

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 for its < 1GHz 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	84
	LTE Band 13	68
	LTE Band 14 / FR1 n14	34
	LTE Band 26/5 / FR1 n26/5	82
	LTE Band 71 / FR1 n71	53

<Antenna tuner Verification result>

Config TX0	RF exposure position														
	Band	Mode	Channel		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 0	LTE Band 12	10M QPSK 1 0	23095	707.5	Left Cheek	0.257	0.338	42	0.301	41	0.275	43	0.266	42	0.298
Ant 0	LTE Band 12	10M QPSK 1 0	23095	707.5	Left Edge 5mm	0.372	0.416	37	0.967	36	0.819	38	0.842	37	0.944
Ant 0	LTE Band 13	10M QPSK 1 0	23230	782	Left Cheek	0.264	0.332	40	0.362	39	0.272	41	0.330	40	0.357
Ant 0	LTE Band 13	10M QPSK 1 0	23230	782	Left Edge 5mm	0.412	0.440	37	0.662	36	0.613	38	0.615	37	0.659
Ant 0	LTE Band 14	10M QPSK 1 0	23330	793	Right Cheek	0.271	0.333	7	0.359	6	0.274	8	0.318	7	0.361
Ant 0	LTE Band 14	10M QPSK 1 0	23330	793	Left Edge 5mm	0.441	0.446	4	0.725	3	0.714	5	0.663	4	0.692
Ant 0	LTE Band 26	15M QPSK 1 0	26865	831.5	Left Cheek	0.264	0.335	7	0.437	6	0.308	8	0.317	7	0.435
Ant 0	LTE Band 26	15M QPSK 1 0	26865	831.5	Left Edge 5mm	0.309	0.320	7	0.617	6	0.476	8	0.370	7	0.613
Ant 0	LTE Band 71	20M QPSK 1 0	133297	680.5	Left Cheek	0.245	0.310	20	0.496	19	0.458	21	0.378	20	0.501
Ant 0	LTE Band 71	20M QPSK 1 0	133297	680.5	Back 5mm	0.407	0.480	20	0.725	19	0.613	21	0.355	20	0.726
Ant 0	FR1 n12	15M BPSK 36 22	141500	707.5	Left Cheek	0.207	0.254	42	0.287	41	0.266	43	0.212	42	0.279
Ant 0	FR1 n12	15M BPSK 36 22	141500	707.5	Left Edge 5mm	0.411	0.442	37	0.679	36	0.605	38	0.579	37	0.682
Ant 0	FR1 n14	10M BPSK 1 1	158600	793	Left Cheek	0.269	0.342	7	0.348	6	0.269	8	0.322	7	0.344
Ant 0	FR1 n14	10M BPSK 1 1	158600	793	Left Edge 5mm	0.438	0.448	4	0.751	3	0.692	5	0.644	4	0.736
Ant 0	FR1 n26	20M BPSK 50 28	166300	831.5	Left Cheek	0.284	0.361	7	0.456	6	0.329	8	0.325	7	0.456
Ant 0	FR1 n26	20M BPSK 1 1	166300	831.5	Left Edge 5mm	0.306	0.339	7	0.623	6	0.502	8	0.402	7	0.613
Ant 0	FR1 n71	20M BPSK 1 1	136100	680.5	Left Cheek	0.207	0.250	20	0.266	19	0.228	21	0.196	20	0.263
Ant 0	FR1 n71	20M BPSK 1 1	136100	680.5	Back 5mm	0.394	0.507	20	0.642	19	0.587	21	0.533	20	0.636

**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 5mm was used for simultaneous transmission SAR analysis since they are more conservative than the 25mm SAR.

Band	Mode	Test Position	Gap (mm)	Antenna	Power State	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)
WCDMA IV	RMC 12.2Kbps	Bottom Edge	25mm	Ant 0	Index 1	1513	1752.6	23.94	24.70	1.191	-	-	-0.05	0.346	0.412
LTE Band 12	10M_QPSK_1_0	Back	25mm	Ant 1	Index 1	23095	707.5	23.83	25.30	1.403	-	-	-0.01	0.111	0.156
FR1 n48	40M_BPSK_1_1	Right Edge	25mm	Ant 2	Index 1	645332	3679.98	23.49	24.60	1.291	-	-	0.03	0.475	0.613
FR1 n25	40M_BPSK_108_54	Right Edge	25mm	Ant 5	Index 1	376500	1882.5	23.00	24.70	1.479	-	-	0.06	0.168	0.248
LTE Band 48	20M_QPSK_1_0	Left Edge	25mm	Ant 6	Index 1	56640	3690	23.66	25.10	1.393	62.9	1.006	-0.07	0.092	0.129
WLAN2.4GHz	802.11b 1Mbps	Left Edge	25mm	Ant 3	Index 0	1	2412	22.43	22.50	1.016	100	1.000	0.05	0.173	0.176
WLAN5GHz	802.11ac-VHT80 MCS0	Back	25mm	Ant 4	Index 0	138	5690	18.36	18.50	1.033	97.75	1.023	0.17	0.319	0.337
Bluetooth	1Mbps	Top Edge	25mm	Ant 4	Index 0	0	2402	18.35	21.00	1.841	76.93	1.083	0.16	0.023	0.046