Appendix E. Power reduction mechanism verification

According to the May 2017 TCBC Workshop, Demonstration of proper functioning of the detection and triggering mechanisms to support the corresponding RF exposure conditions. The verification is through a base station simulator is used to establish a conducted RF connection and monitor output power under different operating conditions related to the power reduction mechanisms. Detail of power reduction mechanisms referring to Operational Description

1. Power verification procedure

- Establish voice call and audio routed through the earpiece to monitor output power under head with simultaneous transmitting power states.
  - Tradition voice call for GSM/WCDMA, voice over IP CMRS operations for LTE/WIFI/5G FR1
  - GSM is set to 1TX slot, LTE is set at 'highest BW, 1RB, RB Offset = 0, QPSK' WCDMA is set AMR 12.2Kbps, 5G FR1 is set at highest BW MHz, 1RF, RB offset = 1, WiFi is set 802.11g, 802.11a

- Establish data connection monitor hotspot power state.
  - GSM is set to GPRS 4TX slot, LTE is set at 'highest BW, 1RB, RB Offset = 0, QPSK' WCDMA is set RMC 12.2Kbps, 5G FR1 is set at highest BW MHz, 1RF, RB offset = 1, WiFi is set 802.11g, 802.11a

- Establish data connection monitor body worn power state.
  - GSM is set to GPRS 2TX slot, LTE is set at 'highest BW, 1RB, RB Offset = 0, QPSK' WCDMA is set RMC 12.2Kbps, 5G FR1 is set at highest BW MHz, 1RF, RB offset = 1, WiFi is set 802.11g, 802.11a
  - Body Detect mechanism was performed for the in-hand and on a stationary object (placed on a table)

- This device incorporates the Samsung S.LSI TAS algorithm feature and through under varying Tx power transmission scenarios in real-time to maintain the time-averaged Tx power compliant with FCC RF exposure requirement.
- In this power validation purpose is to demonstrate of proper functioning of the detection and triggering mechanisms to support the corresponding RF exposure conditions. In order to avoid real-time TX power varying may affect monitor output power related to the power reduction mechanisms, therefore power reduction verification would be disabled WWAN TAS feature.
- Verification performed for each technology to demonstrate that the power reduction applies for both technology and call origination.

2. Test setup for measuring power

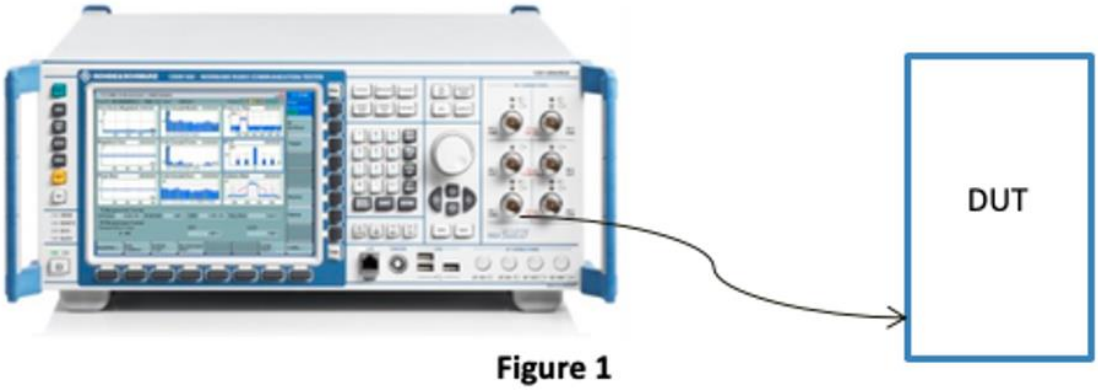

Figure 1

3. Verification output Power Results

Head exposure conditions

Head Exposure condition		Output Power for Voice Call			
Ear acoustic output Status:		ON		ON	
WiFi Status:		OFF		ON	
Power state		WWAN Index 2		WWAN Index 3	
Wireless technology	Antenna	Measured (dBm)	Max. Tune-up (dBm)	Measured (dBm)	Max. Tune-up (dBm)
GSM850 (1TX)	Ant 0	32.58	33.50	32.39	33.50
	Ant 1	30.28	32.10	30.09	31.40
UMTS Band 2	Ant 2	24.09	25.00	23.33	24.40
	Ant 0	24.96	25.00	24.94	25.00
LTE Band 14 (FDD)	Ant 0	24.17	25.00	24.11	25.00
	Ant 1	21.41	23.10	20.79	22.40
LTE Band 25 (FDD)	Ant 2	24.32	25.00	24.31	25.00
	Ant 0	24.08	25.00	24.05	25.00
NR SA n7	Ant 2	22.31	22.90	21.56	22.20
	Ant 0	23.95	25.00	23.71	25.00

Head Exposure condition		Output Power for Voice Call			
Ear acoustic output Status:		ON		ON	
WWAN Status:		OFF		ON	
Power state		WIFI Index 1		WIFI Index 3	
Wireless technology	Antenna	Measured (dBm)	Max. Tune-up (dBm)	Measured (dBm)	Max. Tune-up (dBm)
WiFi 802.11g CH6	(Ant4+3)Ant 3	17.92	19.00	13.13	14.50
	(Ant4+3)Ant 4	17.70	19.00	13.31	14.50
WiFi 802.11a 6Mbps CH157	(Ant4+3)Ant 3	14.26	16.00	6.15	9.50
	(Ant4+3)Ant 4	13.47	16.00	5.26	9.50

Hotspot exposure condition

Hotspot exposure condition		Output Power for data connection			
Wifi Hotspot Status		ON		OFF	
BT Hotspot Status		OFF		ON	
Power state		WWAN Index 4 WIFI Index 7		WWAN Index 4 WIFI Index 7	
Wireless Technology	Antenna	Measured (dBm)	Max. Tune-up (dBm)	Measured (dBm)	Max. Tune-up (dBm)
GSM1900 (4TX)	Ant 2	23.99	24.70	24.00	24.70
	Ant 0	20.99	21.25	20.97	21.25
UMTS Band 2	Ant 2	20.62	21.60	20.61	21.60
	Ant 0	18.05	18.65	18.02	18.65
LTE Band 14 (FDD)	Ant 0	24.12	25.00	24.11	25.00
	Ant 1	23.33	25.00	23.30	25.00
LTE Band 25 (FDD)	Ant 2	19.84	20.80	19.81	20.80
	Ant 0	16.96	18.35	16.94	18.35
NR SA n7	Ant 2	20.78	21.40	20.79	21.40
	Ant 0	16.89	18.25	16.88	18.25
WiFi 802.11g CH6	(Ant4+3)Ant 3	18.44	19.50		
	(Ant4+3)Ant 4	18.43	19.50		
WiFi 802.11a UNII ,CH157	(Ant4+3)Ant 3	13.10	18.00		
	(Ant4+3)Ant 4	12.41	18.00		

Body worn exposure condition

Body Worn exposure condition		Output Power (data connection)					
		Stationary		Body Worn (In hand)			
WIFI/BT Status		OFF		OFF		ON	
Power state		WWAN Index 1		WWAN Index 5		WWAN Index 6	
Wireless Technology	Antenna	Measured (dBm)	Max. Tune-up (dBm)	Measured (dBm)	Max. Tune-up (dBm)	Measured (dBm)	Max. Tune-up (dBm)
GSM1900 (4TX)	Ant 2	26.84	27.50	24.61	25.40	23.93	24.70
	Ant 0	27.39	27.50	23.22	23.25	22.41	22.55
UMTS Band 2	Ant 2	24.12	25.00	21.33	22.30	20.56	21.60
	Ant 0	24.99	25.00	19.93	20.35	19.14	19.65
LTE Band 14 (FDD)	Ant 0	24.21	25.00	24.14	25.00	24.13	25.00
	Ant 1	23.37	25.00	23.35	25.00	23.35	25.00
LTE Band 66 (FDD)	Ant 2	24.06	25.00	21.59	22.60	20.86	21.90
	Ant 0	23.77	25.00	19.28	20.75	18.33	20.05
NR SA n7	Ant 2	24.39	25.00	21.48	22.10	20.71	21.40
	Ant 0	23.92	25.00	18.63	19.95	17.73	19.25

Body Worn exposure condition		Output Power (data connection)					
		Stationary		In hand			
WWAN Status:		OFF		OFF		ON	
Power state		WIFI Index 0		WIFI Index 5		WIFI Index 7	
Wireless technology	Antenna	Measured (dBm)	Max. Tune-up (dBm)	Measured (dBm)	Max. Tune-up (dBm)	Measured (dBm)	Max. Tune-up (dBm)
WiFi 802.11g CH6	(Ant4+3)Ant 3	21.14	22.00	21.14	22.00	18.14	19.50
	(Ant4+3)Ant 4	20.69	22.00	20.70	22.00	18.17	19.50
WiFi 802.11a UNII ,CH157	(Ant4+3)Ant 3	17.69	21.00	17.70	21.00	13.87	18.00
	(Ant4+3)Ant 4	17.44	21.00	17.44	21.00	13.08	18.00

4. Motion Time vs Power verification

a) Body Detect mechanism will be performed for the in-hand and on a stationary object (placed on a table).
b) Verify the functionality of the motion sensor by measuring the output power in the following steps.

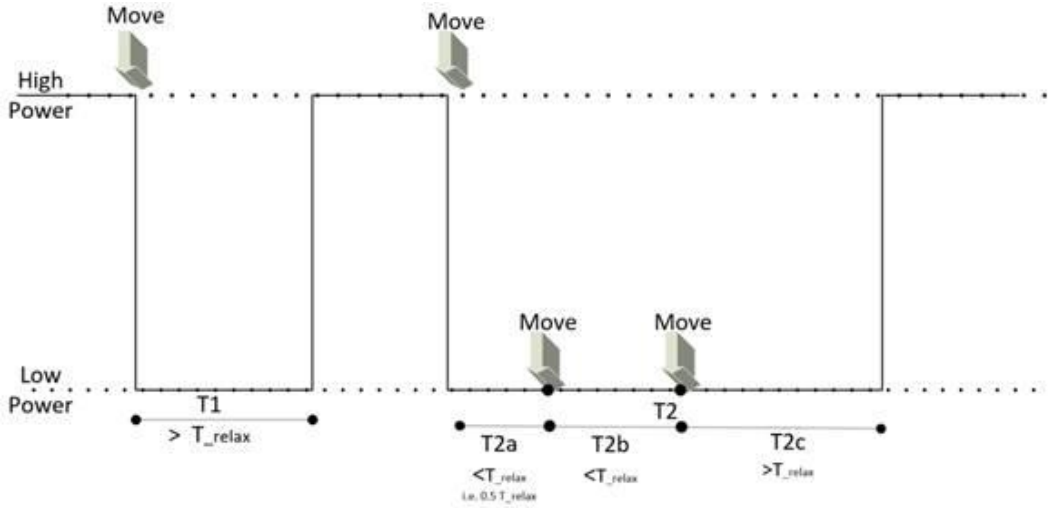

Figure 1 Illustration of the procedure for the validation of the power reduction

The device is embedded with motion sensors only, no proximity sensors are installed.

1. **Placed on a table:** Make the DUT transmit with the maximum output power by using a base station simulator.
   a) Confirm that motion sensor is not triggered by letting the DUT remain stationary with no movements for the period T_{relax} for the motion sensor to reach stationary state.
   b) Record P_{step1} (high power)
2. **In-hand:** Move the DUT to trigger the motion sensor. Apply the motion of the DUT with respect to movements in intended and reasonably foreseeable use conditions of the DUT.
   a) Record P_{step2} (low power)
3. For the validation of T_{relax}, wait a time period $T_1 > T_{relax}$ and confirm DUT restores to high power (P_{step1}).
4. Move the DUT to trigger the motion sensor.
5. Move DUT within T_{relax} to ensure T_{relax} resets when DUT is in motion.
   DUT can be moved once or twice within T_{relax}, (after time periods T_{2a} and T_{2b} in Figure 1.) followed by waiting for a time period greater than T_{relax} (time period T_{2c} in Figure 1.) for DUT to restore high power. The total time duration of this step is T_2, and the power during the whole period T_2 shall be reduced (low power – P_{step2}).

   T_{relax}: *15 sec*
   Monitor period, T_1: 20 *sec*, T_{2a}: 10 sec, T_{2b}:10 sec, T_{2c}: 20 sec

Exposure Condition		Output Power (data connection) (dBm)											
		Stationary Placed on a table		In hand		Stationary Placed on a table		In hand				Stationary Placed on a table	
Power state		Full Power P_{step1}		Low Power P_{step2}		Full Power P_{step1} & $T_1 > T_{relax}$		Low Power P_{step2} & $T_{2a} < T_{relax}$		Low Power P_{step2} & $T_{2b} < T_{relax}$		Full Power P_{step1} & $T_{2c} > T_{relax}$	
Wireless technology	Antenna	Measured	Max. Tune-up	Measured	Max. Tune-up	Measured	Max. Tune-up	Measured	Max. Tune-up	Measured	Max. Tune-up	Measured	Max. Tune-up
LTE Band 66	Ant 2	24.12	25.00	21.63	22.60	24.10	25.00	21.61	22.60	21.59	22.60	24.08	25.00
WiFi 802.11g CH6	(Ant4+3)Ant 4	21.24	22.00	21.06	22.00	21.21	22.00	21.11	22.00	21.14	22.00	21.20	22.00
	(Ant4+3)Ant 3	20.73	22.00	20.62	22.00	20.69	22.00	20.67	22.00	20.70	22.00	20.71	22.00