanations.

sudo ./phio -R

* 1. Crosstalk calibration

Xtalk calibration mode VL53L1\_XTALKCALIBRATIONMODE\_NO\_TARGET. It is the default histogram based mode crosstalk calibration requires a field free of target from 0 to 800mm from the sensor.

sudo ./phio -X "0 1"

Xtalk calibration mode VL53L1\_XTALKCALIBRATIONMODE\_SINGLE\_TARGET. Need for ranging mode Lite Ranging set by the value 4 in –X “1 4”

The actual distance of the target (here 600 mm) is passed through a dedicated tuning param index VL53L1\_TUNING\_SINGLE\_TARGET\_XTALK\_TARGET\_DISTANCE\_MM = 2

sudo ./phio -N "2 600" -X "1 4"

Xtalk calibration mode VL53L1\_XTALKCALIBRATIONMODE\_FULL\_ROI. The actual distance of the target (here 580 mm) is passed through a dedicated tuning param index VL53L1\_TUNING\_XTALK\_FULL\_ROI\_TARGET\_DISTANCE\_MM = 6

sudo ./phio -N "6 580" -X "2 1"

Enable Xtalk compensation in driver:

sudo ./phio –E=1

Enable Live xtalk correction:

sudo ./phio –h=2

* 1. Offset calibration

Perform Offset calibration(arguments = OffsetCalibrationMode, Distance of target, Reflectance of target)

sudo ./phio -F "2 130 5.0"

* 1. Dump or read calibration in file

Read current calibration values into a bin file :

sudo ./phio –c cal.bin

Load Xtalk values from a bin file(updated with fixed xtalk values for instance):

sudo ./phio –C cal.bin

Print the data in calibration bin file in human reading format

sudo ./phio -l "cal.bin out.txt"

cat out.txt

On the other hand you can modify some values in out.txt and recode it to apply to the driver

sudo ./phio -L "out.txt cal.bin "

sudo ./phio –C cal.bin

1. Ranging
   1. Ranging examples

Histogram ranging with full field of view single ROI and 15 ms of timing budget (m=1 infers usage of –Z=nb measurements’ option for getting ranging measurements)

sudo ./phio -m=1 -O="0 15 15 0" -t=15000 -s -Z=10 -S

Multizone ranging with 5 ROIs and 16 ms of timing budget (usage of –Z=nb measurements as it is also an histogram based ranging mode).

The ROIs are scanned and data measurements will report up to 4 objects found in each ROI.

The first –S here is not mandatory but ensure we’re actually stopping the device prior to configure it and thus overcome any bad state resulting of any previous incomplete command.

sudo ./phio -S -m=2 -O="0 15 7 8, 8 15 15 8, 0 7 7 0, 8 7 15 0, 0 15 15 0" -t=16000 -s -Z=12 -S

Lite ranging (aka sigma delta) with full field of view single ROI and 60 ms of timing budget (m=4 infers usage of–M=nb measurements’ option for getting ranging measurements).

sudo ./phio -S -m=4  -O="0 15 15 0" -t=60000 -s -M=10 –S

* 1. Autonomous ranging examples

Example of exercising autonomous ranging (-m=3). As it operates in sigma delta ranging data shall be retrieved thanks to the –M option.

In this example we first set a distance threshold between 1000 & 100 mm and select the cross mode to LOW.

That means the device will detect and report ranging when a target is passing under the lowest (here 100 mm) distance limit from the sensor.

Afterwards thresholds are set to detect a target beyond a distance of 105 mm.

sudo ./phio –S -m=3 -a="500 1 0 0 1000 100 0 0.0 0.0" -a -t=80000 -s -M=3 -S -a="500 1 1 1 105 100 0 0.0 0.0" -a -t=60000 -s -M=5 –S

Details of thresholds settings: -a="500 1 0 0 1000 100 0 0.0 0.0"

500: polling time, i.e the minimum time elapsed between two subsequent measurements if a target is visible.  
1: stands for detection mode == VL53L1\_DETECTION\_DISTANCE\_ONLY (see user manual for further information)   
0: IntrNoTarget = 0 (see user manual for further information)  
0: Cross mode 0 stands for VL53L1\_THRESHOLD\_CROSSED\_LOW (see user manual for further information)  
1000: upper limit in mm, 100: lower limit in mm  
“0 0.0 0.0” : related to signal rate threshold not set here

Details of thresholds settings: -a="500 1 1 1 105 100 0 0.0 0.0"

500: polling time, i.e the minimum time elapsed between two subsequent measurements if a target is visible.  
1: stands for detection mode == VL53L1\_DETECTION\_DISTANCE\_ONLY (see user manual for further information)   
1: IntrNoTarget = 1 (see user manual for further information)  
1: Cross mode 0 stands for VL53L1\_THRESHOLD\_CROSSED\_HIGH (see user manual for further information)  
105: upper limit in mm, 100: lower limit in mm  
“0 0.0 0.0” : related to signal rate threshold not set here

* 1. Low power autonomous ranging example

This mode behaves the same way as the autonomous one in term of parameters settings. However it is consuming less power as described in the user manual

sudo ./phio –S -m=8 -a="500 1 0 0 1000 100 0 0.0 0.0" -a -t=80000 -s -M=3 -S

1. Options detailed
   1. Option –m

Get ranging mode if used alone, set ranging mode if a parameter is passed with ‘ -m=’

* **mode value** 
  + 1 = ranging
  + 2 = multi zone
  + 3 = autonomous
  + 4 = lite ranging
  + 8 = low power autonomous
  1. Option –M or -Z

Run a specific number of measurement. Depending of the ranging mode selected user must pass –M or –Z option.  
-M option is valid when –m selection is 3,4 or 8  
-Z option is valid for –m=1 or –m=2

-M or –Z shall be followed by the number of measurements to perform, -M=xx or –Z =xx.

* 1. Option –r (--range)

Run a specific number of measurement when lite ranging is selected (option –m=4).  
Measurements are taken “on the fly”, phio doesn’t wait for an actual measurement is available to retrieve data thus it’s returning the latest performed by the linux driver.  
Here is an example of use with a pause of 1000 msec performed by phio between each call for a measurement value out of a serie of 10

sudo ./phio -m=4 -P=1000 -s -r=10 -S

* 1. Option –P

Set the device polling delay to time\_ms and run a pause of the same time (see example in option –r).

[-P --Pause time\_ms]

* 1. Option –O

Set ROI values, values are given as list.

The following will set only one ROI with the coordinates x0 y0 x1 y1:  
x0: top left x ROI rectangle’s corner coordinate

y0: top left y ROI rectangle’s corner coordinate

x1: bottom right x ROI rectangle’s corner coordinate

y1: bottom right y ROI rectangle’s corner coordinate

sudo ./phio -O="6 9 9 6"

You can specify several ROI by using list:

sudo ./phio -T=1 -O="0 15 7 8, 8 15 15 8, 0 7 7 0, 8 7 15 0"

To unset the ROI (i.e. reset to full 16x16 spads ROI setting) you shall run:

sudo ./phio -T=1 -O

Please refer to the user manual for further description about ROIs.

* 1. Option –o

Get currently set ROI(s) values, a parameter will indicate up to how many ROIs we’re asking for.

-o --roi\_get no\_of\_roi

The ROI returned are less or equal to the max stored, so no\_of\_roi are returned if the no\_of\_roi < Max defined ROI else the max value will return.  
For instance we set 5 ROIs as follow

sudo ./phio -O="0 15 7 8, 8 15 15 8, 0 7 7 0, 8 7 15 0, 0 15 15 0"

If we ask for ROI(s) setting for up to 10 defined

sudo ./phio –o=10

We get the following response:

[W] ROI asked 10 but got 5

ROI#00 0 15 7 8

ROI#01 8 15 15 8

ROI#02 0 7 7 0

ROI#03 8 7 15 0

ROI#04 0 15 15 0

* 1. Option –s

Start ranging.

* 1. Option –S

Stop ranging.

* 1. Option –t

Set/Get timing budget.

-t [=time\_us]