Part 0: SAR Characterization
EUT RF Exposure Compliance Test Report

For
SMARTPHONE

FCC ID: BCG-E3544A
Model Name: A2403, A2404, A2405

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Revision History

Rev.	Date	Revisions	Revised By
V1	9/15/2020	Initial Issue	--
V2	9/16/2020	Table 2-2 – Corrected LTE B41 and B48 Power	Dave Weaver
V3	9/18/2020	Updated Table 2-2 with correct power and SAR; updated Table 2-3	
V4	9/28/2020	Updated Table 2-3 with the updated n41 power	

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1 Introduction

The equipment under test (EUT) is a smart phone. It contains the Qualcomm modem supporting 2G/3G/4G WWAN technologies. These WWAN modems enable Qualcomm Smart Transmit feature to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is in compliance with the FCC requirement.

In the Part 0 report, the EUT SAR are characterized for WWAN radios (2G/3G/4G/Sub6 NR) to determine the power limit that corresponds to the exposure design target after accounting for all device design related uncertainties, i.e., *SAR_design_target* (< FCC SAR limit) for sub-6. The SAR characterization are denoted as SAR Char.

SAR Char will be used as input for Qualcomm Smart Transmit to operate. SAR Char will be loaded and store in the EUT via the Embedded File System (EFS).

The EUT supports WLAN/BT radio as well but WLAN/BT modem is not enabled with Smart Transmit.

2 SAR Characterization

SAR Char is generated to cover all radio configurations and usage scenarios that are reported in the initial FCC submission.

2.1 Worst-case SAR determination

Based on FCC KDBs, in general, for a smartphone, the SAR evaluation is required for the exposure scenarios shown in Figure 2-1.
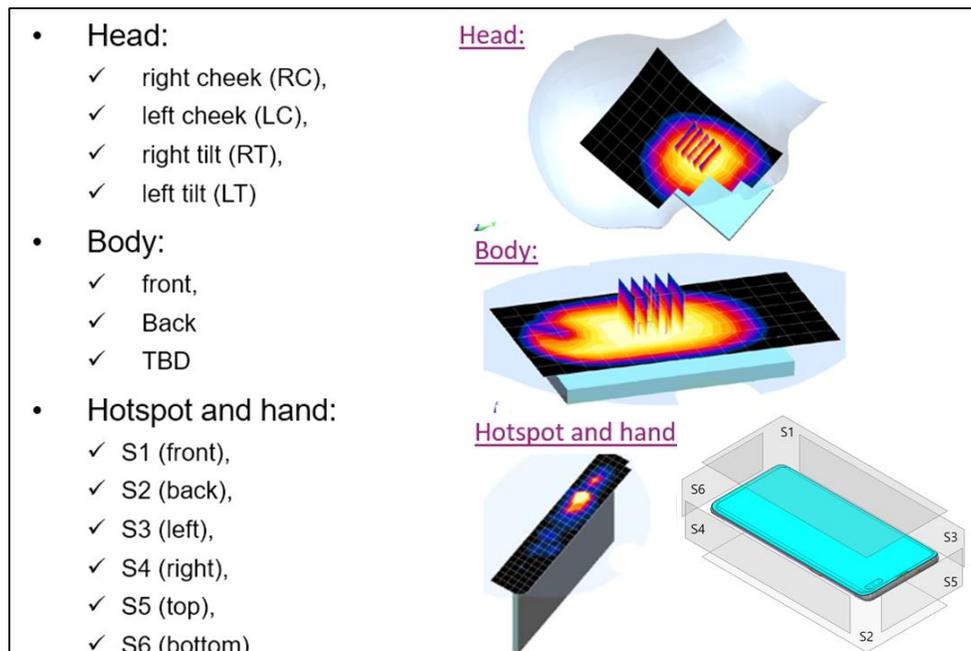

Figure 2-1: SAR evaluation for smartphone application

The device state index (DSI) used in Figure 2-2 represents each exposure scenario. Depending on the detection scheme implemented in the smartphone, the worst-case SAR is further grouped and determined for each or combined exposure scenario(s). Note for the 1g SAR versus 10g SAR exposure scenario, the worst-case is determined in term of exposure ratio (i.e., exposure level relative to the corresponding 1g- or 10g-SAR limit).

- If the device does not have any detection mechanism (**all "no"** in Figure 2-2), then the worst-case SAR is determined by taking the maximum SAR value among all exposure scenarios, i.e., worst-case SAR = $max\{SAR_{head},\ SAR_{body},\ SAR_{hotspot/extremity}\}$
- If the device can distinguish each of the above scenarios (**all "yes"** in Figure 2-2), then the worst-case SAR for each individual exposure scenario is given by corresponding SAR_{head}, SAR_{body}, and $SAR_{hotspot/extremity}$
- If the device can only distinguish a subset of the scenarios (**some "yes", some "no"** in Figure 2-2), then the worst-case SAR is given by:
  - □ Corresponding SAR for each exposure scenario that can be distinguished (DSI=yes)
  - □ Worst-case SAR among all other exposure scenario(s) that cannot be distinguished (DSI=no)
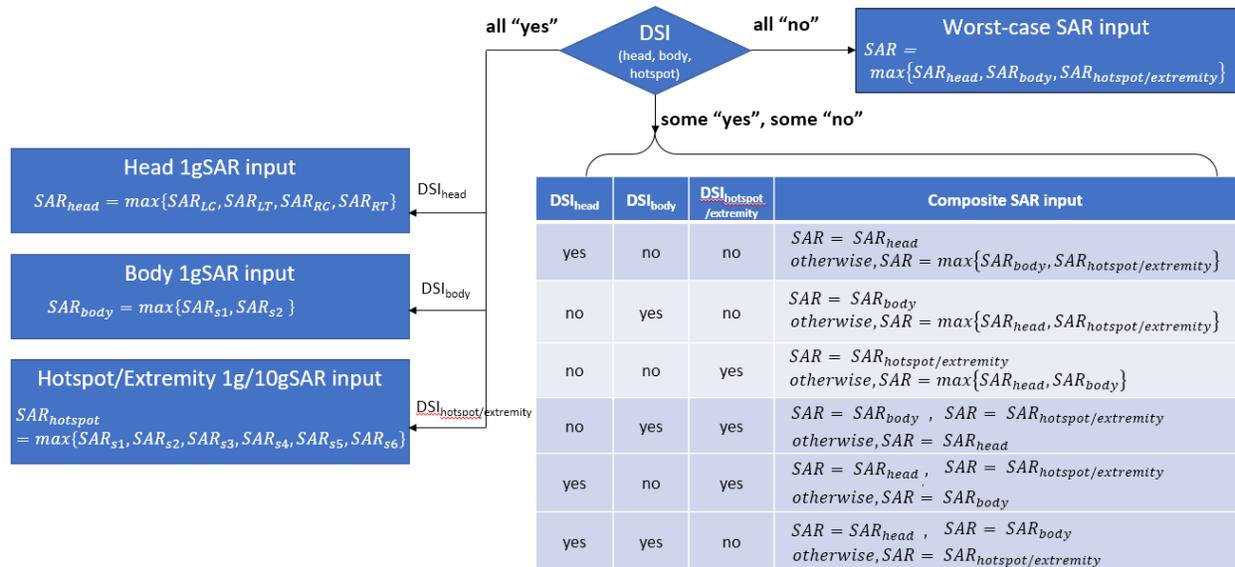
Figure 2-2: Worst-case SAR determination based on DSI

2.2 Usage Scenarios in SAR Evaluation

The EUT has a detection mechanism to distinguish head/body-worn/hotspot exposure, which is represented using DSI = 0 or DSI = 1. These two DSI states were used to determine power limit for Smart Transmit to operate.

The corresponding usage scenarios supported by EUT are summarized in Table 2-1:

Table 2-1: Usage/Exposure Scenario

Scenario	Description	SAR Definition	Worst-case SAR
Head (DSI = 0)	▪ Device positioned next to head ▪ 1g SAR evaluated in four positions (left/right cheek/tilt)	$SAR_{head} = max\{SAR_{LC}, SAR_{LT}, SAR_{RC}, SAR_{RT}\}$	SAR_{head}
Body worn/Hotspot (DSI = 1)	▪ Device state is either body worn or Hotspot at 5mm ▪ 1g SAR evaluated at all surfaces (S_1-S_6 as shown in Figure 2-1) of the EUT with 5 mm test separation distance relative to the flat phantom for body worn exposure	$SAR_{body\_DSI=1} = max\{SAR_{s1\_DSI=1}, SAR_{s2\ DSI=1}, SAR_{s3\ DSI=1}, SAR_{s4\ DSI=1}, SAR_{s5\ DSI=1}, SAR_{s6\ DSI=1}\}$	$SAR_{body\_DSI=1}$

2.3 SAR design target

The total device design related uncertainties of EUT is 1dB (k=2), which includes TxAGC and device to device variation.

To account for the total uncertainty, *SAR_design_target* needs to be:

$$SAR\_design\_target < SAR_{regulatory\_limit} \times 10^{\frac{-total\ uncertainty}{10}}$$

For FCC SAR requirement of 1.6 W/kg for 1g SAR the *SAR_design_target* for EUT is determined as

$SAR\_design\_target = 0.8\ W/kg\ for\ 1gSAR.$

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2.4 SAR Char of EUT

Referring to the initial FCC submission, the worst-case *reported* SAR for each antenna/technology/band/DSI is summarized in Table 2-2:

Table 2-2: Worst-case reported SAR (extracted from UL report 13259310-S1)

Tech/Band	Port	Worst-case SAR (W/kg)	P_{limit} Max Tune-up Power (dBm)	Port	Worst-case SAR (W/kg)	Plimit Max Tune-up Power (dBm)
		Head (DSI: 0)			Body (DSI: 1)	
GSM850	B	0.788	31.00	A	0.758	32.50
GSM1900	D	**0.998**	25.00	A	0.966	22.50
W-CDMA B2	D	0.953	19.00	D	0.968	20.25
W-CDMA B4	B	0.993	18.50	B	0.995	17.25
W-CDMA B5	B	0.696	23.90	A	0.750	25.70
CDMA BC0	B	0.772	23.90	A	0.883	25.70
CDMA BC1	B	0.898	20.00	A	0.957	16.50
CDMA BC10	B	0.755	23.90	A	0.894	25.70
LTE B5	B	0.755	24.50	A	0.697	25.70
LTE B7	B	0.996	16.50	C	0.982	18.00
LTE B12	B	0.664	23.90	A	0.679	25.70
LTE B13	B	0.609	23.90	A	0.753	25.70
LTE B25	D	0.952	19.00	C	0.977	19.50
LTE B26	B	0.754	24.50	A	0.914	25.70
LTE B30	B	0.997	19.75	A	0.982	21.00
LTE B41	D	0.989	21.75	B	0.996	19.75
LTE B48	D	0.976	18.50	C	**0.997**	22.50
LTE B66	B	0.992	18.50	B	0.995	17.25
FR1 n5	B	0.576	24.50	B	0.458	24.50
FR1 n12	B	0.404	23.90	A	0.381	25.70
FR1 n25	B	0.521	20.00	D	0.892	20.25
FR1 n41	B	0.734	16.50	C	0.833	18.00
FR1 n66	D	0.549	20.00	A	0.698	17.00
FR1 n77	B	0.997	17.50	A	0.984	18.25

Using the reported SAR listed in Table 2-2, and following the procedure described in Section 2.1, the SAR Char of this EUT, i.e., P_{limit} corresponding to *SAR_design_target*, is determined for each supported antenna/technology/band/DSI as:

1. for DSI = 0, P_{limit} is calculated based on 1gSAR head exposure evaluation
2. for DSI = 1, P_{limit} is calculated based on body-worn/hotspot 1gSAR evaluation at 5 mm spacing

$$P_{limit} = \min \{ P_{limit} \text{ corresponding to body worn 1gSAR evaluation at 5mm spacing,}$$
$$P_{limit} \text{ corresponding to 1g SAR extremity evaluation at 5mm spacing,}$$
$$P_{max} \text{ maximum RF tuneup power for the case that the SAR test is excluded} \}$$

The SAR Char is listed in Table 2-3.

Table 2-3: SAR Char of EUT

Exposure Scenario		Head		Body-worn & Hotspot		P_{max} (dBm) Tune-up power table
Spatial-average		1g		1g		
Test Distance		0 mm		5 mm		
Power Mode (DSI)		Mode A (DSI=0)		Mode B (DSI=1)		
Antenna	Tech/Band	P_{design} (dBm) corresponding to 1 0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	
	Transmit Average	Burst Average		Burst Average		Burst Average
A	GSM 850 2 slots	39.47	32.50	33.70	32.50	32.50
	GSM 1900 2 slots	37.77	31.00	22.65	22.50	31.00
	W-CDMA B2	31.45	25.70	17.05	16.50	25.70
	W-CDMA B4	29.59	25.70	17.12	17.00	25.70
	W-CDMA B5	31.74	25.70	26.95	25.70	25.70
	CDMA BC0	31.07	25.70	26.24	25.70	25.70
	CDMA BC1	33.68	25.70	16.69	16.50	25.70
	CDMA BC10	31.99	25.70	26.19	25.70	25.70
	LTE Band 5	32.18	25.70	27.27	25.70	25.70
	LTE Band 7	29.04	25.70	19.75	19.50	25.70
	LTE Band 12/17	32.94	25.70	27.38	25.70	25.70
	LTE Band 13	31.88	25.70	26.93	25.70	25.70
	LTE Band 25/2	29.73	25.70	17.12	16.50	25.70
	LTE Band 26	32.70	25.70	26.09	25.70	25.70
	LTE Band 30	28.86	25.70	21.08	21.00	25.70
	LTE Band 41	29.29	25.70	22.50	22.25	25.70
	LTE Band 48	29.08	25.70	22.82	21.00	22.80
	LTE Band 66/4	29.07	25.70	17.43	17.00	25.70
	NR n5	33.00	25.70	29.16	25.70	25.70
	NR n12	36.41	25.70	29.89	25.70	25.70
	NR n25/2	35.49	25.70	17.95	16.50	25.70
	NR n41	33.08	25.70	21.48	20.25	23.70
	NR n66	30.91	25.70	18.56	17.00	25.70
	NR n77	28.02	25.70	18.32	18.25	25.70

Antenna	Tech/Band	Head		Body-worn & Hotspot		P_{max} (dBm) Tune-up power table
	Exposure Scenario	Head		Body-worn & Hotspot		
	Spatial-average	1g		1g		
	Test Distance	0 mm		5 mm		
	Power Mode (DSI)	Mode A (DSI=0)		Mode B (DSI=1)		
		P_{design} (dBm) corresponding to 1 0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	
	Transmit Average	Burst Average		Burst Average		Burst Average
B	GSM 850 2 slots	32.03	31.00	34.13	31.00	31.00
	GSM 1900 2 slots	27.18	26.00	26.64	26.25	28.50
	W-CDMA B2	20.63	20.00	20.84	20.25	23.10
	W-CDMA B4	18.53	18.50	17.27	17.25	23.10
	W-CDMA B5	25.47	23.90	26.14	23.90	23.90
	CDMA BC0	25.02	23.90	25.62	23.90	23.90
	CDMA BC1	20.47	20.00	20.98	20.25	23.10
	CDMA BC10	25.12	23.90	26.96	23.90	23.90
	LTE Band 5	25.72	24.50	28.79	24.50	24.50
	LTE Band 7	16.52	16.50	17.77	17.50	22.80
	LTE Band 12/17	25.68	23.90	28.43	23.90	23.90
	LTE Band 13	26.05	23.90	28.15	23.90	23.90
	LTE Band 25/2	20.53	20.00	20.90	20.25	23.10
	LTE Band 26	25.73	24.50	27.51	24.50	24.50
	LTE Band 30	19.76	19.75	21.17	20.75	22.80
	LTE Band 41	18.98	18.50	19.77	19.75	22.80
	LTE Band 48	19.71	19.50	21.85	21.00	22.70
	LTE Band 66/4	18.53	18.50	17.27	17.25	23.10
	NR n5	26.90	24.50	27.89	24.50	24.50
	NR n12	27.84	23.90	29.43	23.90	23.90
	NR n25/2	22.83	20.00	22.91	20.25	23.10
	NR n41	17.84	16.50	18.96	17.75	25.70
	NR n66	21.95	18.50	19.77	17.25	23.10
	NR n77	17.51	17.50	18.46	18.00	22.70

Antenna	Tech/Band	Head		Body-worn & Hotspot		P_max (dBm) Tune-up power table
Exposure Scenario		**Head**		**Body-worn & Hotspot**		
Spatial-average		1g		1g		
Test Distance		0 mm		5 mm		
Power Mode (DSI)		Mode A (DSI=0)		Mode B (DSI=1)		
		P_{design} (dBm) corresponding to 1 0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	
	Transmit Average	**Burst Average**		**Burst Average**		**Burst Average**
C	GSM 1900 2 slots	35.61	30.00	26.35	25.50	30.00
	W-CDMA B2	27.89	24.70	19.86	19.50	24.70
	W-CDMA B4	29.08	24.70	21.66	21.25	24.70
	LTE Band 7	23.17	23.00	18.08	18.00	25.00
	LTE Band 25/2	27.69	24.70	19.60	19.50	25.00
	LTE Band 30	27.32	24.70	20.34	20.25	24.70
	LTE Band 41	26.75	24.70	20.07	20.00	25.00
	LTE Band 48	30.44	25.20	22.51	22.50	23.70
	LTE Band 66/4	29.56	24.70	21.64	21.25	25.00
	NR n25/2	28.41	24.70	21.97	19.50	25.00
	NR n41	29.57	24.25	18.79	18.00	22.00
	NR n66	32.63	24.70	22.92	21.25	25.00
	NR n77	32.50	25.20	19.61	19.50	25.50
D	GSM 1900 2 slots	25.01	25.00	26.78	26.25	28.00
	W-CDMA B2	19.21	19.00	20.39	20.25	22.70
	W-CDMA B4	21.32	20.00	21.26	21.00	22.70
	LTE Band 7	20.25	20.00	21.65	21.50	22.50
	LTE Band 25/2	19.21	19.00	20.39	20.25	23.00
	LTE Band 30	18.67	18.50	21.23	21.00	22.50
	LTE Band 41	21.80	21.75	22.76	22.20	22.50
	LTE Band 48	22.10	22.00	20.29	20.00	23.50
	LTE Band 66/4	21.64	20.00	22.22	21.00	23.00
	NR n25/2	22.00	19.00	20.75	20.25	23.00
	NR n41	21.22	19.75	22.41	20.75	25.50
	NR n66	22.60	20.00	22.76	21.00	23.00
	NR n77	20.31	20.00	17.94	17.50	23.50