Appendix: Proximity sensor Power reduction information

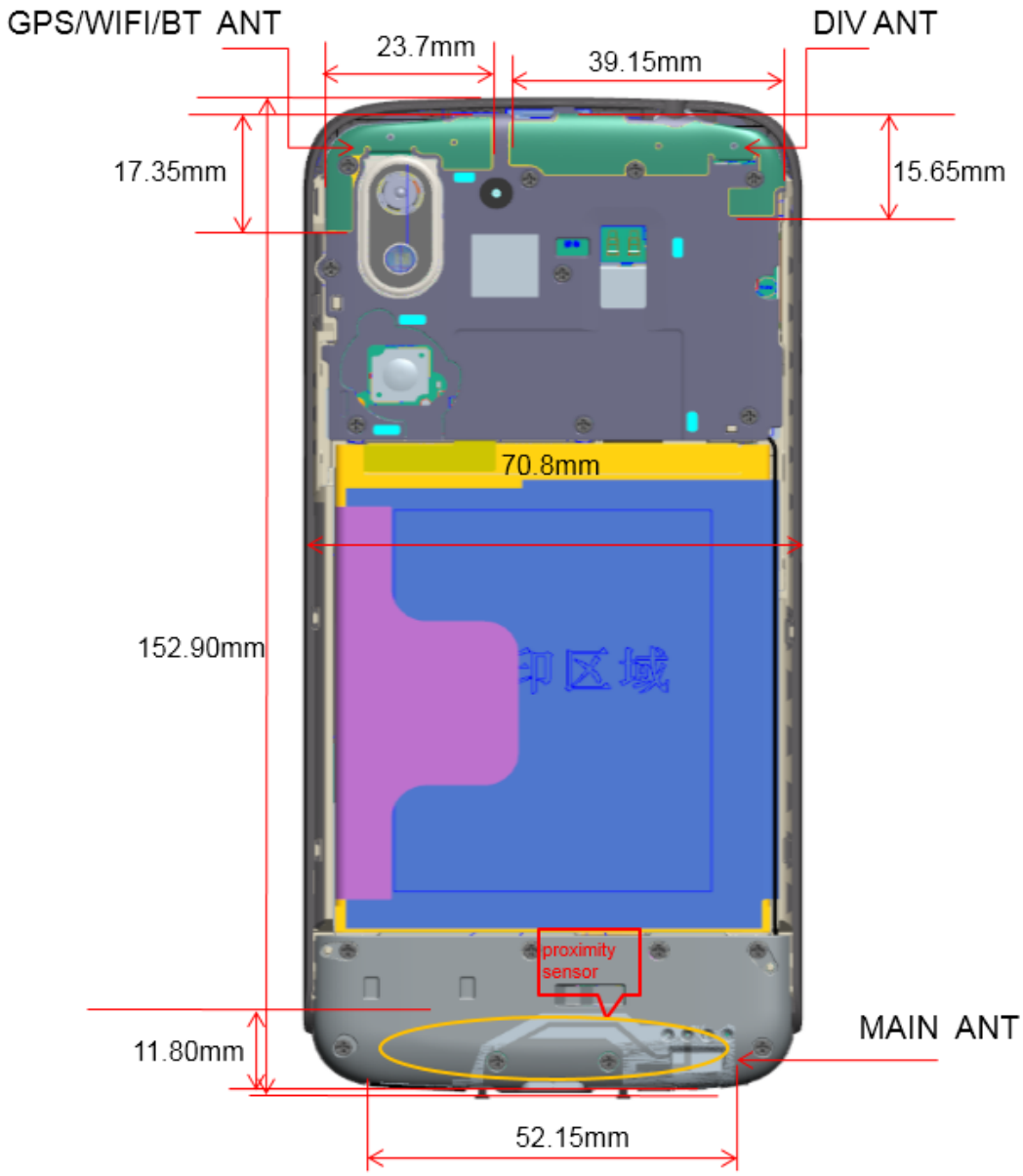
In this section, the following list is used to prepare an inquiry seeking SAR test guidance for proximity sensor power reduction. The procedures in KDB 616217 is applied for SAR testing.

1 General proximity sensor implementation description

This device uses a proximity sensor that share the same metallic electrode as the transmitting antenna to facilitate triggering in typical user interactivity with the device. Due to the operating configurations and exposure conditions required by the device, the proximity sensor is used to indicate when the phone is held close to a user's body exposure condition. It utilizes the proximity sensor to reduce the output power in specific wireless and operating modes to ensure SAR compliance for the following scenarios: To reduce the output power of main antennas during body close to phone.

2 Antennas and sensor placement details

1） Antenna-to-antenna/user separation distances



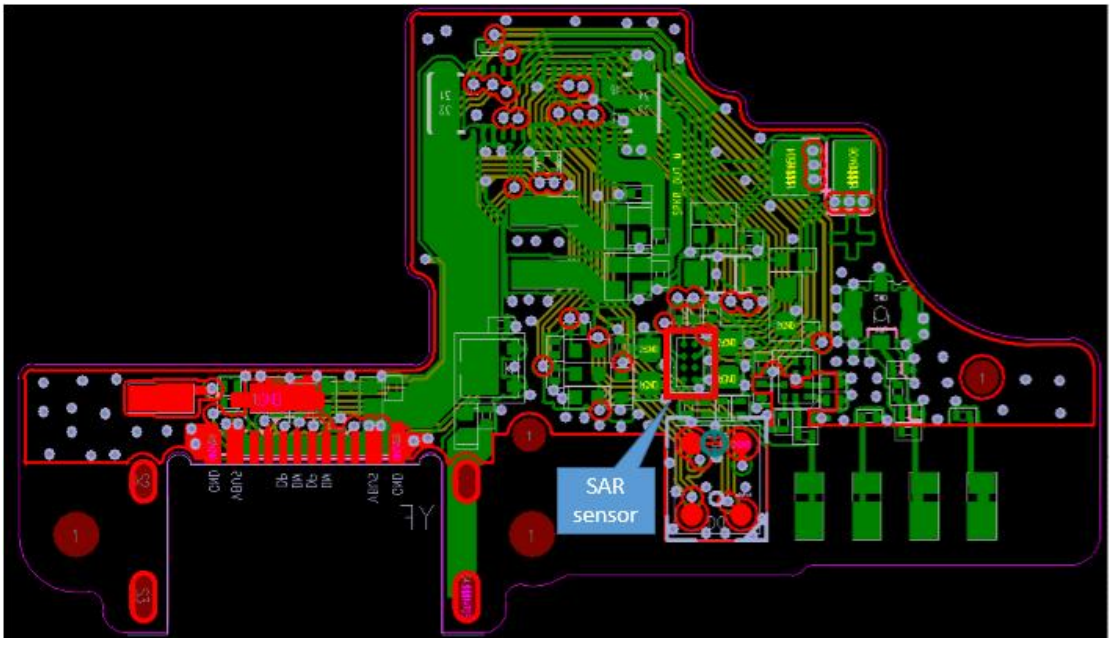
Figue1: The location of the antennas and proximity sensor

Note: The Div Antenna and GPS Antenna does not have the transmit function.

The proximity sensor and main antenna use same metallic electrode ,so the location is same.

	Antenna/Sensor-to- DUT sides separation distances					
Tx Antenna	**Front side**	**Back side**	**Left side**	**Right side**	**Top side**	**Bottom side**
Main 2G&3G&4G Antenna	2.15mm	1mm	9.5mm	11.2mm	139mm	1.0mm
2.4G WiFi Antenna	2.15mm	1mm	46.5mm	4.5mm	2.5mm	139mm
sensor	2.15mm	1mm	9.5mm	11.2mm	139mm	1.0mm
Diversity antenna and GPS antenna	Only receive signal, so it was not figured out in the following pictures					

3 proximity sensor clarification



Figue2: The picture of the Sar sensor

Description of proximity sensor Techniques

The proximity sensor is triggered by capacitance changes due to objects in the vicinity of the sensing element.

Capacitive proximity sensor sharea metallic electrode with the GSM、WCDMA and LTE antenna radiator. The metallic electrode and sar sensor chip works as a sensor. As is shown in Figure 2.

The proximity sensor or the power reduction cannot be intentionally or unintentionally turned-off by the user.

The expected capacitance trigger values are programmed in each device for each power back-off stage. Capacitance trigger value is C1

When a certain object or human body approaches the DUT, if the measured capacitance is lower than C1, proximity sensor is not triggered. If the measured capacitance is equal to C1 or higher than C1, the power back-off is triggered.

Power Reduction operation table

The phone use Qualcomm platform, which have some special NVs for SAR related max power back off, These NVs are used to set a new max power limit based proximity information and call configuration. When human body is in proximity and is detected by sensor, a new max power limit is set using the values stored in the NV. If Base station requests the higher output power above the limit, the power control algorithm inside modem chip will limit the power up to the preset power limit. If base station requests a lower output power less than the limit, the out power is controlled by base station.

4 proximity sensor coverage, distance and angle

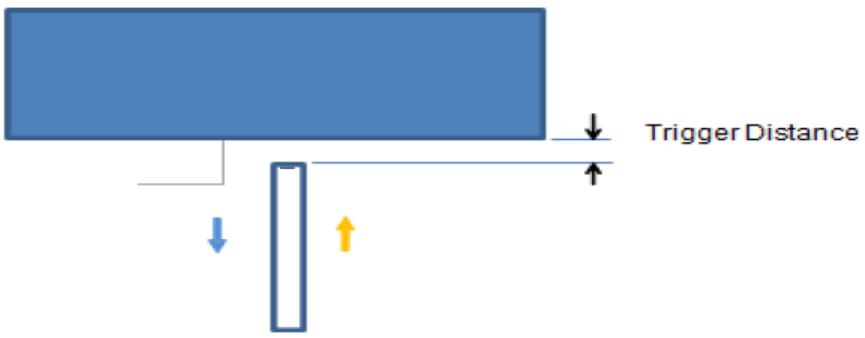
Band	Test position	Sensor Trigger Distance range(DUT to Phantom)	Power reduction amount(dB)	Target Power level （dBm）
WCDMA B1	Extremity SAR(Bottom/Front/Back/Left)	held by hand 0mm	2	21
	Top side	ALL	0	23

	Back side	0<distance≤26mm	2	21
		26mm<distance	0	23
	Front side	0<distance≤18mm	2	21
		18mm<distance	0	23
	Left side	0<distance≤3mm	2	21
		3mm<distance	0	23
	Right side	ALL	0	23
	Bottom side	0<distance≤28mm	2	21
		28mm<distance	0	21
WCDMA B2	Extremity SAR(Bottom/Front/Back/Left)	held by hand 0mm	2	21
	Top side	ALL	0	23
	Back side	0<distance≤26mm	2	21
		26mm<distance	0	23
	Front side	0<distance≤18mm	2	21
		18mm<distance	0	23
	Left side	0<distance≤3mm	2	21
		3mm<distance	0	23
	Right side	ALL	0	23
	Bottom side	0<distance≤28mm	2	21
		28mm<distance	0	23
LTE B1	Extremity SAR(Bottom/Front/Back/Left)	held by hand 0mm	2.1	21
	Top side	ALL	0	23.1
	Back side	0<distance≤26mm	2.1	21
		26mm<distance	0	23.1
	Front side	0<distance≤18mm	2.1	21
		18mm<distance	0	23.1
	Left side	0<distance≤3mm	2.1	21
		3mm<distance	0	23.1
	Right side	ALL	0	23.1
	Bottom side	0<distance≤	2.1	21

		28mm		
		28mm<distance	0	23.1
LTE B7	Extremity SAR(Bottom/Front/Back/Left)	held by hand 0mm	1.9	20.8
	Top side	ALL	0	22.7
	Back side	0<distance≤ 26mm	1.9	20.8
		26mm<distance	0	22.7
	Front side	0<distance≤ 18mm	1.9	20.8
		18mm<distance	0	22.7
	Left side	0<distance≤ 3mm	1.9	20.8
		3mm<distance	0	22.7
	Right side	ALL	0	22.7
	Bottom side	0<distance≤ 28mm	1.9	20.8
		28mm<distance	0	22.7

4.1 Procedures for determining proximity sensor triggering distances (Per KDB616217 § 6.2)

Per FCC KDB 616217 D04v01, the device was tested by the test lab to determine the proximity sensor triggering distances for the back side and each top side of the device. To ensure all production units are compliant, the smallest separation distance determined by the sensor triggering minus 1 mm, must be used as the test separation distance for SAR testing.These SAR tests are included in addition to the SAR tests for the device touching the SAR phantom with reduced power.



Picture: Proximity sensor triggering distances assessment (Tops)

Picture: Proximity sensor triggering distances assessment (Back side)

Table: Summary of Trigger Distances

Liquid Type(MHz)	Trigger distance – Front side		Trigger distance – back side		Trigger distance – bottom side	
	Moving toward phantom	Moving from phantom	Moving toward phantom	Moving from phantom	Moving toward phantom	Moving from phantom
1900	18mm	18mm	26mm	26mm	28mm	28mm
1900	18mm	18mm	26mm	26mm	28mm	28mm
1900	18mm	18mm	26mm	26mm	28mm	28mm
2550	18mm	18mm	26mm	26mm	28mm	28mm

Note:

1) For Front side, based on the most conservative measured triggering distance of N mm, additional SAR test is required at (N-1) mm.

2) For back side, based on the most conservative measured triggering distance of N mm, additional SAR test is required at (N-1) mm.

3) For Bottom side, based on the most conservative measured triggering distance of N mm, additional SAR test is required at (N-1) mm.

The proximity sensor is not triggered, when approaching from other sides (Left, Right, and Top). Therefore, the proximity sensor coverage is not evaluated on these orientations.

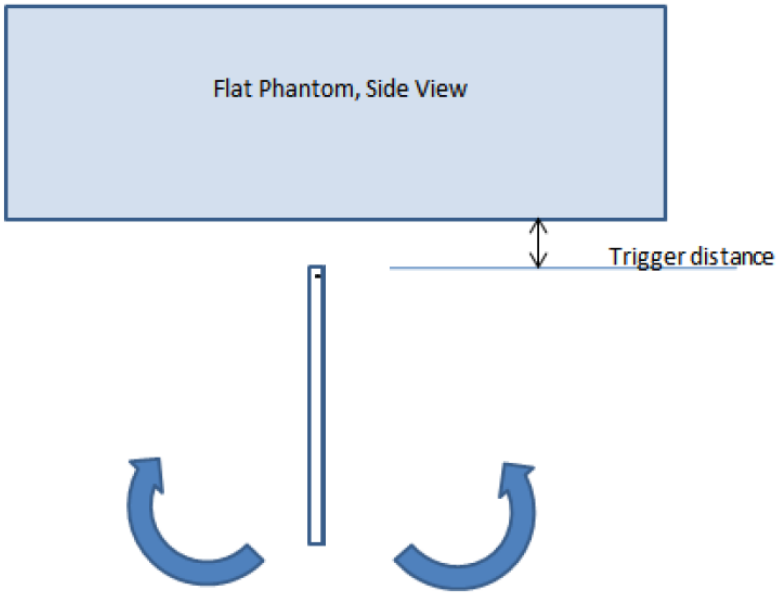
4.2 Procedures for determining antenna and proximity sensor coverage (Per KDB616217 § 6.3)

The proximity sensor and main antenna use same metallic electrode, so there is no spatial offset.

4.3 Procedures for determining device tilt angle influences to proximity sensor triggering (Per KDB616217 § 6.4)

Per FCC KDB 616217 D04v01, the DUT was positioned directly below the flat phantom at the minimum measured trigger distance with each applicable top parallel to the base of the flat phantom for each band.

The EUT was rotated about each applicable top for angles up to +/- 45°. If the output power increased during the rotation the DUT was moved 1mm toward the phantom and the rotation repeated. This procedure was repeated until the power remained reduced for all angles up to +/- 45°.



Picture: Proximity sensor tilt angle assessment (Tops)

Table: Summary of Phone Tilt Angle Influence to Proximity Sensor Triggering

Band(MHz)	Minimum trigger distance Per KDB616217§6.2	Minimum trigger distance at which power reduction was maintained over ±45°	Power Reduction Status										
			-45°	-35°	-25°	-15°	-5°	0°	5°	15°	25°	35°	45°
W1900	28mm	28mm	on	on	on	on	on	on	on	on	on	on	on
W2100	28mm	28mm	on	on	on	on	on	on	on	on	on	on	on
LTE Band1	28mm	28mm	on	on	on	on	on	on	on	on	on	on	on
LTE Band7	28mm	28mm	on	on	on	on	on	on	on	on	on	on	on

4.4 Summary SAR test Plan for Proximity sensor power reduction

For Body SAR compliance, the device uses proximity sensor power reduction for some frequency bands of Main antenna and test positions. To ensure all production units are compliant, the smallest separation distance determined by the sensor triggering and sensor coverage for normal and tilt positions for each applicable side and top triggering conditions, minus 1 mm, is used as the test separation distance for SAR testing. These SAR tests are included in addition to the SAR tests for the device touching the SAR phantom with reduced power.

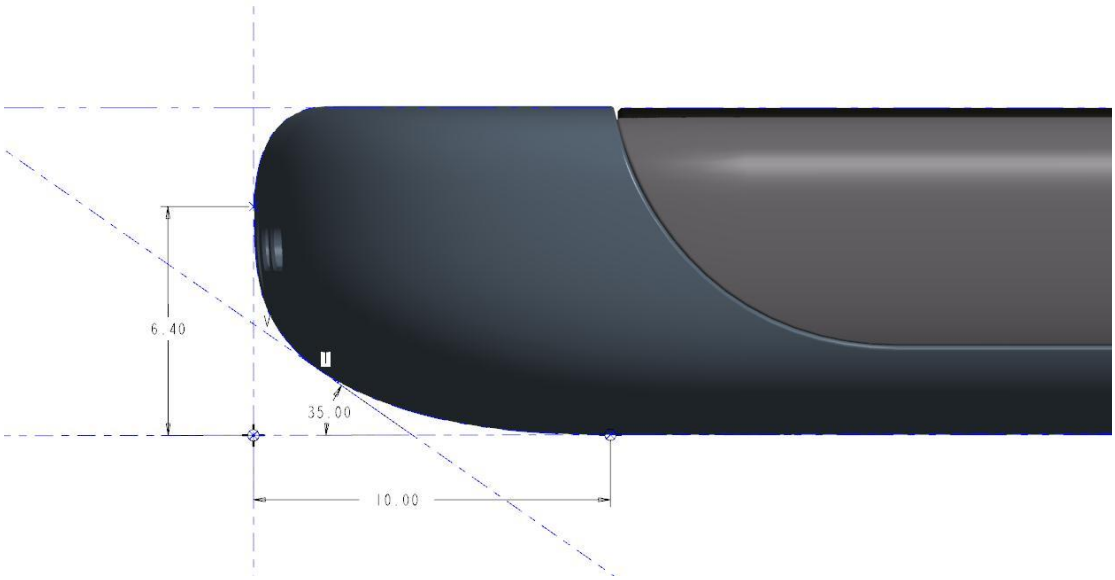
Appendix A：the distance between antenna and Curved Face

MAIN antenna：

X：6.4mm

Y：10mm

α：35°


6.40
35.00
10.00