5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

No.	Identity	Document Title
1	FCC 47 CFR Part 2 Subpart J	Frequency allocations and radio treaty matters; general rules and regulations
2	FCC 47 CFR Part 22 Subpart H	Cellular Radiotelephone Service
3	FCC 47 CFR Part 27	Miscellaneous Wireless Communications Services
4	FCC 47 CFR Part 24 Subpart E	PART 24 – PERSONAL COMMUNICATIONS SERVICES Subpart E – Broadband PCS
5	ANSI/TIA-603-E-2016	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
6	KDB 971168 D01	KDB 971168 D01 Power Meas License Digital Systems v03r01

5.2 EFFECTIVE RADIATED POWER

Test Requirement: FCC 47 CFR Part 2.1046(a),
GSM 850 & WCDMA Band V & LTE Band 5: FCC 47 CFR Part 22.913(a),
GSM 1900 & WCDMA Band II & LTE Band 2: FCC 47 CFR Part 24.232(c),
WCDMA Band IV & LTE Band 4: FCC 47 CFR Part 27.50(d)(4),
LTE Band 12 & Band 17: FCC 47 CFR Part 27.50(c)(10)
LTE Band 13: FCC 47 CFR Part 27.50(b)(10)
LTE Band 7: FCC 47 CFR Part 27.50(h)(2)

Test Method: KDB 971168 D01v03r01& ANSI/TIA-603-E-2016

Limit:

FCC 47 CFR Part 22.913(a)
The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.
FCC 47 CFR Part 24.232(c)
Mobile and portable stations are limited to 2 watts EIRP.
FCC 47 CFR Part 27.50(d)(4)
Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP.
FCC 47 CFR Part 27.50(b)(10): Portable stations (hand-held devices) transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP.
FCC 47 CFR Part 27.50(c)(10):
Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.
FCC 47 CFR Part 27.50(h)(2): Mobile and other user stations. Mobile stations are limited to 2.0 watts EIRP. All user stations are limited to 2.0 watts transmitter output power.

Test Procedure:

Test procedure as below:

1) The EUT was powered ON and placed on a 0.8/1.5m high table at a 3 meter semi/fully Anechoic Chamber. The antenna of the transmitter was extended to its maximum length. Modulation mode and the measuring receiver shall be tuned to the frequency of the transmitter under test.
2) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3) The disturbance of the transmitter was maximized on the test receiver display by raising and lowering from 1m to 4m the receive antenna and by rotating through 360° the turntable. After the fundamental emission was maximized, a field strength measurement was made.
4) Steps 1) to 3) were performed with the EUT and the receive antenna in both vertical and horizontal polarization.
5) The transmitter was then removed and replaced with another antenna. The center of the antenna was approximately at the same location as the center of the transmitter.
6) A signal at the disturbance was fed to the substitution antenna by means of a non-radiating cable. With both the substitution and the receive antennas horizontally polarized, the receive antenna was raised and lowered to obtain a maximum reading at the test receiver. The level of the signal generator was adjusted until the measured field strength level in step 3) is obtained for this set of conditions.
7) The output power into the substitution antenna was then measured.
8) Steps 6) and 7) were repeated with both antennas polarized.

9) Calculate power in dBm by the following formula:

ERP(dBm) = Pg(dBm) – cable loss (dB) + antenna gain (dBd)

EIRP(dBm) = Pg(dBm) – cable loss (dB) + antenna gain (dBi)

EIRP=ERP+2.15dB

where:

Pg is the generator output power into the substitution antenna.

10) Test the EUT in the lowest channel, the middle channel the Highest channel
11) The radiation measurements are performed in X, Y, Z axis positioning for EUT operation mode, and found the Y axis positioning which it is worse case.
12) Repeat above procedures until all frequencies measured was complete.

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
30MHz-1GHz	Peak	100kHz	300kHz	Peak
Above 1GHz	Peak	1MHz	3MHz	Peak

Test Setup: Refer to section 4.2.1 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Link mode

Test Results: Pass

Test Data: See table below

Maximum ERP (dBm)					
Channel	**GSM 850 1Tx-slot**	**EDGE 850 1Tx-slot**	**WCDMA Band V RMC 12.2Kbps**	**Limit (dBm)**	**Result**
Lowest	30.04	24.97	19.64	38.45	Pass
Middle	30.09	24.87	19.85	38.45	Pass
Highest	30.11	24.69	19.62	38.45	Pass

Maximum EIRP (dBm)					
Channel	**GSM 1900 1Tx-slot**	**EDGE 1900 1Tx-slot**	**WCDMA Band II RMC 12.2Kbps**	**Limit (dBm)**	**Result**
Lowest	30.95	28.92	23.93	33.01	Pass
Middle	31.03	28.52	23.96	33.01	Pass
Highest	31.05	28.12	23.94	33.01	Pass

Maximum EIRP (dBm)			
Channel	**WCDMA Band IV RMC 12.2Kbps**	**Limit (dBm)**	**Result**
Lowest	23.95	30.00	Pass
Middle	24.47	30.00	Pass
Highest	24.55	30.00	Pass

LTE Band 2 Maximum EIRP (dBm)					
Channel	QPSK; RB:1	16QAM; RB:1	64QAM; RB:1	Limit (dBm)	Result
Channel Bandwidth: 1.4MHz					
Lowest	24.09	23.45	22.36	33.01	Pass
Middle	24.30	23.42	22.19	33.01	Pass
Highest	24.07	23.51	22.21	33.01	Pass
Channel Bandwidth: 3MHz					
Lowest	24.27	23.49	22.38	33.01	Pass
Middle	24.24	23.51	22.17	33.01	Pass
Highest	24.21	23.35	22.24	33.01	Pass
Channel Bandwidth: 5MHz					
Lowest	24.27	23.34	22.39	33.01	Pass
Middle	24.24	23.38	22.24	33.01	Pass
Highest	24.28	23.39	22.30	33.01	Pass
Channel Bandwidth: 10MHz					
Lowest	24.12	23.49	22.29	33.01	Pass
Middle	24.28	23.46	22.26	33.01	Pass
Highest	24.20	23.49	22.29	33.01	Pass
Channel Bandwidth: 15MHz					
Lowest	24.25	23.40	22.36	33.01	Pass
Middle	24.27	23.52	22.20	33.01	Pass
Highest	24.30	23.45	22.35	33.01	Pass
Channel Bandwidth: 20MHz					
Lowest	24.29	23.51	22.45	33.01	Pass
Middle	24.30	23.55	22.31	33.01	Pass
Highest	24.34	23.52	22.38	33.01	Pass

LTE Band 4 Maximum EIRP (dBm)					
Channel	QPSK; RB:1	16QAM; RB:1	64QAM; RB:1	Limit (dBm)	Result
Channel Bandwidth: 1.4MHz					
Lowest	23.76	22.77	22.14	30.00	Pass
Middle	23.68	22.90	21.91	30.00	Pass
Highest	23.61	22.73	21.92	30.00	Pass
Channel Bandwidth: 3MHz					
Lowest	23.61	22.90	22.08	30.00	Pass
Middle	23.77	22.91	21.88	30.00	Pass
Highest	23.56	22.70	21.96	30.00	Pass
Channel Bandwidth: 5MHz					
Lowest	23.78	22.86	22.06	30.00	Pass
Middle	23.75	22.86	22.05	30.00	Pass
Highest	23.62	22.66	22.01	30.00	Pass
Channel Bandwidth: 10MHz					
Lowest	23.76	22.86	21.99	30.00	Pass
Middle	23.75	22.81	21.89	30.00	Pass
Highest	23.62	22.68	21.98	30.00	Pass
Channel Bandwidth: 15MHz					
Lowest	23.62	22.76	22.09	30.00	Pass
Middle	23.73	22.95	22.05	30.00	Pass
Highest	23.55	22.66	21.90	30.00	Pass
Channel Bandwidth: 20MHz					
Lowest	23.78	22.91	22.15	30.00	Pass
Middle	23.79	22.98	22.06	30.00	Pass
Highest	23.69	22.78	22.06	30.00	Pass

LTE Band 5 Maximum ERP (dBm)					
Channel	QPSK; RB:1	16QAM; RB:1	64QAM; RB:1	Limit (dBm)	Result
Channel Bandwidth: 1.4MHz					
Lowest	22.64	21.66	20.70	38.45	Pass
Middle	22.65	21.62	20.57	38.45	Pass
Highest	22.68	21.61	20.62	38.45	Pass
Channel Bandwidth: 3MHz					
Lowest	22.56	21.75	20.72	38.45	Pass
Middle	22.50	21.79	20.53	38.45	Pass
Highest	22.40	21.79	20.69	38.45	Pass
Channel Bandwidth: 5MHz					
Lowest	22.54	21.76	20.63	38.45	Pass
Middle	22.55	21.65	20.55	38.45	Pass
Highest	22.50	21.78	20.71	38.45	Pass
Channel Bandwidth: 10MHz					
Lowest	22.58	21.81	20.77	38.45	Pass
Middle	22.64	21.82	20.62	38.45	Pass
Highest	22.60	21.80	20.77	38.45	Pass

LTE Band 7 Maximum ERIP (dBm)					
Channel	QPSK; RB:1	16QAM; RB:1	64QAM; RB:1	Limit (dBm)	Result
Channel Bandwidth: 5MHz					
Lowest	19.39	18.84	17.81	33.01	Pass
Middle	19.25	18.47	17.81	33.01	Pass
Highest	18.94	18.17	17.73	33.01	Pass
Channel Bandwidth: 10MHz					
Lowest	19.50	18.73	17.91	33.01	Pass
Middle	19.24	18.47	17.79	33.01	Pass
Highest	19.00	18.13	17.66	33.01	Pass
Channel Bandwidth: 15MHz					
Lowest	19.39	18.83	17.80	33.01	Pass
Middle	19.35	18.63	17.83	33.01	Pass
Highest	19.04	18.22	17.64	33.01	Pass
Channel Bandwidth: 20MHz					
Lowest	19.57	18.87	17.94	33.01	Pass
Middle	19.36	18.64	17.88	33.01	Pass
Highest	19.13	18.23	17.82	33.01	Pass

LTE Band 12 Maximum ERP (dBm)					
Channel	**QPSK; RB:1**	**16QAM; RB:1**	**64QAM; RB:1**	**Limit (dBm)**	**Result**
Channel Bandwidth: 1.4MHz					
Lowest	18.92	17.90	17.01	34.77	Pass
Middle	18.97	17.97	16.94	34.77	Pass
Highest	18.73	17.79	16.98	34.77	Pass
Channel Bandwidth: 3MHz					
Lowest	18.73	17.81	16.92	34.77	Pass
Middle	18.74	17.96	16.93	34.77	Pass
Highest	18.65	17.80	16.91	34.77	Pass
Channel Bandwidth: 5MHz					
Lowest	18.76	17.82	16.97	34.77	Pass
Middle	18.81	17.99	16.89	34.77	Pass
Highest	18.79	17.67	16.82	34.77	Pass
Channel Bandwidth: 10MHz					
Lowest	18.84	17.94	17.05	34.77	Pass
Middle	18.84	18.01	16.93	34.77	Pass
Highest	18.83	17.83	17.00	34.77	Pass

LTE Band 13 Maximum ERP (dBm)					
Channel	**QPSK; RB:1**	**16QAM; RB:1**	**64QAM; RB:1**	**Limit (dBm)**	**Result**
Channel Bandwidth: 5MHz					
Lowest/ Middle/ Highest	18.81	17.93	16.86	34.77	Pass
	18.63	17.81	16.90	34.77	Pass
	18.75	17.68	16.96	34.77	Pass
Channel Bandwidth: 10MHz					
Lowest/ Middle/ Highest	18.69	17.81	17.00	34.77	Pass
				34.77	Pass
				34.77	Pass

LTE Band 17 Maximum ERP (dBm)					
Channel	**QPSK; RB:1**	**16QAM; RB:1**	**64QAM; RB:1**	**Limit (dBm)**	**Result**
Channel Bandwidth: 5MHz					
Lowest	18.58	17.63	16.64	34.77	Pass
Middle	18.42	17.64	16.71	34.77	Pass
Highest	18.47	17.48	16.51	34.77	Pass
Channel Bandwidth: 10MHz					
Lowest	18.61	17.70	16.72	34.77	Pass
Middle	18.57	17.68	16.82	34.77	Pass
Highest	18.55	17.60	16.63	34.77	Pass

5.3 CONDUCTED OUTPUT POWER

Test Requirement: FCC 47 CFR Part 2.1046(a)
GSM850 & WCDMA V & LTE Band5: FCC 47 CFR Part 22.913(a)
GSM1900 & WCDMA II & LTE Band 2: FCC 47 CFR Part 24.232(c)
WCDMA Band IV & LTE Band 4: FCC 47 CFR Part 27.50(d)(4)
LTE Band 7: FCC 47 CFR Part 27.50(h)(2)
LTE Band 12 & Band 17: FCC 47 CFR Part 27.50(c)(10)
LTE Band 13: FCC 47 CFR Part 27.50(b)(10)

Test Method: ANSI/TIA-603-E-2016 & KDB 971168 D01v03r01

Limit:

FCC 47 CFR Part 22.913(a)
The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.
FCC 47 CFR Part 24.232(c)
Mobile and portable stations are limited to 2 watts EIRP.
FCC 47 CFR Part 27.50(d)(4)
Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP.
FCC 47 CFR Part 27.50(b)(10): Portable stations (hand-held devices) transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP
FCC 47 CFR Part 27.50(c)(10):
Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.
FCC 47 CFR Part 27.50(h)(2): Mobile and other user stations. Mobile stations are limited to 2.0 watts EIRP. All user stations are limited to 2.0 watts transmitter output power.

Test Procedure:

The EUT was set up for the maximum power with GSM, GPRS, EDGE, WCDMA, and LTE link data modulation and link up with simulator. Set the EUT to transmit under low, middle and high channel and record the power level shown on simulator.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.2.2 for details.
Instruments Used: Refer to section 3 for details
Test Mode: Link mode
Test Results: Pass
Test Data: The full result refer to section 4.5 for details.

5.4 PEAK-TO-AVERAGE RATIO

Test Requirement: GSM 850 & WCDMA Band V & LTE Band 5: FCC 47 CFR Part 22.913(a),
GSM 1900 & WCDMA Band II & LTE Band 2: FCC 47 CFR Part 24.232(c),
WCDMA Band IV & LTE Band 4: FCC 47 CFR Part 27.50(d)(5),
LTE Band 12 & Band 17: FCC 47 CFR Part 27.50(d)(5)
LTE Band 13: FCC 47 CFR Part 27.50(d)(5)
LTE Band 7: FCC 47 CFR Part 27.50(d)(5)

Test Method: ANSI/TIA-603-E-2016 & KDB 971168 D01v03r01

Limit: In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB

Test Procedure:

The transmitter output was connected to a calibrated coaxial cable and coupler, the other end of which was connected to a spectrum analyzer.

a) Set resolution/measurement bandwidth ≥ signal's occupied bandwidth
b) Set the number of counts to a value that stabilizes the measured CCDF curve
c) Record the maximum PAPR level associated with a probability of 0.1 %

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.2.2 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Link mode

Test Results: Pass

Test Data: See table below

Peak-to-average ratio (dB)					
Channel	**GSM 1900 1Tx-slot**	**EDGE 1900 1Tx-slot**	**WCDMA Band II RMC 12.2Kbps**	**Limit (dBm)**	**Result**
Lowest	-1.43	-2.47	2.93	13	Pass
Middle	-1.01	-2.76	3.10	13	Pass
Highest	-1.45	-2.82	2.75	13	Pass

The test plots as follows:

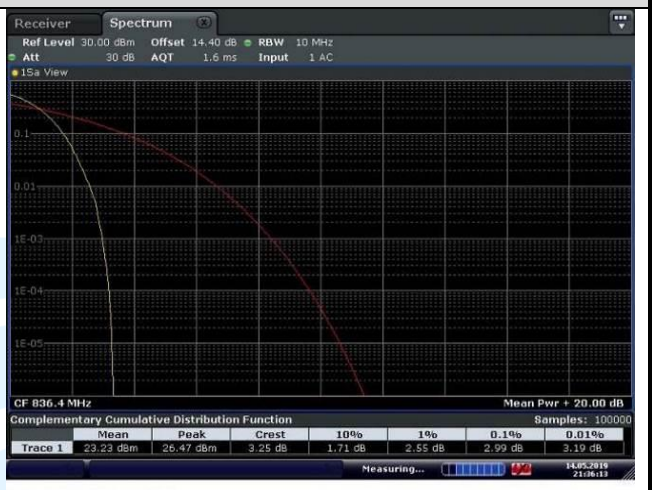
GSM 1Tx-slot	EDGE 1Tx-slot
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

WCDMA RMC 12.2Kbps	
Lowest Channel	**Middle Channel**
	
Highest Channel	
	N/A

Peak-to-average ratio (dB)					
Channel	**GSM 850 1Tx-slot**	**EDGE 850 1Tx-slot**	**WCDMA Band V RMC 12.2Kbps**	**Limit (dBm)**	**Result**
Lowest	-0.26	-2.46	3.07	13	Pass
Middle	-0.26	-2.49	2.99	13	Pass
Highest	-0.29	-2.60	2.90	13	Pass

The test plots as follows:

GSM 1Tx-slot	EDGE 1Tx-slot
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

WCDMA RMC 12.2Kbps	
Lowest Channel	**Middle Channel**
	
Highest Channel	
	N/A

Peak-to-average ratio (dB)			
Channel	WCDMA Band IV RMC 12.2Kbps	Limit (dB)	Result
Lowest	3.22	13	Pass
Middle	2.93	13	Pass
Highest	3.07	13	Pass

The test plots as follows:

WCDMA RMC 12.2Kbps

Lowest Channel

Middle Channel

Highest Channel

N/A

LTE Band 2

Peak-to-average ratio (dB)						
Channel	RB Configuration	Channel Bandwidth: 20 MHz			Limit (dB)	Result
		QPSK	16QAM	64QAM		
Lowest	1 RB	3.97	4.06	4.84	13	Pass
	Full RB	4.58	4.55	5.59	13	Pass
Middle	1 RB	4.26	4.00	4.99	13	Pass
	Full RB	4.72	4.72	5.71	13	Pass
Highest	1 RB	2.70	2.67	3.74	13	Pass
	Full RB	4.46	4.49	5.36	13	Pass

LTE Band 2 / 20MHz / QPSK	
1 RB	Full RB
Lowest Channel	
 Date: 15.MAY.2019 23:22:21	 Date: 15.MAY.2019 23:22:47
Middle Channel	
 Date: 15.MAY.2019 23:24:01	 Date: 15.MAY.2019 23:23:46
Highest Channel	
 Date: 15.MAY.2019 23:24:58	 Date: 15.MAY.2019 23:25:15

LTE Band 2 / 20MHz / 16QAM	
1 RB	Full RB
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

LTE Band 2 / 20MHz / 64QAM	
1 RB	Full RB
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

LTE Band 4

Peak-to-average ratio (dB)						
Channel	RB Configuration	Channel Bandwidth: 20 MHz			Limit (dB)	Result
		QPSK	16QAM	64QAM		
Lowest	1 RB	5.01	5.22	4.72	13	Pass
	Full RB	5.01	5.07	5.71	13	Pass
Middle	1 RB	4.14	4.17	4.38	13	Pass
	Full RB	4.81	4.78	5.83	13	Pass
Highest	1 RB	4.35	4.23	5.19	13	Pass
	Full RB	4.72	4.75	5.65	13	Pass

LTE Band 4 / 20MHz / QPSK	
1 RB	Full RB
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

LTE Band 4 / 20MHz / 16QAM	
1 RB	Full RB
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

LTE Band 4 / 20MHz / 64QAM	
1 RB	Full RB
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

LTE Band 5

Peak-to-average ratio (dB)						
Channel	RB Configuration	Channel Bandwidth: 10 MHz			Limit (dB)	Result
		QPSK	16QAM	64QAM		
Lowest	1 RB	3.91	3.97	4.52	13	Pass
	Full RB	4.87	4.96	5.65	13	Pass
Middle	1 RB	4.06	4.29	4.52	13	Pass
	Full RB	5.01	5.04	5.94	13	Pass
Highest	1 RB	3.97	4.17	4.93	13	Pass
	Full RB	3.39	4.99	5.57	13	Pass