

Appendix E. Power reduction mechanism verification

1. Power verification introduction

- This device supports the manufacturer's proprietary power reduction mechanisms for cellular and Wi-Fi transmitters. Further details of the specific mechanisms for the power reduction mechanism can be found in the Operational Description
- Demonstration of proper functioning of the detection and triggering mechanisms to support the corresponding RF exposure conditions, the verification plan consists of measuring the power levels of the cellular and Wi-Fi transmitters at each wireless technology under different operating conditions related to the power reduction mechanisms.
- This device incorporates the WWAN 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 WWAN real-time TX power varying was disabled and keep in static output power for power reduction mechanism validation.
- For testing purposes, the device was measured against each Index supported for the cellular and Wi-Fi technologies. The target power level and measured power levels are detailed in the following table and clearly shows that each power reduction mechanism operates as expected.

2. Power verification procedure

- The verification is through a base station simulator is used to establish a conducted RF connection and record output power under different operating conditions related to the power reduction mechanisms.
- Verification of power reduction levels for Wi-Fi is performed with cellular transmitters on and off, for cellular is performed with Wi-Fi transmitters on and off.
- Verification of RCV mechanism is via establish voice call and audio routed through the earpiece to record output power under head power states.
- Verification of Hotspot power reduction is via establish data connection and enable hotspot feature to record output power under hotspot power state.
- Verification of Body Detector mechanism is via establish data connection to record output power under body worn power state.
 - On a stationary object (placed on a table)
 - In-hand or on knee
 - Body detect and monitor period validation

3. Test setup for conducted power measurement

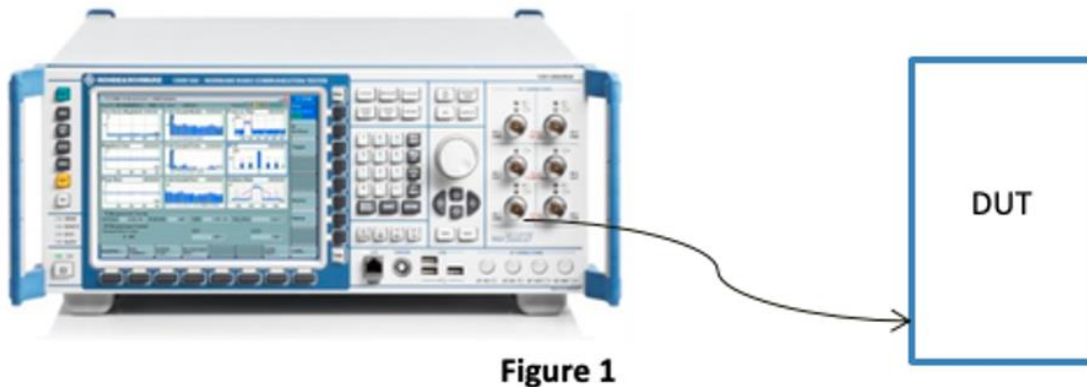


Figure 1

4. 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	32.31	33.50	32.31	33.50
	Ant 1	30.07	31.20	29.18	30.50
UMTS Band 5	Ant 0	24.14	25.50	24.12	25.50
	Ant 1	21.72	23.40	21.01	22.70
LTE Band 7 (FDD)	Ant 2	23.88	25.00	23.57	24.20
	Ant 0	23.95	25.00	23.94	25.00
LTE Band 26 (FDD)	Ant 0	23.72	25.00	23.71	25.00
	Ant 1	21.77	23.50	21.09	22.40
LTE Band 41 (TDD) PC3	Ant 2	23.82	25.10	23.81	24.70
	Ant 0	23.97	25.10	23.95	25.10
NR SA n7	Ant 2	23.31	24.30	22.57	23.10
	Ant 0	24.13	25.00	24.12	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)
802.11g 6Mbps CH6	(Ant3+4)Ant 3	16.90	17.50	12.90	13.50
	(Ant3+4)Ant 4	16.38	17.50	12.41	13.50
802.11a 6Mbps CH116	(Ant3+4)Ant 3	14.53	16.50	10.79	11.00
	(Ant3+4)Ant 4	14.42	16.50	10.94	11.00

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	25.03	26.70	25.01	26.70
	Ant 0	19.46	21.40	19.47	21.40
UMTS Band 2	Ant 2	21.35	23.10	21.34	23.10
	Ant 0	16.36	18.00	16.36	18.00
LTE Band 7 (FDD)	Ant 2	19.48	20.90	19.49	20.90
	Ant 0	18.29	19.80	18.30	19.80
LTE Band 25 (FDD)	Ant 2	19.64	21.10	19.63	21.10
	Ant 0	16.05	17.60	16.04	17.60
LTE Band 41 (TDD) PC3	Ant 2	20.71	22.00	20.71	22.00
	Ant 0	21.12	21.80	21.12	21.80
NR SA n25	Ant 2	20.07	21.60	20.07	21.60
	Ant 0	16.55	18.10	16.54	18.10
802.11g 6Mbps CH6	(Ant3+4)Ant 3	17.31	18.00		
	(Ant3+4)Ant 4	16.91	18.00		
WiFi 802.11a CH157	(Ant3+4)Ant 3	15.40	17.00		
	(Ant3+4)Ant 4	15.61	17.00		

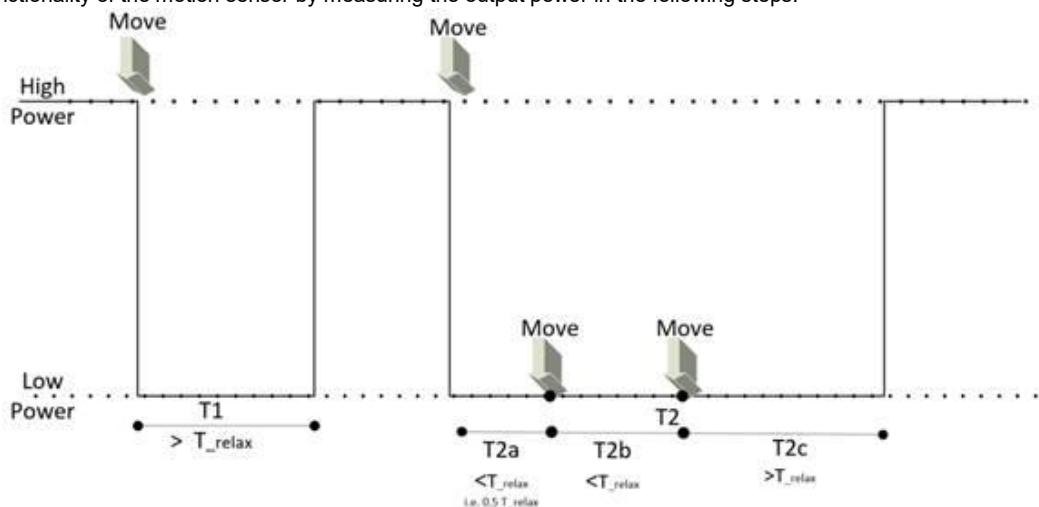
Body worn exposure condition

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	25.67	27.40	25.62	27.40	25.26	27.00
	Ant 0	25.16	26.70	21.41	23.40	20.71	22.70
UMTS Band 2	Ant 2	23.79	25.50	22.08	23.80	21.31	23.10
	Ant 0	24.10	25.50	18.95	20.60	18.22	19.90
LTE Band 7 (FDD)	Ant 2	23.64	25.00	20.18	21.60	19.47	20.90
	Ant 0	23.73	25.00	20.46	22.00	19.78	21.30
LTE Band 25 (FDD)	Ant 2	23.54	25.00	20.34	21.80	19.64	21.10
	Ant 0	23.52	25.00	18.61	20.20	17.89	19.50
LTE Band 41 PC3 (TDD)	Ant 2	23.81	25.10	21.42	22.70	20.72	22.00
	Ant 0	23.87	25.10	22.94	24.10	22.23	23.40
LTE Band 41 PC2 (TDD)	Ant 2	25.72	26.90	23.02	24.20	22.21	23.50
	Ant 0	25.79	26.70	24.56	25.40	23.85	24.70
NR SA n25	Ant 2	23.51	25.00	20.76	22.30	20.08	21.60
	Ant 0	23.56	25.00	18.62	20.20	17.96	19.50

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)
802.11g 6Mbps CH6	(Ant3+4)Ant 3	19.15	21.50	19.21	21.50	17.31	18.00
	(Ant3+4)Ant 4	18.89	21.50	18.81	21.50	16.90	18.00
WiFi 802.11a CH157	(Ant3+4)Ant 3	17.44	19.00	17.41	19.00	15.39	17.00
	(Ant3+4)Ant 4	17.52	19.00	17.58	19.00	15.63	17.00

Body detect and monitor period validation

- Body Detect mechanism will be performed for the in-hand and on a stationary object (placed on a table).
- 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

- Placed on a table:** Make the DUT transmit with the maximum output power by using a base station simulator.
 - 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.
 - Record P_{step1} (high power)
- 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.
 - Record P_{step2} (low power)
- For the validation of T_{relax} , wait a time period $T_1 > T_{relax}$ and confirm DUT restores to high power (P_{step1}).
- Move the DUT to trigger the motion sensor.
- 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 $P_{\text{step1}} \ \& \ T_1 > T_{\text{relax}}$		Low Power $P_{\text{step2}} \ \& \ T_{2a} < T_{\text{relax}}$		Low Power $P_{\text{step2}} \ \& \ T_{2b} < T_{\text{relax}}$		Full Power $P_{\text{step1}} \ \& \ T_{2c} > T_{\text{relax}}$		
		Wireless technology	Antenna	Measured	Max. Tune-up	Measured	Max. Tune-up	Measured	Max. Tune-up	Measured	Max. Tune-up	Measured	Max. Tune-up	
UMTS Band 2		Ant 0	23.68	25.50	20.16	20.60	23.65	25.50	20.15	20.60	20.17	20.60	23.72	25.50

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
WWAN + WiFi 802.11a CH157	Ant 4+3 (4)	17.41	19.00	15.34	17.00	17.42	19.00	15.29	17.00	15.28	17.00	17.39	19.00
	Ant 4+3 (3)	17.43	19.00	15.61	17.00	17.40	19.00	15.53	17.00	15.51	17.00	17.42	19.00