6.9. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS @ FCC 2.1049, 22.217, 24.238 & 90.210

6.9.1. Limits

Emissions outside the permitted band shall be attenuated below the mean output power of the transmitter as follows:

Frequency Range (MHz)	FCC Rules	FCC Applicable Mask
1930-1990 MHz (PCS)	24.238 (a)	• 43+10*log(P) dBc, P is power in watts or –13 dBm,
869-894 MHz (Base Cellular)	22.217(e)	• 43+10*log(P) dBc, P is power in watts or –13 dBm
929-930 MHz 935-940 MHz (Paging-928-941 MHz)	90.210(b),(g),(I) 90.210(j)	• 43+10*log(P) dBc, P is power in watts or –13 dBm • 50+10*log(P) dBc, P is power in watts or –20 dBm
851-866 MHz (Trunking)	90.210(g) &(g)	• 43+10*log(P) dBc, P is power in watts or –13 dBm

6.9.2. Method of Measurements

Refer to Exhibit 8, § 8.2 of this report for measurement details

6.9.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz to 32 GHz with external mixer for frequency above 32 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A	3116A00661	1 GHz to 26.5 GHz
Active Loop Antenna	EMCO	6507	8906-1167	1 kHz – 30 MHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna with Mixer	EMCO	3160-09	1007	18 GHz – 26.5 GHz
Horn Antenna with Mixer	EMCO	3160-10	1001	26.5 GHz – 40 GHz

6.9.4. Test Arrangement

Refer to Photograph # 1 and 2 in Annex 2 for detailed test setup.

Remarks:

The transmitter radiated emissions will be performed on the EUT with a single, un-modulated signal input and output since this represent the worst case of interference based on our prescans and rf conducted emission test data.

6.9.4.1. 1930 –1990 MHz (PCS)

6.9.4.1.1. Lowest Frequency (1930 MHz)

Fundamental Frequency: 1930 MHz
RF Output Power: +20.5 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	ANTENNA LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
3860.00	42.5	-55.0	PEAK	V	-13.0	-42.0	PASS
3860.00	44.3	-53.2	PEAK	H	-13.0	-40.2	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.1.2. Middle Frequency (1960 MHz)

Fundamental Frequency: 1960 MHz
RF Output Power: +20.5 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
3920.00	48.8	-48.7	PEAK	V	-13.0	-35.7	PASS
3920.00	48.8	-48.7	PEAK	H	-13.0	-35.7	PASS
5880.00	39.1	-58.4	PEAK	V	-13.0	-45.4	PASS
5880.00	39.9	-57.6	PEAK	H	-13.0	-44.6	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.1.3. Highest Frequency (1990 MHz)

Fundamental Frequency: 1990 MHz
RF Output Power: +20.5 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
3980.00	46.1	-51.4	PEAK	V	-13.0	-38.4	PASS
3980.00	44.3	-53.2	PEAK	H	-13.0	-40.2	PASS
5970.00	36.8	-60.7	PEAK	V	-13.0	-47.7	PASS
5970.00	38.8	-58.7	PEAK	H	-13.0	-45.7	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.2. 869 – 894 (Base Cellular)

6.9.4.2.1. Lowest Frequency (869 MHz)

Fundamental Frequency: 869 MHz
RF Output Power: +24.8 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1738.00	47.6	-49.9	PEAK	V	-13.0	-36.9	PASS
1738.00	44.6	-52.9	PEAK	H	-13.0	-39.9	PASS
2607.00	32.3	-65.2	PEAK	V	-13.0	-52.2	PASS
2607.00	31.2	-66.3	PEAK	H	-13.0	-53.3	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.2.2. Middle Frequency (881.5 MHz)

Fundamental Frequency: 881.5 MHz
RF Output Power: +24.8 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	ANTENNA LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1763.00	48.7	-48.8	PEAK	V	-13.0	-35.8	PASS
1763.00	50.0	-47.5	PEAK	H	-13.0	-34.5	PASS
2644.50	35.3	-62.2	PEAK	V	-13.0	-49.2	PASS
2644.50	37.1	-60.4	PEAK	H	-13.0	-47.4	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.2.3. Highest Frequency (894 MHz)

Fundamental Frequency: 894 MHz
RF Output Power: +24.8dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	ANTENNA LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1788.00	50.0	-47.5	PEAK	V	-13.0	-34.5	PASS
1788.00	50.9	-46.6	PEAK	H	-13.0	-33.6	PASS
2682.00	33.8	-63.7	PEAK	V	-13.0	-50.7	PASS
2682.00	34.8	-62.7	PEAK	H	-13.0	-49.7	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.3. 928 – 941 MHz (Paging)

6.9.4.3.1. Lowest Frequency (928 MHz)

Fundamental Frequency: 928 MHz
RF Output Power: +23.8 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	ANTENNA LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1856.00	50.0	-47.5	PEAK	V	-20.0	-27.5	PASS
1856.00	50.0	-47.5	PEAK	H	-20.0	-27.5	PASS
2784.00	43.2	-54.3	PEAK	V	-20.0	-34.3	PASS
2784.00	46.1	-51.4	PEAK	H	-20.0	-31.4	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.3.2. Middle Frequency (934.5 MHz)

Fundamental Frequency: 934.5 MHz
RF Output Power: +23.9 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1869.00	48.1	-49.4	PEAK	V	-20.0	-29.4	PASS
1869.00	47.3	-50.2	PEAK	H	-20.0	-30.2	PASS
2803.50	53.4	-44.1	PEAK	V	-20.0	-24.1	PASS
2803.50	43.1	-54.4	PEAK	H	-20.0	-34.4	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.3.3. Highest Frequency (941 MHz)

Fundamental Frequency: 941 MHz
RF Output Power: +23.1 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	ANTENNA LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1882.00	44.8	-52.7	PEAK	V	-20.0	-32.7	PASS
1882.00	46.8	-50.7	PEAK	H	-20.0	-30.7	PASS
2823.00	41.9	-55.6	PEAK	V	-20.0	-35.6	PASS
2823.00	35.1	-62.4	PEAK	H	-20.0	-42.4	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.4. 851 – 866 MHz (Trunking)

6.9.4.4.1. Lowest Frequency (851 MHz)

Fundamental Frequency: 851 MHz
RF Output Power: +25.3 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	ANTENNA LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1702.00	47.1	-50.4	PEAK	V	-13.0	-37.4	PASS
1702.00	49.9	-47.6	PEAK	H	-13.0	-34.6	PASS
2553.00	33.1	-64.4	PEAK	V	-13.0	-51.4	PASS
2553.00	32.6	-64.9	PEAK	H	-13.0	-51.9	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.4.2. Middle Frequency (858.5 MHz)

Fundamental Frequency: 858.5 MHz
RF Output Power: +25.4 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	ANTENNA LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1717.00	51.3	-46.2	PEAK	V	-13.0	-33.2	PASS
1717.00	52.0	-45.5	PEAK	H	-13.0	-32.5	PASS
2575.50	39.4	-58.1	PEAK	V	-13.0	-45.1	PASS
2575.50	39.7	-57.8	PEAK	H	-13.0	-44.8	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

6.9.4.4.3. Highest Frequency (866 MHz)

Fundamental Frequency: 866 MHz
RF Output Power: +24.8 dBm
Modulation: unmodulated

FREQUENCY (MHz)	RF Field Level @3m (dBuV/m)	RF Power Level (dBm)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	ANTENNA LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
1732.00	52.5	-45.0	PEAK	V	-13.0	-32.0	PASS
1732.00	50.9	-46.6	PEAK	H	-13.0	-33.6	PASS
2598.00	35.0	-62.5	PEAK	V	-13.0	-49.5	PASS
2598.00	36.3	-61.2	PEAK	H	-13.0	-48.2	PASS

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 60 dB below the limits were recorded.

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivit	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67$(Bi) 0.3 (Lp) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k=2 is used:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB

EXHIBIT 8. GENERAL MEASUREMENT METHODS

8.1. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the Spectrum Analyzer controls set as RBW = 30 kHz minimum , VBW $\geq$ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC CFR 47, Para. 2.1057 - Frequency spectrum to be investigated:- The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC CFR 47, Para. 2.1051 - Spurious Emissions at Antenna Terminal:- The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

8.2. SPURIOUS EMISSIONS (RADIATED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the Spectrum Analyzer controls set as RBW = 100 kHz minimum , VBW $\geq$ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC CFR 47, Para. 2.1057 - Frequency spectrum to be investigated:- The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC CFR 47, Para. 2.1053 - Field Strength Spurious Emissions

(a) Measurements was made to detect spurious emissions radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data were supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph 2.1049(c) as appropriate. For equipment operating on frequencies below 1 GHz , an Open Field Test is normally required, with the measuring instrument antenna located in the far field at all test frequencies. In event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurement will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections

which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with the reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

(b) Measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emission are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission.

Maximizing RF Emission Level:

(a) The measurements was performed with standard modulation
(b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
(c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
(d) The biconilog Antenna (20 MHz to 1 GHz) or Horn Antenna (1 GHz to 18 GHz) was used for measuring.
(e) The spectrum analyzer was tuned to transmitter carrier frequency. The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
(f) The transmitter was rotated through 360^{o} about a vertical axis until a higher maximum signal was received.
(g) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.

(h) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
(i) The field strength level measured at 3m is converted to the power in dBm by subtracting a constant factor of 97.5 dB

METHOD OF CALCULATION FOR TRANSMITTED POWER (P) FROM THE MEASURED FIELD STRENGTH LEVEL (E):

According to IEC 801-3, the power density can be calculated as follows:

$S = P / (4xPIxD^2)$ Where: S: Power density in watts per square feet
P: Transmitted power in watts
PI: 3.1416
D: Distance in meters

The power density S (W/m^2) and electric field E (V/m) is related by:

$S = E^2/(120xPI)$

Accordingly, the field intensity of isotropic radiator in free space can be expressed as follows:

$E = (30xP)^{1/2}/D = 5.5x(P)^{1/2}/D$

For Halfwave dipole antenna or other antennas correlated to dipole in direction of maximum radiation:

$S = (1.64xP)/(4xPIxD^2)$
$E = (49.2xP)^{1/2}xD = 7.01x(P)^{1/2}/D$

$$P = (ExD/7.01)^2$$

Calculation of transmitted power P (dBM) given a measured field intensity E (dBuV/m):

$P(W) = [E(V/m)xD/7.01]^2$
$P(mW) = P(W)x1000$
=> $P(dBm) = 10logP(mW)$
$= 20logE(V/m) + 20log(D) - 20log(7.01) + 10log1000$
$= E(dBV/m) + 20logD + 13$
$= E(dBuV/m) - 120 + 20log(D) + 13$
$= E(dBuV/m) + 20log(D) - 107$

The Transmitted Power @ D = 3 Meters

P(dBm) = E(dBuV/m) - 97.5