

Appendix G. Supplemental Antenna Tuner Tests Results

General Note:

1. This device implements antenna tuning techniques in the several frequency band and list as below. SAR test proposal was measured according to the normally required SAR configurations with the tuner active and worst tune state (auto tune) was used for SAR testing and this design will provide the highest power at different user scenarios and would not influence to the antenna characteristics other than impedance matching.
2. Dynamic antenna tuning mechanism is available at Ant.0 / 2 for its < 3GHz LTE and NR band. The number of supported tune codes is different for each frequency band as shown in the following table. And it's verified that tune state results in the highest SAR configuration
3. The antenna tuner state shall be controlled remotely such that the DUT position is not moved during the series of single-point SAR measurements.
4. For each air interface, exposure condition, and antenna that supports dynamic antenna tuning (DAT), the following procedure shall be followed:
 - a. An area scan is performed with the DUT positioned for the exposure condition with auto-tuner enabled to determine the peak SAR location
 - b. A single-point SAR measurement (i.e., time sweep) is performed at the peak SAR location of step a (that is, with auto-tuner enabled). The auto-tuner state shall be recorded, after verifying that it is stable. If fluctuations occur, the scan procedure can be restarted, or the state with the highest SAR needs to be recorded
 - c. Without moving the probe, or introducing any other perturbation, the auto-tuner shall be disabled, and two other adjacent tune states shall be chosen by increasing and decreasing the state identification number by 1
 - d. A single point SAR measurement is then performed on both chosen adjacent states and compared with the value of step b. The measured SAR for auto-tuner disabled is expected to be less than or equal to the recorded SAR of step b. If the measured SAR is higher beyond documented tolerance, then the auto-tuning feature is not working as intended and is not suitable for compliance. DAT functionality shall be removed or adjusted by the manufacturer. If the measured SAR is higher than the value of step b but within tolerance, the next adjacent state(s) shall be chosen and the measure repeated until a lower SAR value can be shown; otherwise, the DAT is considered inoperative and shall be removed or adjusted by the manufacturer.
 - e. Repeat step b with auto-tuning enabled as a test for variability within tolerance: the previous measured value in step 2.2 shall be recovered. If the measured SAR is outside the expected tolerance, then the auto-tuning feature is considered not working as intended and not suitable for compliance. DAT functionality shall be removed or adjusted by the manufacturer
 - f. If any single-point SAR measurement result is >1.4 W/kg, then all tune states for that particular combination of air interface, exposure condition, and antenna selection shall be evaluated with single-point SAR measurements.

Antenna	Band	Number of tune states
Ant 0	LTE Band 12/17/ FR1 n12	70
	LTE Band 13	30
	LTE Band 14 / FR1 n14	57
	LTE Band 26/5 / FR1 n26/5	68
	LTE Band 71 / FR1 n71	54
Ant 2	LTE Band 7 / FR1 n7	74
	LTE Band 25/2 / FR1 n25/2	101
	LTE Band 30 / FR1 n30	63
	LTE Band 41 / FR1 n41	75
	LTE Band 66/4 / FR1 n66	96

<Antenna tuner Verification result>

Config TX0	RF exposure position															
	Band	Mode	Channel		Setting	Test Position	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Auto-tuner enable_Initial		Auto-tuner disabled Verify adjacent tuner				Repeat Auto-tuner enable	
									State	Single Point SAR (W/kg)	State	Single Point SAR (W/kg)	State	Single Point SAR (W/kg)	State	Single Point SAR (W/kg)
Ant 2	LTE Band 7	20M QPSK 1 0	21100	2535	Full	Right Cheek	0.651	0.823	39	1.183	38	0.473	40	0.488	39	1.181
Ant 2	LTE Band 7	20M QPSK 1 0	21100	2535	203	Right Edge	0.445	0.528	39	0.757	38	0.211	40	0.201	39	0.755
Ant 0	LTE Band 12	10M QPSK 1 0	23095	707.5	Full	Left Cheek	0.202	0.234	39	0.256	38	0.176	40	0.166	39	0.251
Ant 0	LTE Band 12	10M QPSK 1 0	23095	707.5	Full	Left Edge	0.379	0.439	39	0.517	38	0.222	40	0.211	39	0.511
Ant 0	LTE Band 13	10M QPSK 1 0	23230	782	Full	Left Cheek	0.255	0.311	11	0.750	10	0.744	12	0.698	11	0.749
Ant 0	LTE Band 13	10M QPSK 1 0	23230	782	229	Left Edge	0.411	0.501	11	0.772	10	0.488	12	0.505	11	0.751
Ant 0	LTE Band 14	10M QPSK 1 0	23330	793	Full	Left Cheek	0.264	0.329	29	0.413	28	0.046	1	0.133	29	0.409
Ant 0	LTE Band 14	10M QPSK 1 0	23330	793	228	Left Edge	0.383	0.471	10	0.699	9	0.588	11	0.511	10	0.688
Ant 2	LTE Band 25	20M QPSK 1 0	26340	1880	Full	Right Cheek	0.462	0.629	39	0.886	38	0.684	40	0.612	39	0.816
Ant 2	LTE Band 25	20M QPSK 1 0	26340	1880	204	Right Edge	0.387	0.486	39	0.744	38	0.598	40	0.411	39	0.732
Ant 0	LTE Band 26	15M QPSK 1 0	26865	831.5	Full	Left Cheek	0.342	0.428	38	0.374	37	0.155	39	0.210	38	0.355
Ant 0	LTE Band 26	15M QPSK 1 0	26865	831.5	Full	Back	0.485	0.540	38	0.767	37	0.252	39	0.305	38	0.755
Ant 2	LTE Band 30	10M QPSK 1 0	27710	2310	Full	Right Cheek	0.512	0.658	21	0.872	20	0.847	22	0.810	21	0.856
Ant 2	LTE Band 30	10M QPSK 1 0	27710	2310	196	Right Edge	0.456	0.564	21	0.938	20	0.904	22	0.911	21	0.928
Ant 2	LTE Band 41	20M QPSK 1 0	40620	2593	Full	Right Cheek	0.547	0.717	46	0.938	45	0.920	47	0.903	46	0.921
Ant 2	LTE Band 41	20M QPSK 1 0	40620	2593	220	Right Edge	0.481	0.528	46	1.110	45	0.955	47	0.911	46	1.050
Ant 2	LTE Band 66	20M QPSK 1 0	132322	1745	Full	Right Cheek	0.534	0.691	35	0.755	34	0.685	36	0.655	35	0.744
Ant 2	LTE Band 66	20M QPSK 1 0	132322	1745	218	Right Edge	0.511	0.592	32	0.673	31	0.671	33	0.655	32	0.672
Ant 0	LTE Band 71	20M QPSK 1 0	133297	680.5	Full	Left Cheek	0.240	0.266	20	0.244	19	0.052	21	0.155	20	0.243
Ant 0	LTE Band 71	20M QPSK 1 0	133297	680.5	Full	Left Edge	0.381	0.423	20	0.663	19	0.133	21	0.130	20	0.655
Ant 2	FR1 n7	50M BPSK 135 68	507000	2535	NV 230	Right Cheek	0.650	0.912	39	1.070	38	0.422	40	0.410	39	1.040
Ant 2	FR1 n7	50M BPSK 135 68	507000	2535	215	Right Edge	0.792	0.839	39	1.310	38	0.785	40	1.220	39	1.300
Ant 0	FR1 n12	15M BPSK 36 22	141500	707.5	Full	Left Cheek	0.254	0.305	39	0.246	38	0.211	40	0.059	39	0.240
Ant 0	FR1 n12	15M BPSK 36 22	141500	707.5	Full	Left Edge	0.478	0.512	33	0.681	32	0.617	34	0.570	33	0.655
Ant 0	FR1 n14	10M BPSK 1 1	158600	793	Full	Left Cheek	0.265	0.339	29	0.349	28	0.038	1	0.111	29	0.349
Ant 0	FR1 n14	10M BPSK 1 1	158600	793	230	Left Edge	0.388	0.487	16	0.917	15	0.472	17	0.455	16	0.912
Ant 2	FR1 n25	40M BPSK 1 1	376500	1882.5	Full	Right Cheek	0.458	0.619	39	0.888	38	0.611	40	0.629	39	0.885
Ant 2	FR1 n25	40M BPSK 1 1	376500	1882.5	209	Right Edge	0.421	0.524	39	0.775	38	0.716	40	0.666	39	0.771
Ant 0	FR1 n26	20M BPSK 50 28	166300	831.5	Full	Left Cheek	0.288	0.369	38	0.337	37	0.138	39	0.113	38	0.333
Ant 0	FR1 n26	20M BPSK 1 1	166300	831.5	Full	Left Edge	0.502	0.644	38	0.677	37	0.299	39	0.306	38	0.666
Ant 2	FR1 n30	10M BPSK 25 14	462000	2310	Full	Right Cheek	0.457	0.570	21	0.664	20	0.588	22	0.614	21	0.619
Ant 2	FR1 n30	10M BPSK 25 14	462000	2310	205	Right Edge	0.577	0.697	21	1.050	20	1.010	22	0.831	21	1.030
Ant 2	FR1 n41	100M_BPSK_1_1	518598	2592.99	23	Right Cheek	0.679	0.845	46	1.388	45	1.302	47	0.344	46	1.311
Ant 2	FR1 n41	100M_BPSK_1_1	518598	2592.99	21	Right Edge	0.648	0.774	46	1.300	45	1.250	47	0.333	46	1.220
Ant 2	FR1 n66	40M BPSK 108 54	349000	1745	Full	Right Cheek	0.402	0.531	34	0.620	33	0.588	35	0.577	34	0.614
Ant 2	FR1 n66	40M BPSK 1 1	349000	1745	220	Right Edge	0.542	0.665	32	0.796	31	0.787	33	0.767	32	0.791
Ant 0	FR1 n71	20M BPSK 1 1	136100	680.5	Full	Left Cheek	0.211	0.263	20	0.275	19	0.056	21	0.102	20	0.270
Ant 0	FR1 n71	20M BPSK 1 1	136100	680.5	Full	Left Edge	0.432	0.513	20	0.681	19	0.136	21	0.363	20	0.675

Appendix G. Supplemental SAR Tests Results

SAR test result

1. The test data is selected according to the worst case SAR configuration per cellular technology.
2. The test data is to demonstrate the device is in compliance with FCC requirements at 25mm when all power reduction mechanisms are OFF. The worst case body SAR at 10mm was used for simultaneous transmission SAR analysis since they are more conservative than the 25mm SAR.

Band	Mode	Test Position	Gap (mm)	Antenna	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
GSM1900_Ant 0	GPRS (4 Tx slots)	Bottom Edge	25mm	-	661	1880	25.85	26.70	1.216	-	-	0.02	0.362	0.440
WCDMA II_Ant 0	RMC 12.2Kbps	Bottom Edge	25mm	-	9400	1880	24.36	25.50	1.300	-	-	-0.01	0.617	0.802
LTE Band 25_Ant 0	20M_QPSK_1_0	Bottom Edge	25mm	-	26340	1880	23.76	25.00	1.330	-	-	-0.01	0.573	0.762
FR1 n25_Ant 0	40M_BPSK_1_1	Bottom Edge	25mm	-	376500	1882.5	23.98	25.00	1.265	-	-	0.01	0.561	0.710
WLAN2.4GHz	802.11b 1Mbps	Front	25mm	Ant 4	6	2437	21.39	21.50	1.026	100	1.000	-0.17	0.053	0.054
WLAN5GHz	802.11n-HT40 MCS0	Back	25mm	Ant 4+3(4)	151	5755	18.99	19.00	1.002	98.98	1.010	-0.11	0.039	0.039
WLAN5GHz	802.11n-HT40 MCS0	Back	25mm	Ant 4+3(3)	151	5755	18.52	19.00	1.117	98.98	1.010	-0.11	0.189	0.213
Bluetooth	1Mbps	Left Edge	25mm	Ant 3	39	2441	20.37	21.00	1.156	76.96	1.082	-0.06	0.050	0.063