5   Performance

5.1   Measurement conditions

In all measurement tables in the document, it is considered that the full Field Of View (FOV) is covered.
VL53L0X system FOV is 25degrees.
Reflectance targets are standard ones (Grey 17% N4.74 and White 88% N9.5 Munsell charts).

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

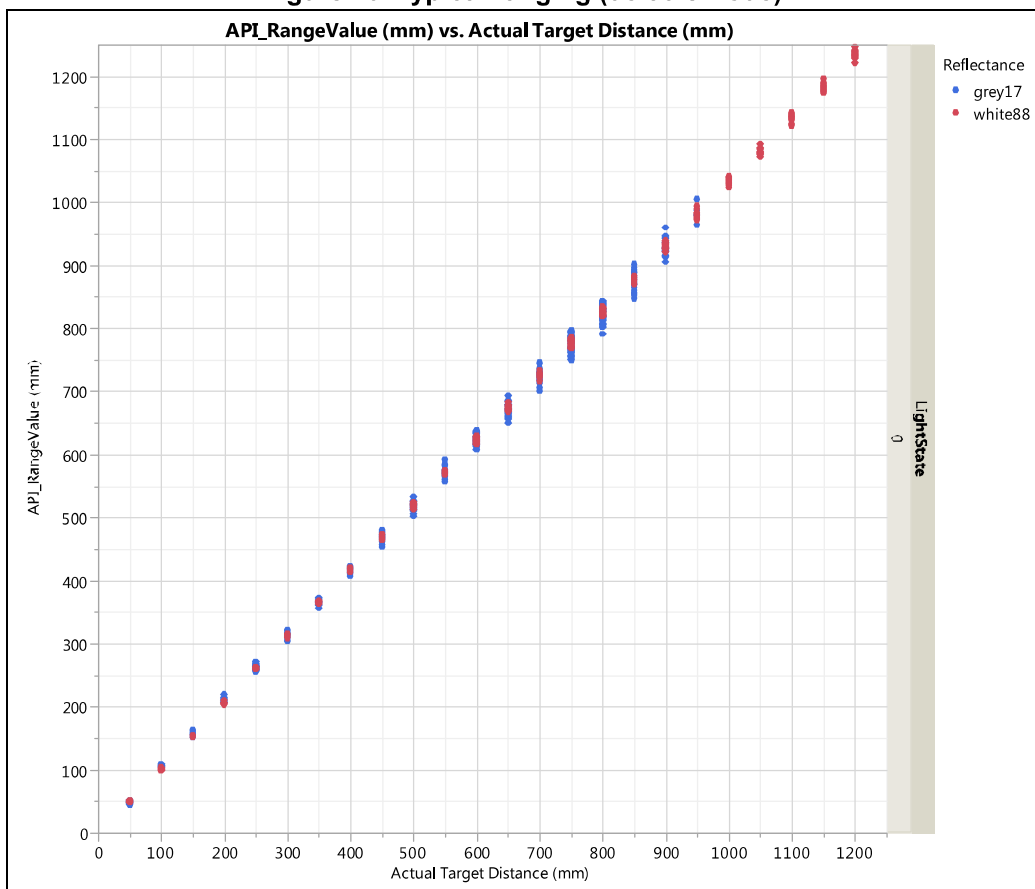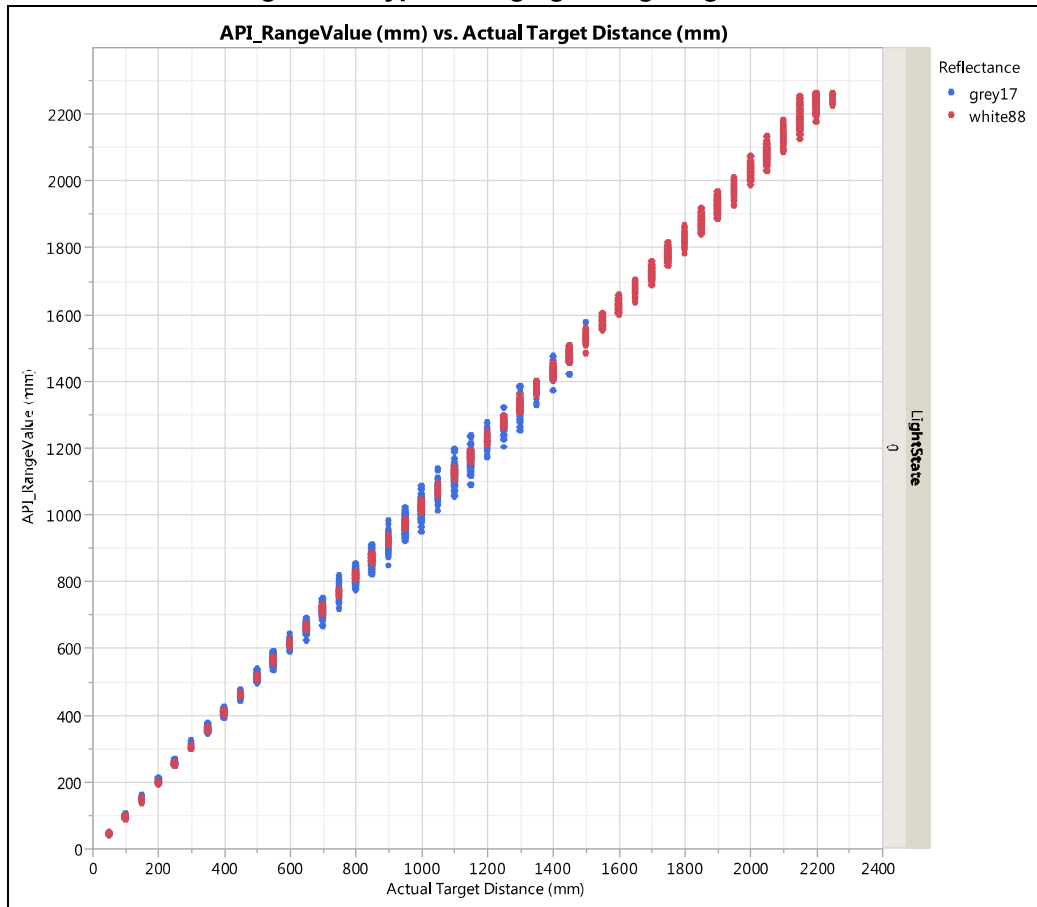**Figure 20. Typical ranging (default mode)**

Figure 21. Typical ranging - Long range mode

5.2 Max ranging distance

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

Table 11. Max ranging capabilities with 33ms timing budget

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

Note (1): using long range API profile

Note (2):

- Indoor: no infrared
- 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

Measurement conditions:

- Targets reflectance used : Grey (17%), White (88%)
- Nominal Voltage (2.8V) and Temperature (23degreesC)
- All distances are for a complete Field of View covered (FOV = 25degrees)
- 33ms timing budget

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.

5.3 Ranging accuracy

5.3.1 Standard deviation

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

Table 12. Ranging accuracy

Target reflectance level (Full FOV)	Indoor (no infrared)			Outdoor		
	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%

Measurement conditions:

- Targets reflectance used: Grey (17%), White (88%)
- Offset correction done at 10cm from sensor.
- Indoor: no Infrared   /   Outdoor: eq. 5kLux equivalent sunlight (10kcps/SPAD)
- Nominal Voltage (2v8) and Temperature (23degreesC)
- All distances are for a complete Field of View covered (FOV = 25degrees)
- Detection rate is considered at 94% minimum

5.3.2 Range profile examples

Table 13 details typical performance for the four example ranging profiles, as per measurement conditions in *Section 5.3: Ranging accuracy*.

Table 13. Range profiles

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

5.3.3 Ranging offset error

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

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

Table 14. Ranging offset

	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