Applicant name: Elitegroup Computer Systems Co., Ltd.

FCC ID: QISMU733

Topic:

The Technical Description of Proximity Sensor and Power Reduction

Editor: William Chung

Date: 2014/07/1

Index:

1. Introduction

This EUT is a 10” tablet device, and this document is described for the tech. portion for Proximity sensor. In the beginning, the front view of the tablet device is shown in Figure 1-1 and the dimension of EUT is L270mm x W175mm x H8mm. The back and side view of tablet device is shown in the Figure 1-2.

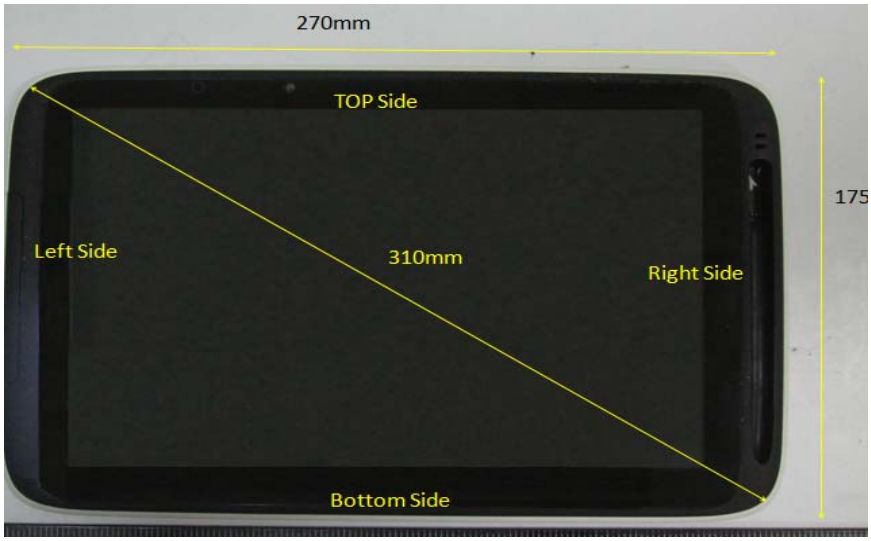


Figure 1-1 The front view of the device.

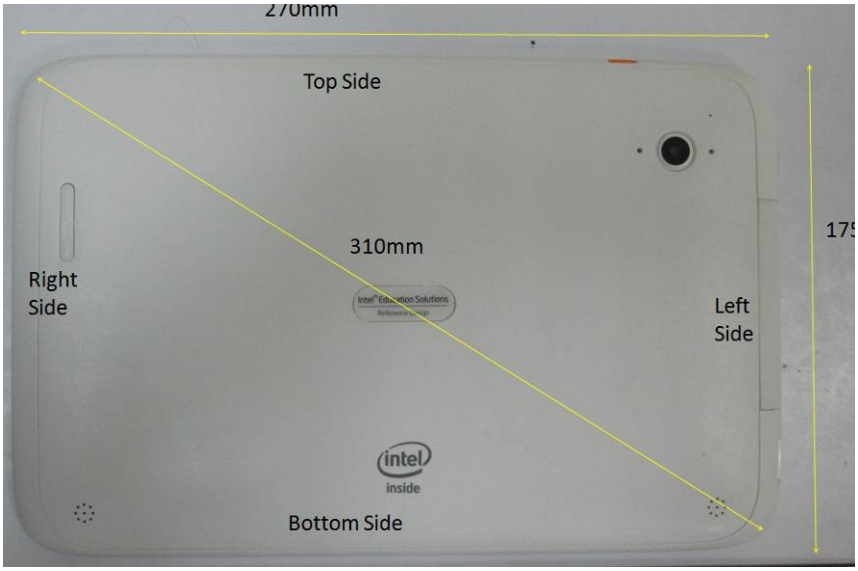


Figure 1-2 The back and side view of device

The operation scenario could support 1).Top side, 2).Left side, 3).Bottom side, 4).Right side, 5) Rear face, which are all shown in the figure 1-3.

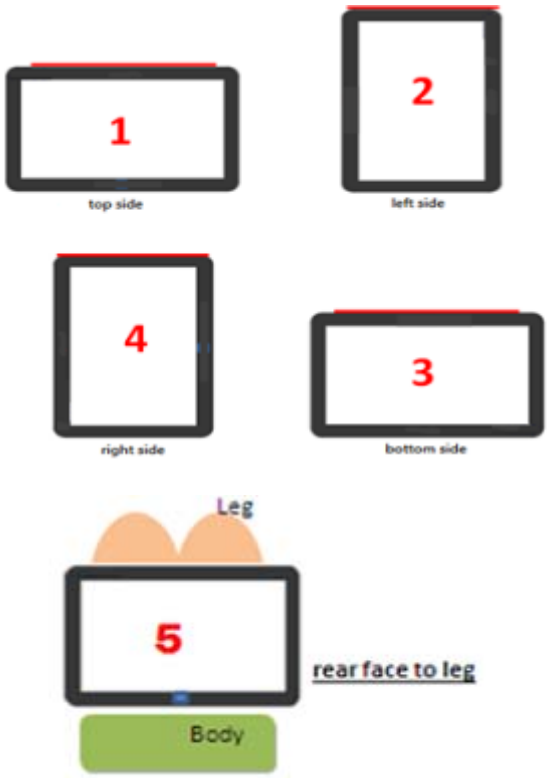


Figure 1-3 the operation scenario

2. Antenna description

There is an TX antennas in the EUT, including WWAN antenna (TX/RX), All antennas P-sensor locations are shown in Figure 2-1 and Figure 2-2. Table 2-1 describes the function of each antenna

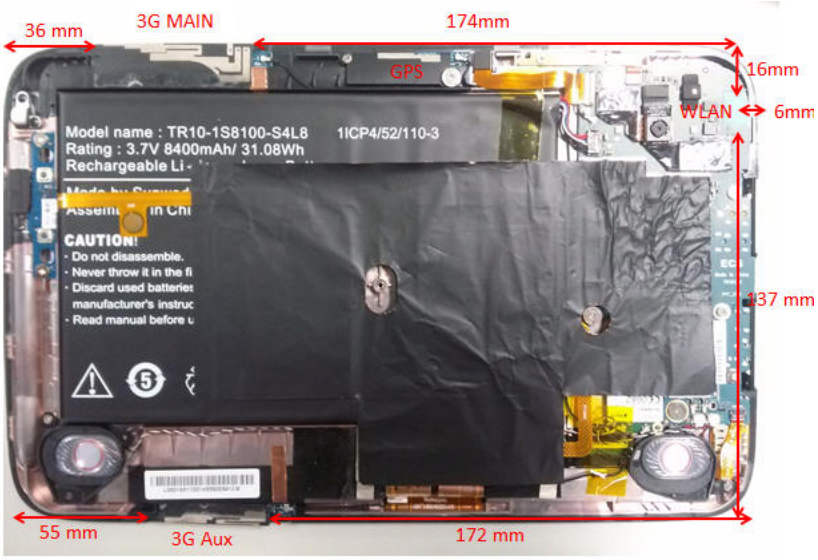


Figure 2-1 the antenna and P-sensor location (back view)

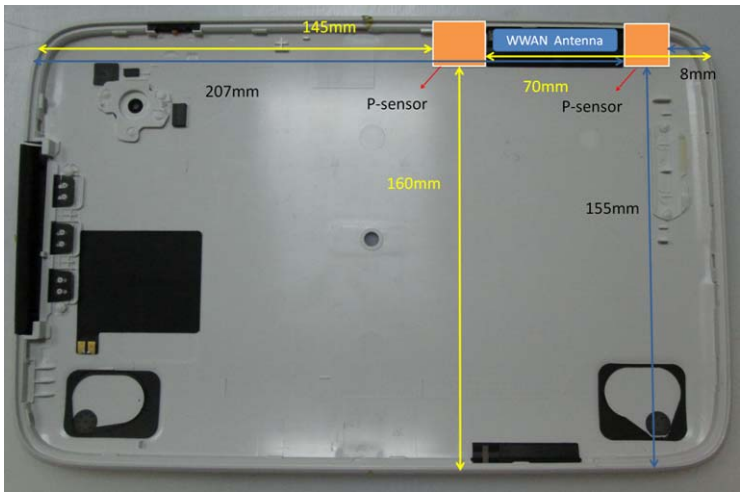


Figure 2-2 the P-sensor location (front view)

Table 2-1 EUT TX Antenna Configuration

No	Antenna Name	Antenna Usage	Technologies	Transmit Frequency (MHz)
1	Primary TX	GSM850/1900 TX/RX UMTS B2/B4/B5 TX/RX	GPRS / EDGE WCDMA	824~849 1710~1755 1850~1910

The relative distance between each antenna, and the distance to each edge of EUT are listed in the Table 2-2.

Table 2-2 The distance between each antenna and each antenna to chassis

Distance from antenna to user	**Main Antenna** ***Based on Top side:*** **3 mm** from main antenna-to-the edge of tablet ***Based on Top side with the following configurations:*** - to Right side: **36 mm** from main antenna-to- the edge of tablet - to Left side: **174 mm** from main antenna-to- the edge of tablet - to Bottom side: **145 mm** from main antenna-to- the edge of tablet

3. The design concept for proximity sensor

In order to reduce the transmit power and meet SAR criteria, the proximity sensor is implemented in the EUT. In the hardware portion, one proximity sensor IC and a sensor path are adopted. The system block is as Figure 3-1 described. The sensing path will be described in clause 4. The sensor path is attached on the back cover of EUT and connects to proximity sensor IC by a mental spring. The sensor path is composed by a metal pads align to the LTE TX antenna. The design theory for software portion is to read the different capacitance between sensor path and PCB. Then the proximity sensor IC sends a trigger signal to modem base on the difference of capacitance. (i.e. when human hand or body is close to the EUT, this tissue will change the capacitance.) Then, CPU will send an AT command to inform LTE module to reduce RF transmit power.

Figure 3-1 Sensor system block.

Most end-users' operating scenarios are using hands to hold four edges of EUT or human body is close to rear of EUT. However, based on KDB#447498 and the antennas' location in the previous chapter (figure 2-2), active modes of proximity sensor are focus to top side and rear face of EUT. The sensing region is shown in the Figure 3-1. The next chapter will illustrate the sensing area in detail.

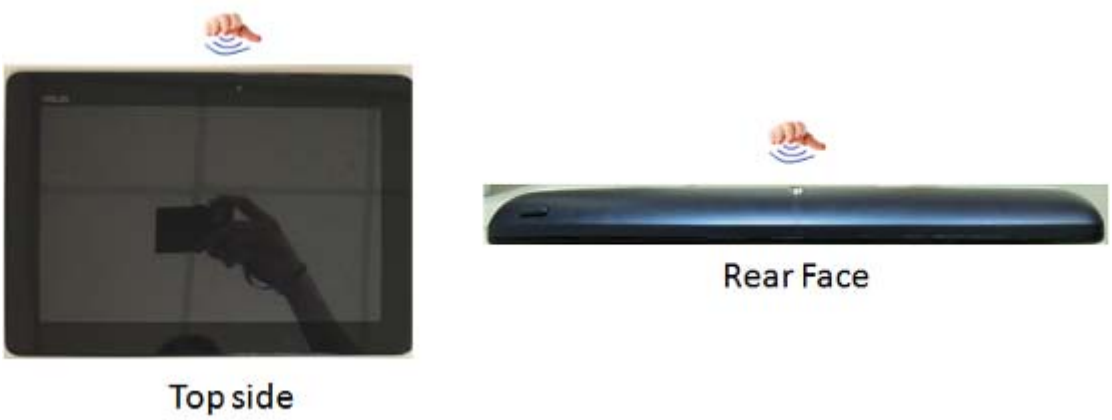


Figure 3-2 Active area of proximity sensor

4. Sensing path structure, design and sensing region

In this chapter, the sensor pad structure was illustrated. Then, sensing path and sensing region will be described and defined.

The sensor pad is attached on the back cover of EUT and connects to proximity sensor IC by a mental spring as figure 2-2 shown. The sensing path surrounds the WWAN main antenna like figure 4-1 shown. As the Figure 2-2 and 4-1 shown, the coverage contains the WWAN main antenna; therefore, our design could guarantee handheld situation.

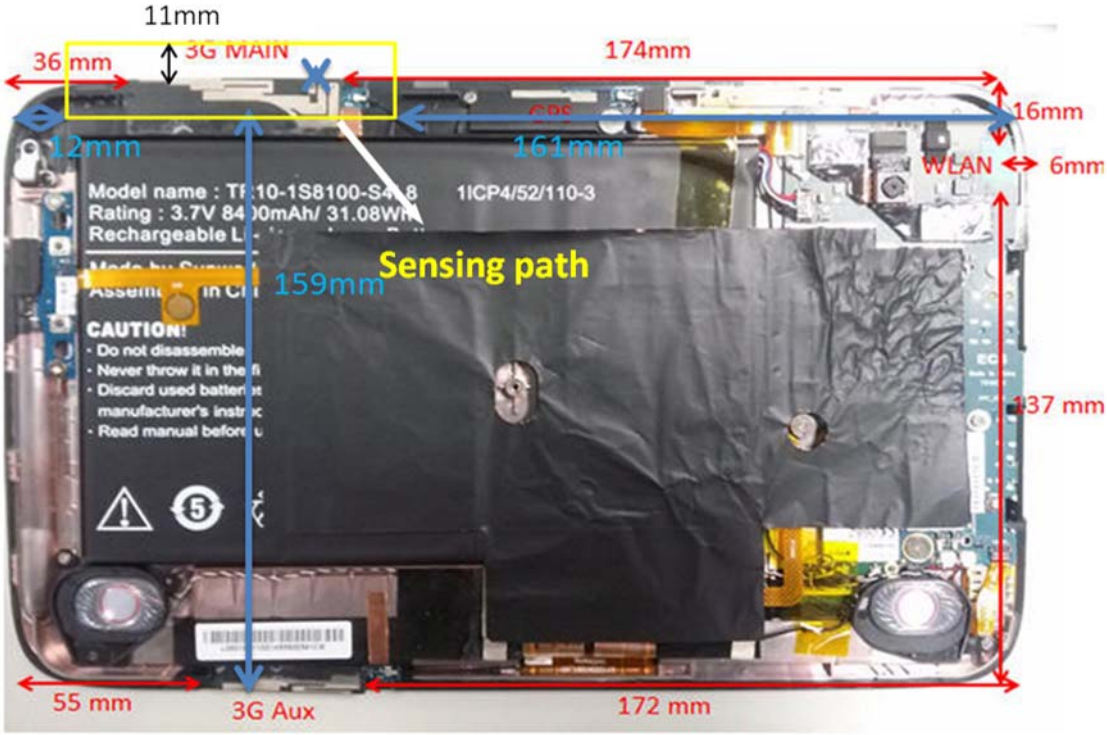


Figure 4-1 the sensing path illustration

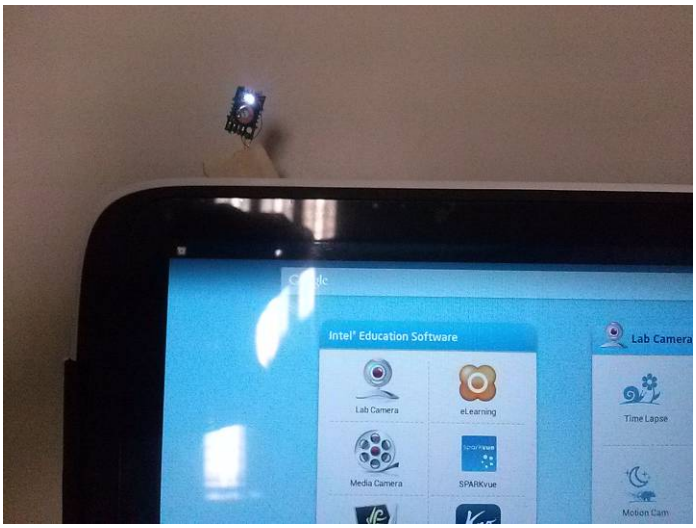
Figure 4-2 illustrates the sensing area to trig sensor. As below showed, on the top side, the distance from top side of tablet for effectively trigging is 11mm. On the other hand, the height from rear face for effectively trigging sensor is 7mm.

Figure 4-2 describes the Sensing region of Top side and Rear face.

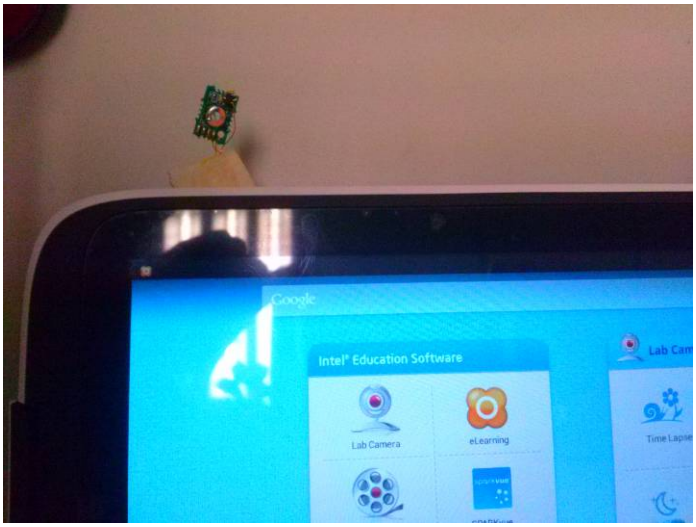
5. SAR testing considerations and feasibility study

5-0 Setup for P-sensor Triggered Distance and Coverage

The triggered distance and proximity sensor coverage is determined according to KDB 616217. This device has installed proper software application and it can be detected and display on the index light on upper left corner of Tablet. This program will continuously read the status of proximity sensor. When the sensor is not triggered, the index light is on. When the sensor is triggered, the index light will be off.



When the sensor is not triggered, the index light is on



When the sensor is triggered, the index light is off

For proximity sensor triggered distance and coverage determining setup, the status of proximity sensor continuously read and shows on the index light of this device. For RF output power checking and measurement, this device is connected to system simulator through RF cable. When the proximity sensor does not be triggered, the RF output power is transmitted at full power. When the proximity sensor is triggered, the RF output power is transmitted at power reduction mode.

The triggered distance test is done under phantom using appropriate body liquid, Liquid of Band 850 and 1900 MHz are used and applied for triggering distance experiment. In clause 5-4, the power versus triggering distance will be described in detail as Figure 5-3 and 5-4.

Setup for Triggering Distance and Sensor Coverage Determination

5-1 the definition for the active distance of Proximity sensor

In order to meet FCC requirement for SAR criteria, the mechanism of power reduction by a proximity sensor is implemented in this EUT. First, we define the two statuses called active/non-active mode (trigger/non-trigger) for this sensor.

Rear Face of EUT

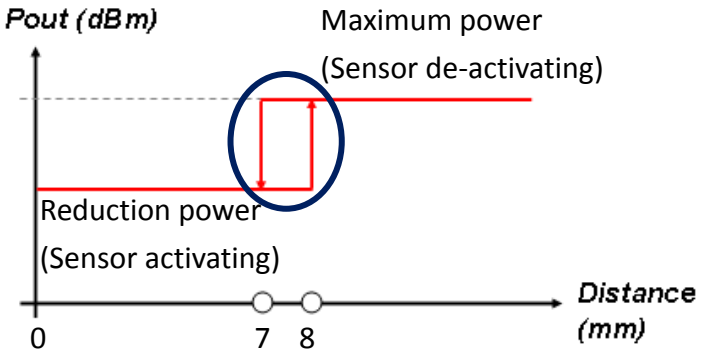
1. **The distance (from the edge of DUT rear face to human hand/body) is smaller/equal 7mm:** the mechanism of power reduction is workable (the proximity sensor will be active /triggered).
2. **The distance (from the edge of DUT rear face to human hand/body) is larger than 7mm:** the mechanism of power reduction is NOT workable, so the EUT will transmit Max. power. (the proximity sensor will NOT be active /triggered).

Top Side of EUT

1. **The distance (from the edge of DUT top side to human hand/body) is smaller/equal 11mm:** the mechanism of power reduction is workable (the proximity sensor will be active /triggered).
2. **The distance (from the edge of DUT top side to human hand/body) is larger than 11mm:** the mechanism of power reduction is NOT workable, so the EUT will transmit Max. power. (the proximity sensor will NOT be active /triggered).

The trigger threshold is defined at 7mm for rear side of EUT and 11 mm for top side of EUT. Once the human tissue is close to sensor's active region—equal and under 7mm (rear side) and 11mm (top side) , the sensor will be triggered and reduce the power. The trigger distance versus WWAN output power is shown in the Figure 5-1 (rear face) and Figure 5-2 (top side).

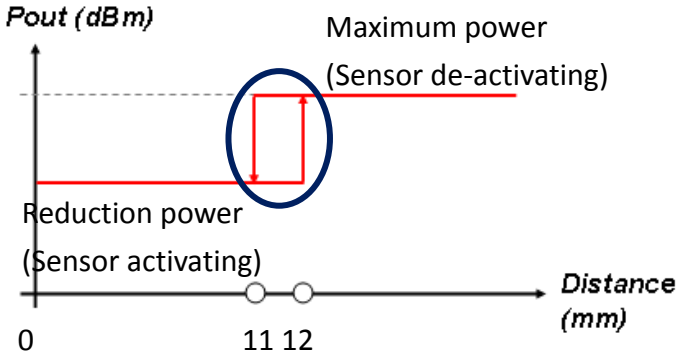
Rear Face of EUT



Moving Toward Phantom (mm)	0	1	2	3	4	5	6	7	8	…	15	16	17	18	19	20
P-sensor Trigger?	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
Moving Away Phantom (mm)	0	1	2	3	4	5	6	7	8	…	15	16	17	18	19	20
P-sensor Trigger?	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO

Figure 5-1 The LTE Band 4 RF output power v.s. trigger distance of Rear Face

Top Side of EUT



Moving Toward Phantom (mm)	0	1	2	3	4	5	6	…	11	12	13	14	15	16	17	18
P-sensor Trigger?	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO
Moving Away Phantom (mm)	0	1	2	3	4	5	6	7	11	12	13	14	15	16	17	18
P-sensor Trigger?	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO

Figure 5-2 The LTE Band 4 RF output power v.s. trigger distance of Top Side

Table 5-1 The sensor trigger condition

Proximity Sensor Trigger Distance (mm)	Yes: With Power Reduction No: Max. Power without Power Reduction	
	Rear face of device	Top side of device
0	YES	YES
1	YES	YES
2	YES	YES
3	YES	YES
4	YES	YES
5	YES	YES
6	YES	YES
≤7	YES	YES
>7	NO	YES
8	NO	YES
9	NO	YES
10	NO	YES
≤11	NO	Yes
>11	NO	NO
12	NO	NO
13	NO	NO
14	NO	NO
15	NO	NO
16	NO	NO
17	NO	NO
18	NO	NO
19	NO	NO
20	NO	NO

5-2 SAR Testing Mode Estimation/Distance definition for Top side of DUT

The tablet can be operated at 4 orientations as mention above (figure 1-2), but according to the KDB # 447498, the testing modes for edge evaluation are only Top side for LTE antenna. The relevant location and distance between antennas to edges are referred to figure 2-2.

In this section, we define the edge SAR testing mode and evaluate reduced power/ full power mode in distances from different edges to flat phantom

SAR for three different edges is listed as below:

1. **Top side of EUT: 0mm~10mm (power reduction) and more than 11mm (full power).**
2. **Right side of EUT: 0mm (full power).**
3. **Left side of EUT: 0mm (full power).**

5-3 SAR Testing Mode Estimation / Distance for the Rear Side of EUT

In this section, we define the SAR testing mode for rear side of EUT and evaluate reduced power/ full power mode in distances from rear side to flat phantom

Rear Side of EUT: 0mm~6mm (power reduction) and more than 7mm (full power)

5-4 Actual Measurement result for Power Reduction v.s. Distance

This sensing distance of proximity sensor is **11 mm for Top side and 7mm for Rear face of DUT**. The evaluation procedure is based on the KDB 616217 D04 v01, SAR for laptop and tablet, and evaluated in test lab. Table 5-2 and 5-3 shows that proximity sensor activate with different measuring distances. Figure 5-3 and Figure 5-4 illustrates the power reduction results for supported band and modulation when human body moves into the sensing distance of proximity sensor at Top side and Rear face of EUT respectively.

Power Reduction for Top side of EUT

mm	1	2	3	5	7	9	11	12	13	15	17	19	20
P-Sensor	On	On	On	On	On	On	On	Off	Off	Off	Off	Off	Off

Table 5-2 Power Reduction Graph by Top side

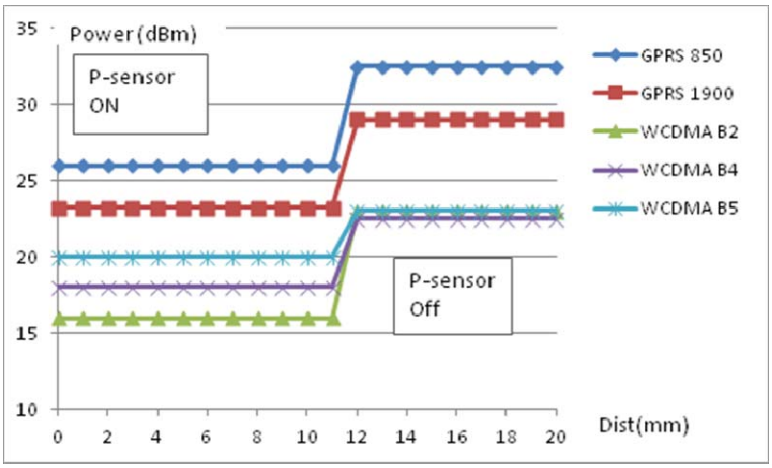


Figure 5-3 Power Reduction Graph by Top side

Power Reduction for Rear face of EUT

mm	1	2	3	5	7	8	10	13	15	17	18	19	20
P-Sensor	On	On	On	On	On	Off	Off	Off	Off	Off	Off	Off	Off

Table 5-3 Power Reduction Graph by rear face of EUT

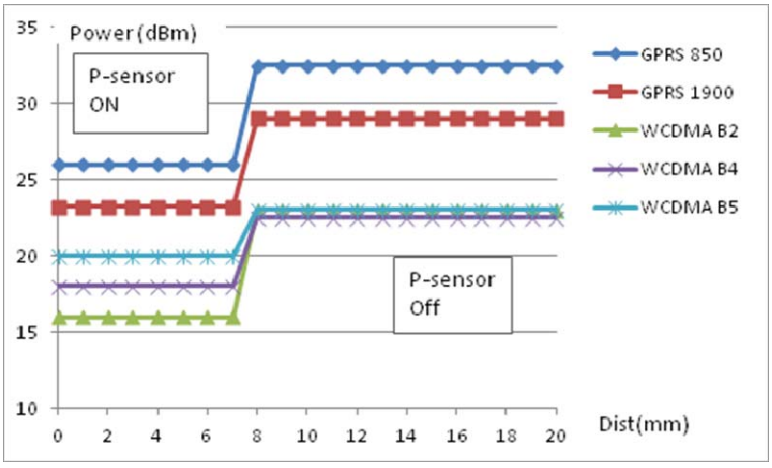


Figure 5-4 Power Reduction Graph by rear face of EUT

mm

5-5 Actual Measurement result for Tilt Angle Influence

The distance of 11mm from Top side to flat phantom is determined as shortest triggering distance at Top side. The rotation of EUT around the edge within ±45 degree would not cause proximity sensor releasing trigger to de-active state, therefore the smallest distance for tilt angle influence is **11mm for Top side of EUT**. Table 5-4 and Figure 5-6 illustrate the Tilt angle influence on Top side of EUT.

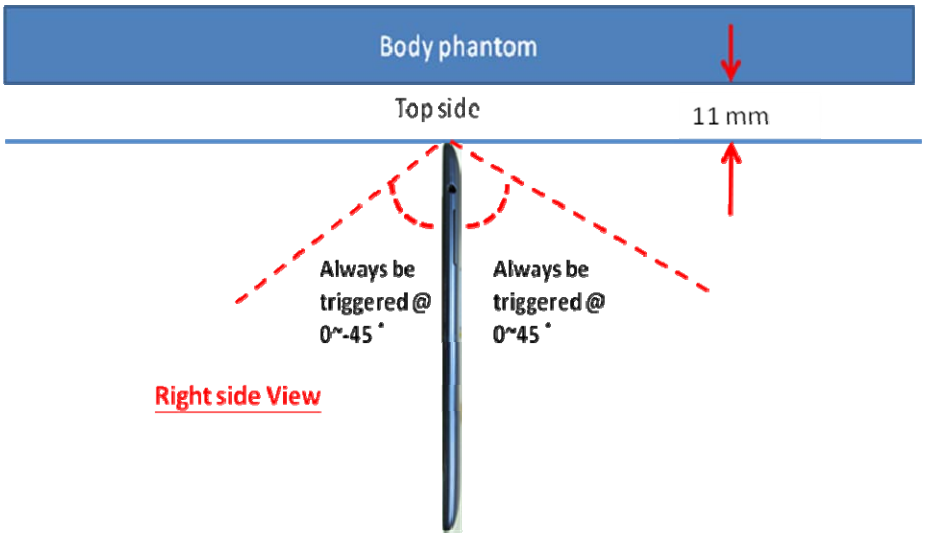


Figure 5-5 Tilt angle influence on Top side of EUT

Tilt angle (degree)	-45	-40	-30	-20	-10	0	10	20	30	40	45
P-sensor	on	on	on	on	on	on	on	on	on	on	on

Table 5-4 Power Reduction by Tilt Angle Measurement

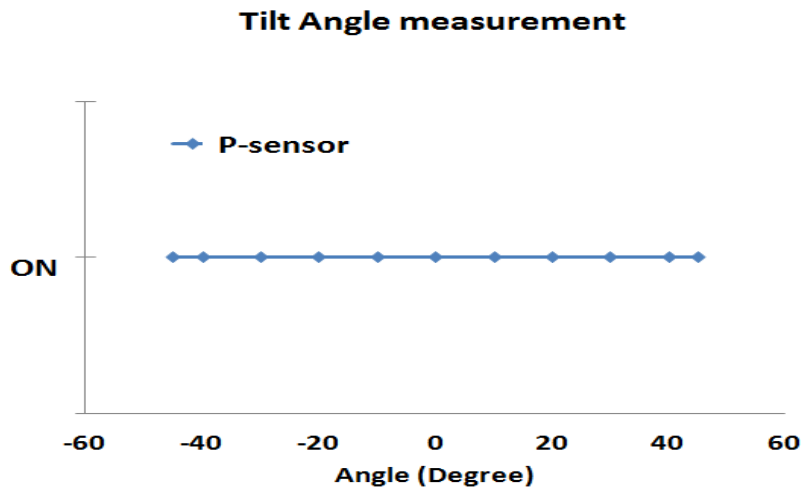


Figure5-6 Power Reduction Graph of Top side of EUT with Tilt angle