



**Part 0: SAR Characterization
EUT RF Exposure Compliance Test Report**

For
SMARTPHONE

**FCC ID: BCG-E3543A
Model Name: A2402**

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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 B30 and B66 power	Dave Weaver
V3	9/28/2020	Updated Table 2-3 with the updated power for n41	Nathan Sousa
V4	10/27/2020	Removed mention of millimeter wave support	Dave Weaver

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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 and 5G NR Sub-6 GHz 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.

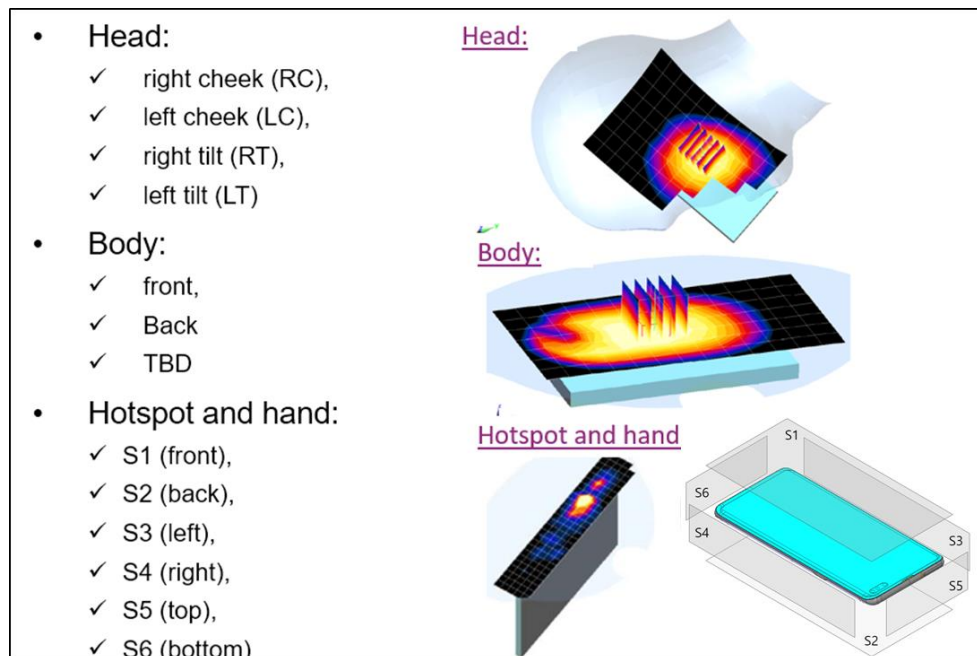


Figure 2-1: SAR evaluation for smartphone application

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., $\text{worst-case SAR} = \max\{SAR_{\text{head}}, SAR_{\text{body}}, SAR_{\text{hotspot/extremity}}\}$
- 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 $SAR_{\text{hotspot/extremity}}$
- 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)

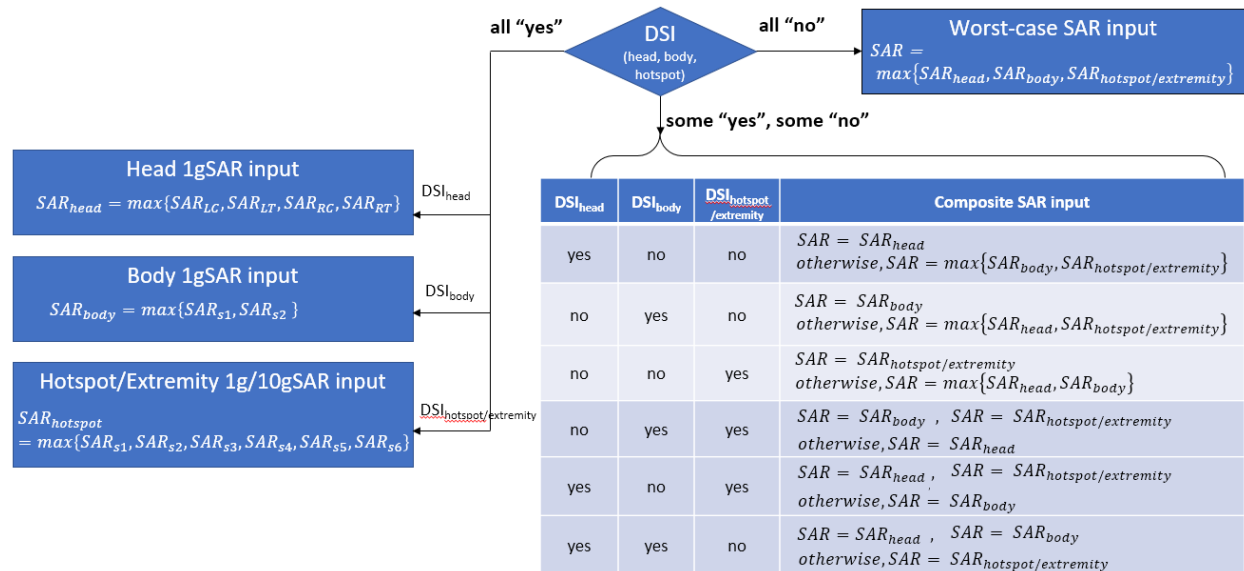


Figure 2-2: Worst-case SAR determination based on DSI

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 (S₁-S₆ 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.

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 13131736-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	0.724	31.00	A	0.542	32.50
GSM1900	D	0.965	25.00	D	0.912	26.25
W-CDMA B2	D	0.973	19.00	C	0.959	19.50
W-CDMA B4	B	0.985	18.50	B	0.983	17.25
W-CDMA B5	B	0.767	23.90	A	0.679	25.70
CDMA BC0	B	0.778	23.90	A	0.914	25.70
CDMA BC1	B	0.863	20.00	B	0.980	20.25
CDMA BC10	B	0.711	23.90	A	0.649	25.70
LTE B5	B	0.889	24.50	A	0.796	25.70
LTE B7	B	0.979	16.50	A	0.998	19.50
LTE B12	B	0.610	23.90	A	0.663	25.70
LTE B13	B	0.644	23.90	A	0.645	25.70
LTE B14	B	0.561	23.90	B	0.680	23.90
LTE B25	D	0.882	19.00	A	0.967	16.50
LTE B26	B	0.759	24.50	A	0.788	25.70
LTE B30	D	0.976	18.50	B	0.999	20.75
LTE B41	B	0.993	18.50	B	0.987	19.75
LTE B48	B	0.985	19.50	A	0.991	21.00
LTE B66	B	0.999	18.50	D	0.998	21.00
LTE B71	B	0.783	24.50	A	0.671	25.70
FR1 n5	B	0.533	24.50	A	0.573	25.70
FR1 n12	B	0.453	23.90	A	0.485	25.70
FR1 n25	D	0.719	19.00	A	0.845	16.50
FR1 n41	B	0.976	16.50	B	0.897	17.75
FR1 n66	D	0.840	20.00	A	0.742	17.00
FR1 n71	B	0.466	24.50	A	0.404	25.70
FR1 n77	B	0.979	17.50	A	0.998	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)		
Port	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	38.52	32.50	35.16	32.50	32.50
	GSM 1900 2 slots	37.89	31.00	23.03	22.50	31.00
	W-CDMA B2	30.61	25.70	16.77	16.50	25.70
	W-CDMA B4	31.92	25.70	17.57	17.00	25.70
	W-CDMA B5	31.68	25.70	27.38	25.70	25.70
	CDMA BC0	31.32	25.70	26.09	25.70	25.70
	CDMA BC1	29.89	25.70	16.62	16.50	25.70
	CDMA BC10	31.90	25.70	27.58	25.70	25.70
	LTE Band 5	31.98	25.70	26.69	25.70	25.70
	LTE Band 7	30.12	25.70	19.51	19.50	25.70
	LTE Band 12/17	32.10	25.70	27.48	25.70	25.70
	LTE Band 13	32.06	25.70	27.60	25.70	25.70
	LTE Band 14	31.92	25.70	28.60	25.70	25.70
	LTE Band 25/2	30.68	25.70	16.64	16.50	25.70
	LTE Band 26	31.95	25.70	26.74	25.70	25.70
	LTE Band 30	27.90	25.70	21.08	21.00	25.70
	LTE Band 41	31.12	25.70	22.37	22.25	25.70
	LTE Band 48	29.69	25.70	21.04	21.00	22.80
	LTE Band 66/4	28.90	25.70	17.31	17.00	25.70
	LTE Band 71	32.19	25.70	27.43	25.70	25.70
	NR n5	32.82	25.70	28.12	25.70	25.70
	NR n12	30.31	25.70	28.84	25.70	25.70
	NR n25/2	34.84	25.70	17.23	16.50	25.70
	NR n41	33.45	25.70	21.15	20.25	23.70
NR n66	31.35	25.70	18.30	17.00	25.70	
NR n71	35.06	25.70	29.64	25.70	25.70	
NR n77	27.84	25.70	18.26	18.25	25.70	

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)		
Port	Tech/Band	P _{design} (dBm) corresponding to 10 W/kg (SAR design target)	P _{limit} (dBm) Tune-up power table	P _{design} (dBm) corresponding to 10 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	32.40	31.00	33.94	31.00	31.00
	GSM 1900 2 slots	26.79	26.00	26.83	26.25	28.50
	W-CDMA B2	20.86	20.00	20.99	20.25	23.10
	W-CDMA B4	18.57	18.50	17.32	17.25	23.10
	W-CDMA B5	25.05	23.90	26.82	23.90	23.90
	CDMA BC0	24.99	23.90	26.12	23.90	23.90
	CDMA BC1	20.64	20.00	20.34	20.25	23.10
	CDMA BC10	25.38	23.90	27.00	23.90	23.90
	LTE Band 5	25.01	24.50	28.66	24.50	24.50
	LTE Band 7	16.59	16.50	17.79	17.50	22.80
	LTE Band 12/17	26.05	23.90	28.63	23.90	23.90
	LTE Band 13	25.81	23.90	27.71	23.90	23.90
	LTE Band 14	26.41	23.90	25.57	23.90	23.90
	LTE Band 25/2	21.42	20.00	20.81	20.25	23.10
	LTE Band 26	25.70	24.50	25.57	24.50	24.50
	LTE Band 30	20.55	19.75	20.75	20.75	22.80
	LTE Band 41	18.53	18.50	19.81	19.75	22.80
	LTE Band 48	19.57	19.50	22.14	21.00	22.70
	LTE Band 66/4	18.50	18.50	17.32	17.25	23.10
	LTE Band 71	25.56	24.50	27.15	24.50	24.50
	NR n5	27.23	24.50	28.60	24.50	24.50
	NR n12	27.34	23.90	30.12	23.90	23.90
	NR n25/2	25.70	20.00	23.48	20.25	23.10
	NR n41	16.61	16.50	18.22	17.75	25.70
	NR n66	21.10	18.50	19.50	17.25	23.10
	NR n71	27.82	24.50	29.17	24.50	24.50
	NR n77	17.59	17.50	18.85	18.00	22.70

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)		
Port	Tech/Band	P _{design} (dBm) corresponding to 10 W/kg (SAR _{design_target})	P _{limit} (dBm) Tune-up power table	P _{design} (dBm) corresponding to 10 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	36.05	30.00	27.16	25.50	30.00
	W-CDMA B2	28.66	24.70	19.68	19.50	24.70
	W-CDMA B4	30.04	24.70	22.94	21.25	24.70
	LTE Band 7	23.21	23.00	18.08	18.00	25.00
	LTE Band 25/2	27.35	24.70	20.12	19.50	25.00
	LTE Band 30	27.25	24.70	20.29	20.25	24.70
	LTE Band 41	26.81	24.70	20.09	20.00	25.00
	LTE Band 48	29.19	25.20	22.57	22.50	23.70
	LTE Band 66/4	29.34	24.70	21.58	21.25	25.00
	NR n25/2	31.16	24.70	21.15	19.50	25.00
	NR n41	28.09	24.25	19.36	18.00	22.00
	NR n66	31.48	24.70	23.11	21.25	25.00
	NR n77	31.84	25.20	20.07	19.50	25.50
D	GSM 1900 2 slots	25.15	25.00	26.65	26.25	28.00
	W-CDMA B2	19.12	19.00	20.51	20.25	22.70
	W-CDMA B4	20.32	20.00	21.21	21.00	22.70
	LTE Band 7	20.11	20.00	21.70	21.50	22.50
	LTE Band 25/2	19.55	19.00	20.57	20.25	23.00
	LTE Band 30	18.61	18.50	21.46	21.00	22.50
	LTE Band 41	21.78	21.75	23.80	22.20	22.50
	LTE Band 48	22.11	22.00	20.11	20.00	23.50
	LTE Band 66/4	20.29	20.00	21.01	21.00	23.00
	NR n25/2	20.43	19.00	21.42	20.25	23.00
	NR n41	20.81	19.75	25.15	20.75	25.50
	NR n66	20.76	20.00	22.67	21.00	23.00
	NR n77	20.10	20.00	17.92	17.50	23.50