11. Spurious Emissions at Antenna Terminals (AWS)

11.1 Test Specification

FCC Part 27, Subpart C, Section 27.53 (g)

11.2 Test procedure

The power of any emission outside of the authorized bandwidth must be attenuated below the transmitting power (P) by a factor of at least

43 + log (P) dB, yielding –13dBm.

The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (max total Loss= 33.0 dB).

The resolution bandwidth was set to 1.0 kHz for the frequency range 9 kHz – 1 MHz, 100 kHz for the frequency range 1 MHz to 1 GHz, and 1 MHz in the frequency range 1 – 22 GHz.

The E.U.T was evaluated in 3 modulations: 64QAM, GSM, WCDMA and at the low, mid and high channels of each modulation.

11.3 Results

See additional information in *Figure 91* to *Figure 99.*

JUDGEMENT: Passed

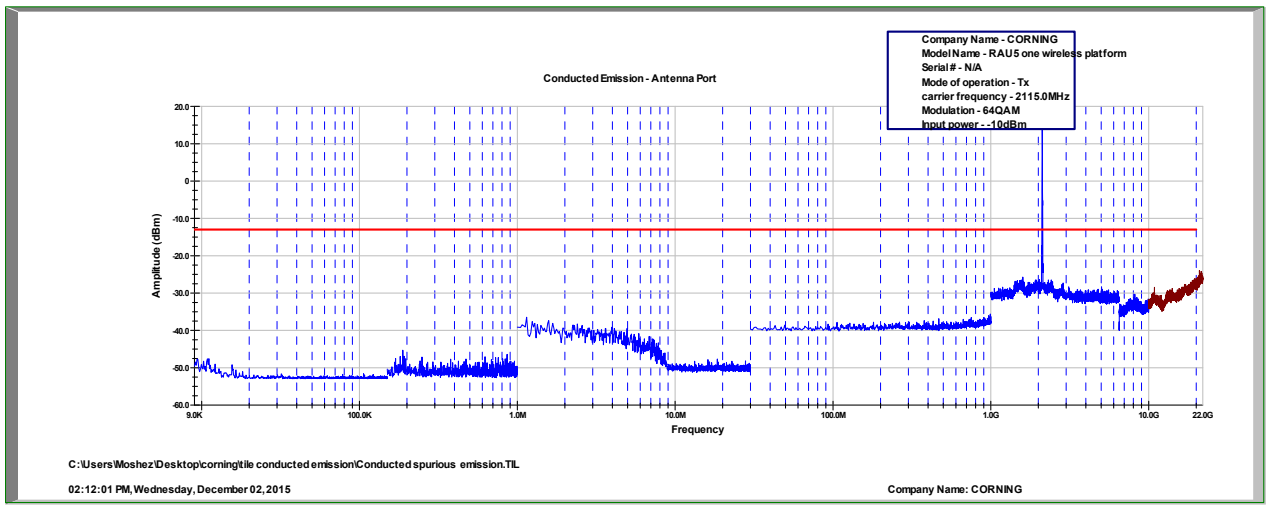

Figure 91 Spurious Emissions at Antenna Terminals 64QAM, 2115.0MHz

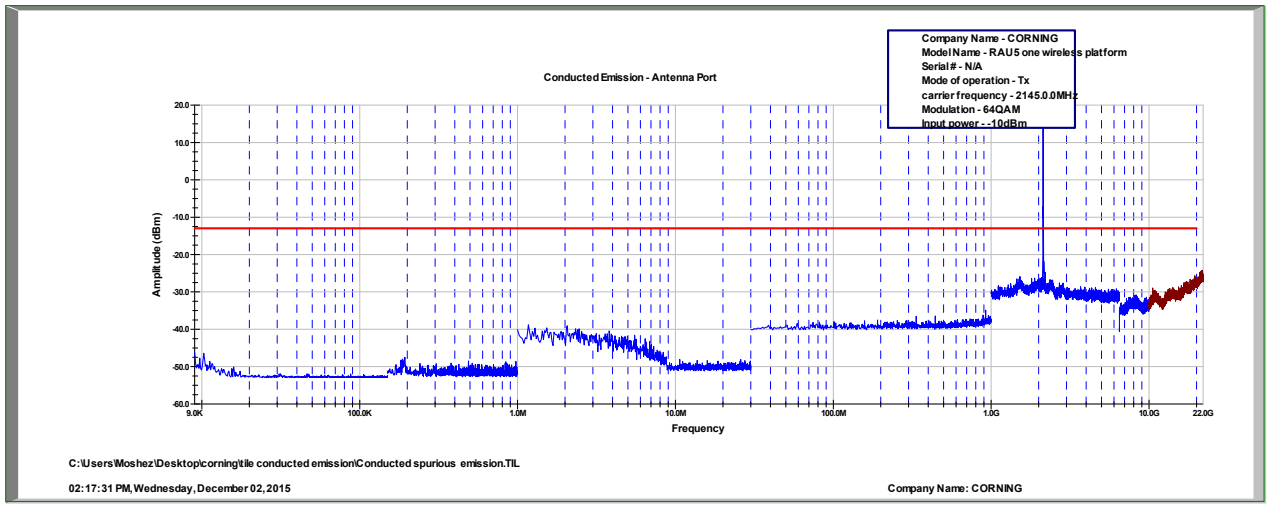

Figure 92 Spurious Emissions at Antenna Terminals 64QAM, 2145.0MHz

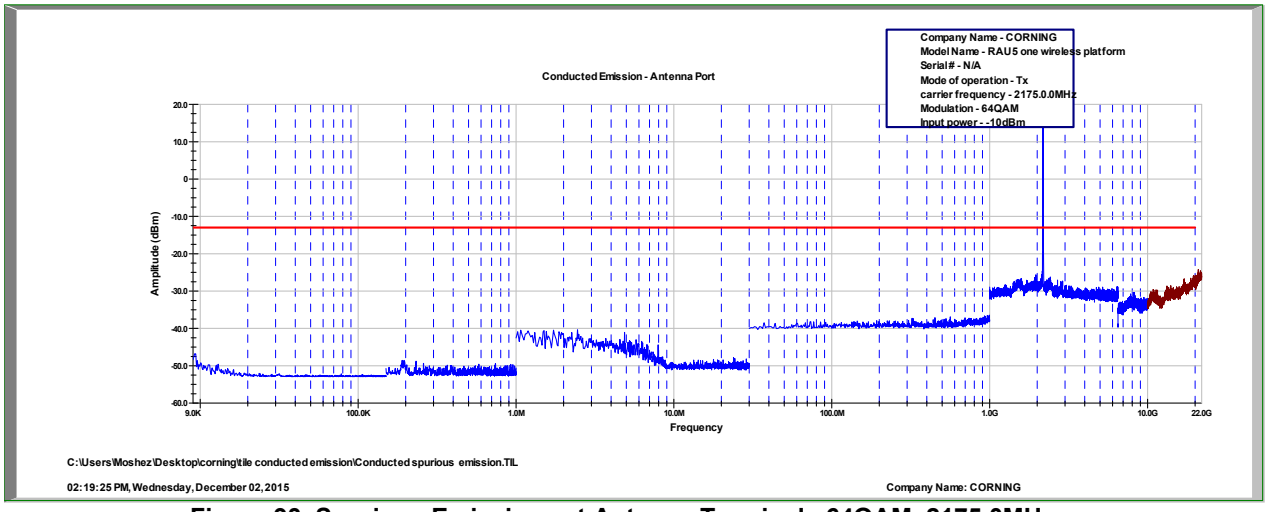

Figure 93 Spurious Emissions at Antenna Terminals 64QAM, 2175.0MHz

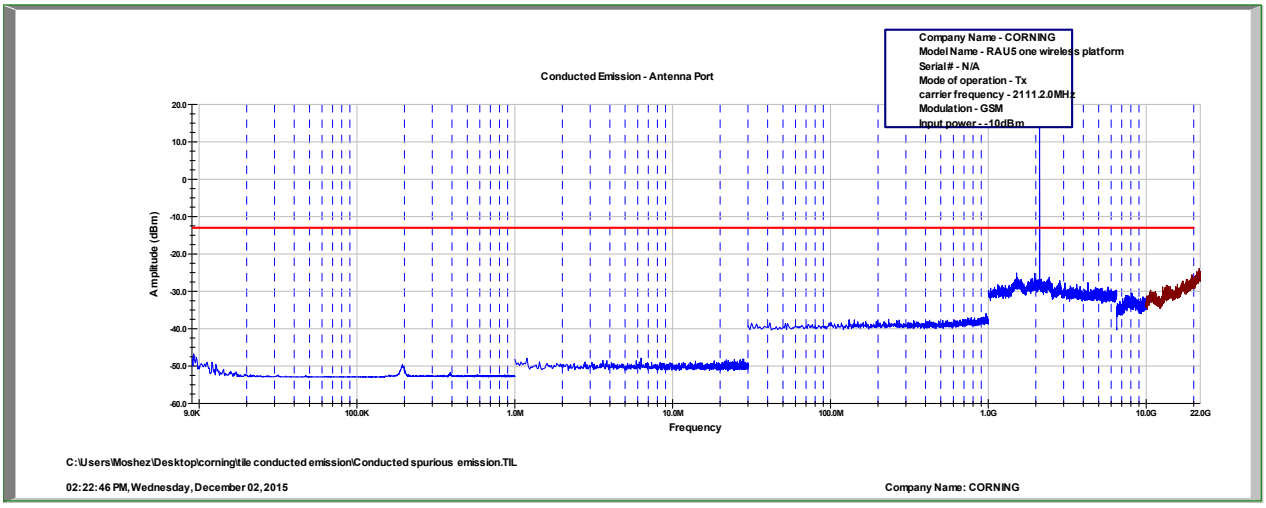

Figure 94 Spurious Emissions at Antenna Terminals GSM, 2111.2MHz

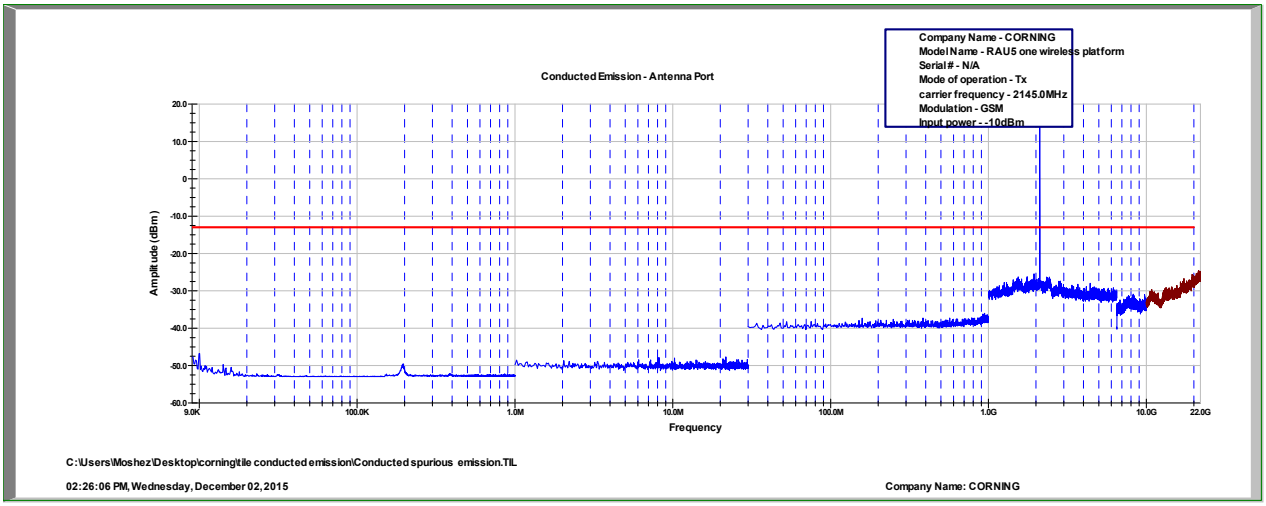

Figure 95 Spurious Emissions at Antenna Terminals GSM, 2145.0MHz

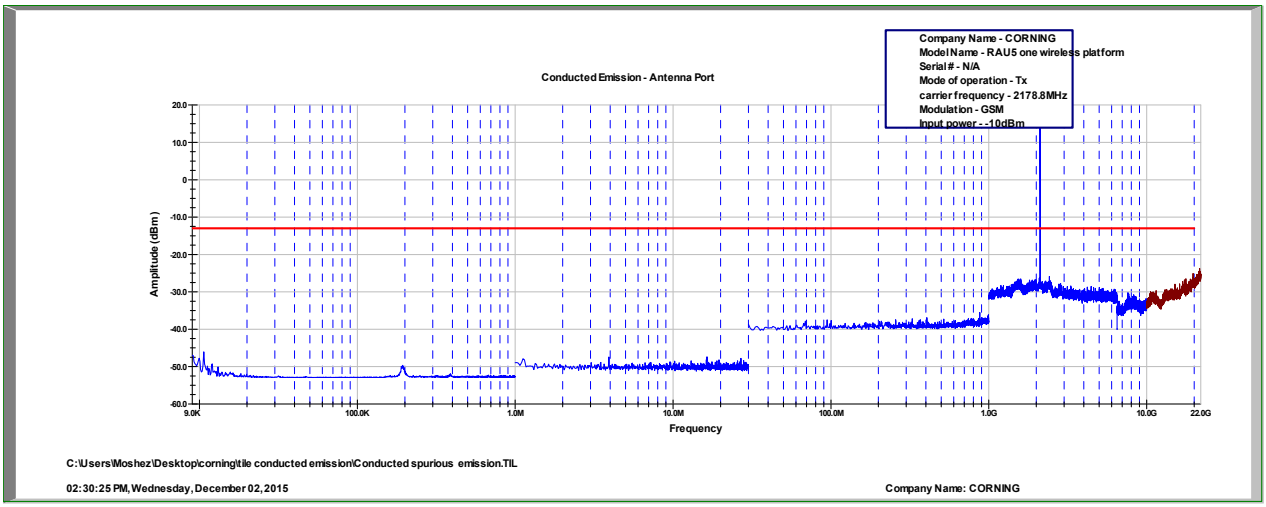

Figure 96 Spurious Emissions at Antenna Terminals GSM, 2178.8MHz

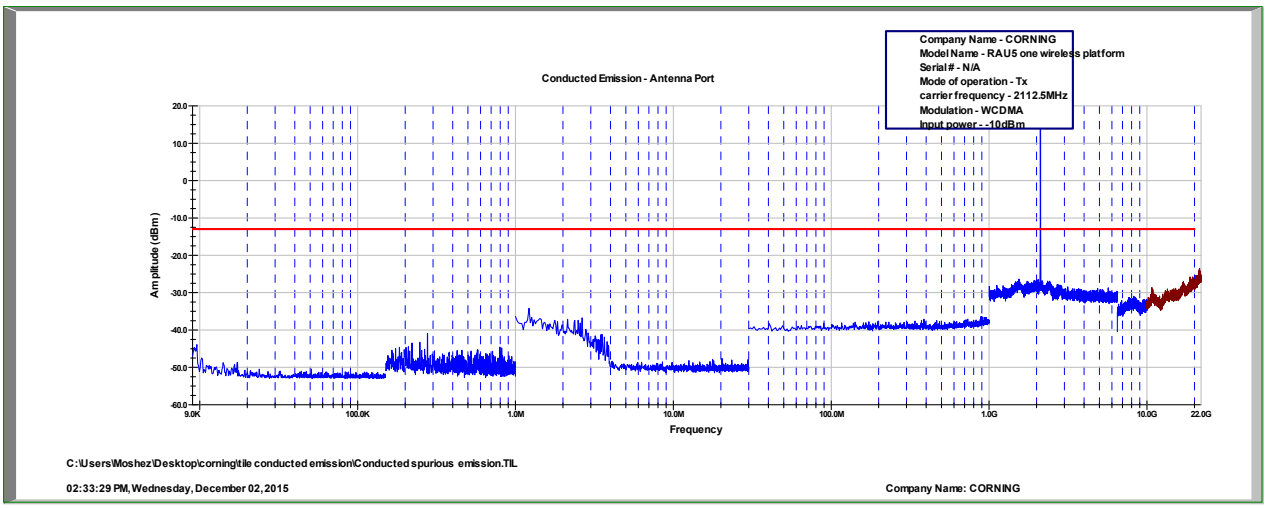

Figure 97 Spurious Emissions at Antenna Terminals WCDMA, 2112.5MHz

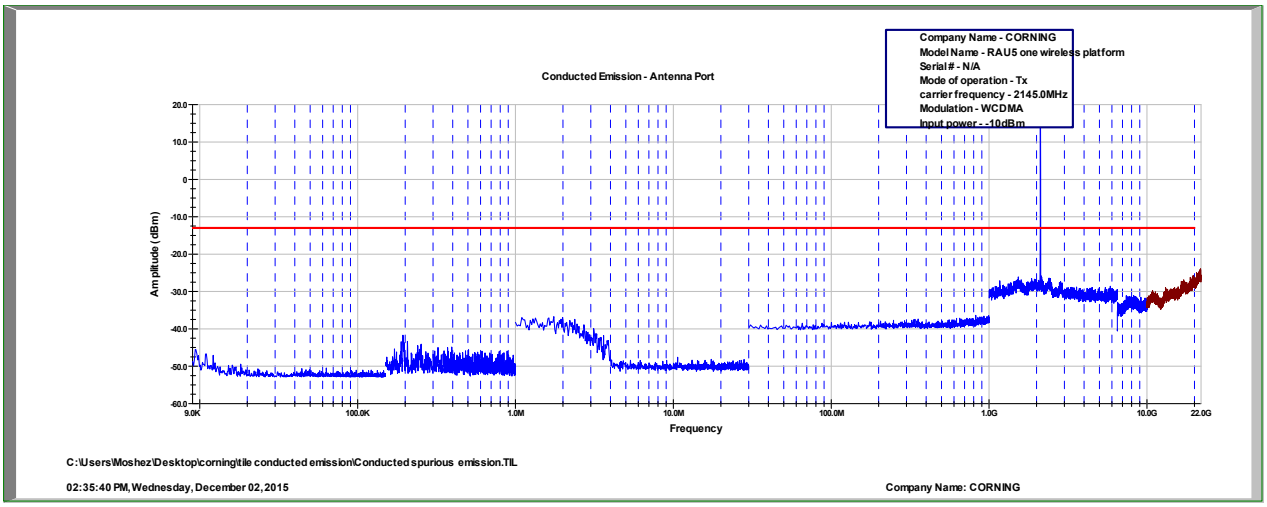

Figure 98 Spurious Emissions at Antenna Terminals WCDMA, 2145.0MHz

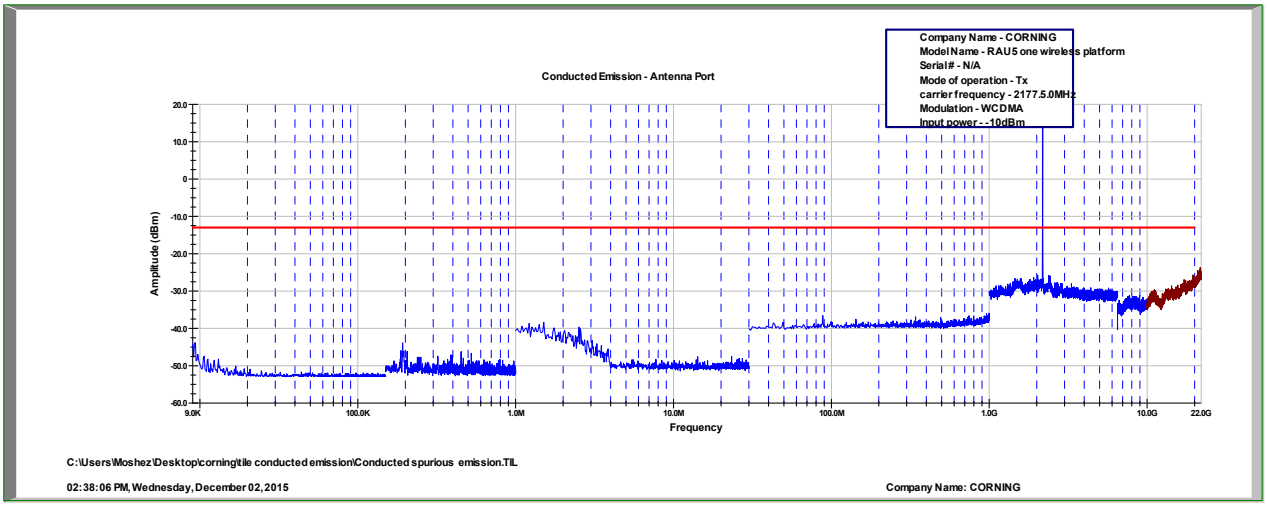

Figure 99 Spurious Emissions at Antenna Terminals WCDMA, 2177.5MHz

11.4 Test Equipment Used; Spurious Emissions at Antenna Terminals AWS

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration	Period
Spectrum Analyzer	HP	8592L	3826A01204	March 4, 2015	1 year
Vector Signal Generator	Agilent	N5182A	MY48180244	July 16, 2015	1 year
30 dB Attenuator	Weinschel Engineering	49-30-34	PD426	January 14, 2015	1 year

Figure 100 Test Equipment Used

12. Band Edge Spectrum AWS

12.1 Test Specification

FCC Part 27, Subpart C, Section 27.53 (m 4-6)

12.2 Test Procedure

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + log (P) dB, yielding –13dBm.
The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (30.5 dB).
RBW was set to 100 kHz.

The E.U.T was evaluated in 3 modulations: 64QAM, GSM, WCDMA and at the low and high channels of each modulation.

12.3 Test Results

Modulation	Operation Frequency (MHz)	Band Edge Frequency (MHz)	Reading (dBm)	Specification (dBm)	Margin (dB)
LTE 64QAM	2115.0	2110.0	-24.5	-13.0	-11.5
LTE 64QAM	2175.0	2180.0	-26.1	-13.0	-13.1
GSM	2111.2	2110.0	-40.1	-13.0	-27.1
GSM	2178.8	2180.0	-39.1	-13.0	-26.1
W-CDMA	2112.5	2110.0	-24.7	-13.0	-11.7
W-CDMA	2177.5	2180.0	-24.2	-13.0	-11.2

Figure 101 Band Edge Spectrum Results AWS

See additional information in *Figure 102* to *Figure 107.*

JUDGEMENT: Passed by 11.2 dB

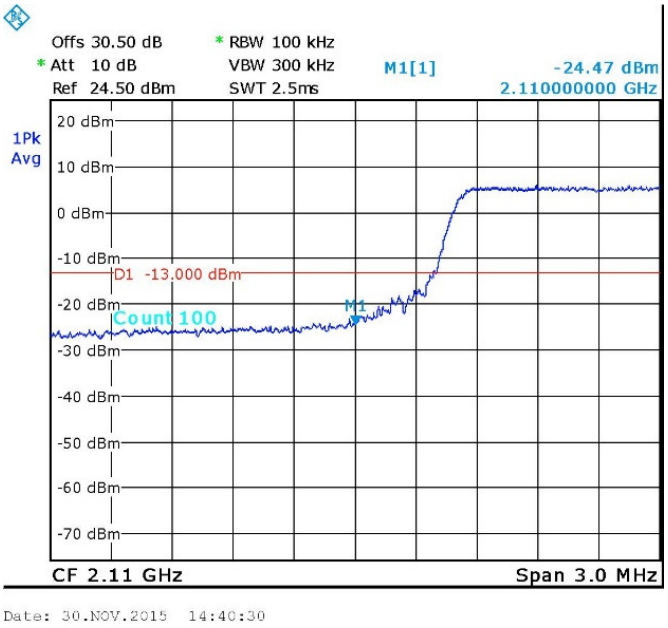

Figure 102. — LTE 64QAM 2115.0 MHz

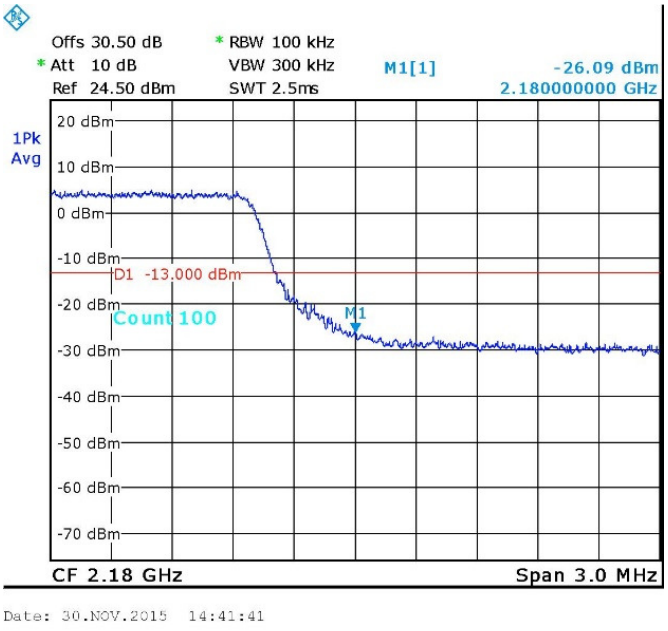

Figure 103. — LTE 64QAM 2175.0 MHz

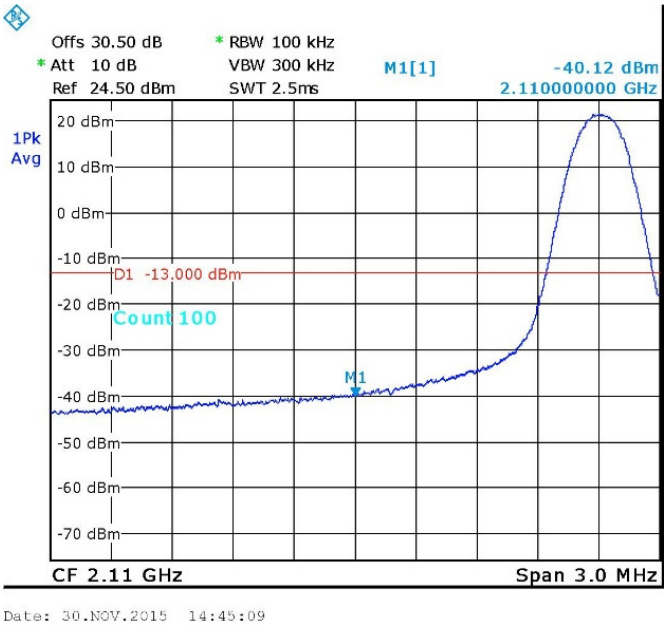

Figure 104. — GSM 2111.2 MHz

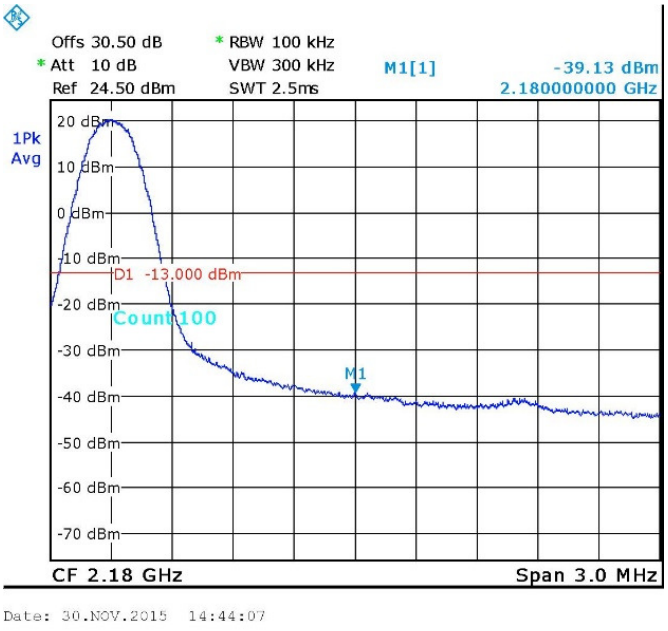

Figure 105. — GSM 2178.8 MHz

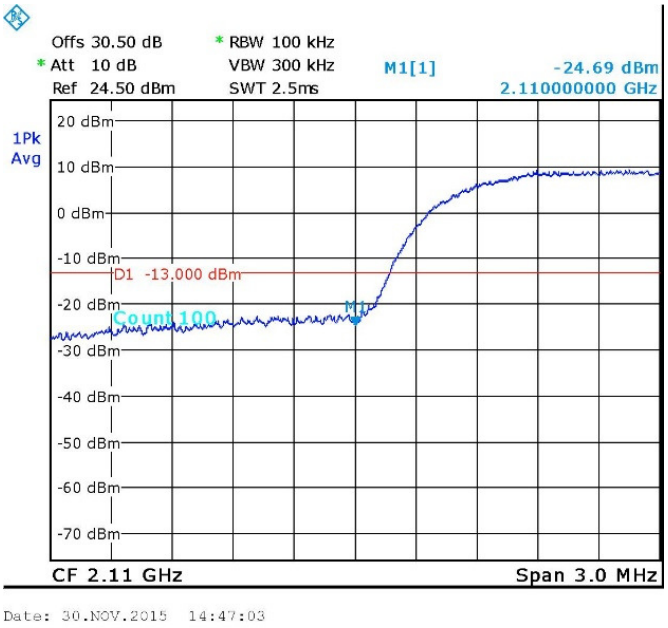

Figure 106. — WCDMA 2112.5 MHz

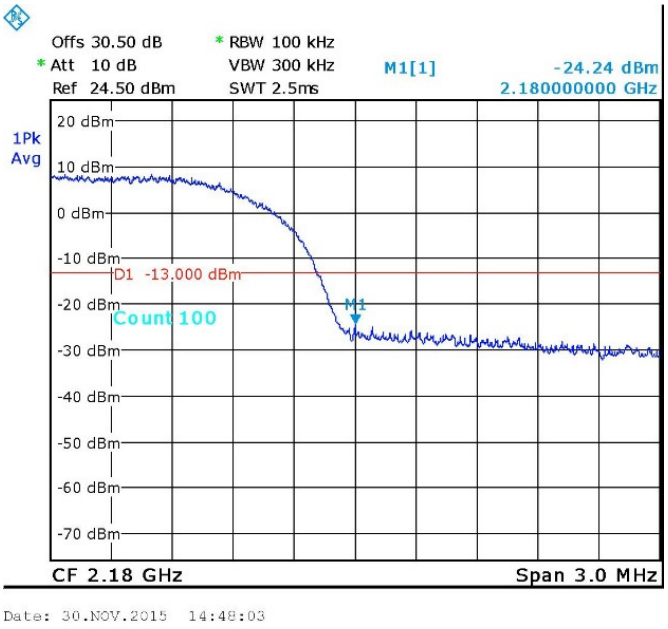

Figure 107. — WCDMA 2177.5 MHz

12.4 Test Equipment Used; Band Edge Spectrum AWS

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Calibration	Period
Spectrum Analyzer	R&S	FSL6	100194	January 1, 2015	1 year
Vector Signal Generator	Agilent	N5182A	MY48180244	July 16, 2015	1 year
30 dB Attenuator	Weinschel Engineering	49-30-34	PD426	January 14, 2015	1 year

Figure 108 Test Equipment Used

13. Spurious Radiated Emission (AWS)

13.1 Test Specification

FCC, Part 27, Subpart C Section 27.53 (g)

13.2 Test Procedure

The test method was based on ANSI/TIA-603-C: 2004, Section 2.2.12 Unwanted Emissions: Radiated Spurious.
The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB, yielding –13dBm.
The E.U.T. operation mode and test set-up are as described in Section 3 of this report.

For measurements between 0.009MHz-30MHz:

The E.U.T was tested inside the shielded room at a distance of 3 meters and the E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The frequency range 0.009MHz-30MHz was scanned. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

For measurements between 30MHz-1GHz:
A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.0 meters above the ground. The frequency range 30MHz -1GHz was scanned and the list of the highest emissions was verified and updated accordingly.
The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

For measurements between 1GHz-22GHz:

The E.U.T was evaluated inside the shielded room at a distance of 3 meters and the E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The frequency range 1GHz -22G was scanned and the readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

(a) The E.U.T. was replaced by a substitution antenna driven by a signal generator. The height was readjusted for maximum reading. The signal generator level was adjusted to obtain the same reading on the EMI receiver as in step (a).
The signals observed in step (a) were converted to radiated power using:

$P_d(dBm) = P_g(dBm) – Cable\ Loss\ (dB) + Substitution\ Antenna\ Gain\ (dB)$

P_d = Dipole equivalent power (result).
P_g = Signal generator output level.

13.3 Test Results

Carrier Channel (MHz)	Freq. (MHz)	Antenna Pol. (V/H)	Maximum Peak Level (dBµV/m)	Signal Generator RF Output (dBm)	Cable Loss (dB)	Antenna Gain (dBi)	EIRP (dBm)	Spec. (dBm)	Margin (dB)
2111.2	4222.4	V	37.4	-61.7	0.5	9.5	-52.7	-13.0	-39.7
2111.2	1150.0	H	36.5	-63.1	0.5	6.0	-57.6	-13.0	-44.6
2145.0	4290.0	V	38.1	-61.0	0.5	9.5	-52.0	-13.0	-39.0
2145.0	1150.0	H	36.5	-63.1	0.5	6.0	-57.6	-13.0	-44.6
2178.8	4356.0	V	37.1	-62.0	0.5	9.5	-53.0	-13.0	-40.0
2178.8	1150.0	H	36.7	-62.9	0.5	6.0	-57.4	-13.0	-44.4

Figure 109 Spurious Radiated Emission AWS

JUDGEMENT: Passed by 39.0 dB

The E.U.T met the requirements of the FCC, Part 27, Subpart C, Section 27.53 (g) specifications.

13.4 Test Instrumentation Used, Radiated Measurements AWS

Instrument	Manufacturer	Model	Serial Number	Calibration	Period
EMC Analyzer	HP	8593EM	3536A00120ADI	February 24, 2015	1 year
EMI Receiver	HP	8542E	3906A00276	March 11, 2015	1 year
RF Filter Section	HP	85420E	3705A00248	March 19, 2015	1 year
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	N/A	N/A
Active Loop Antenna	EMCO	6502	9506-2950	November 4, 2015	1 year
Biconical Antenna	EMCO	3104	2606	December 28, 2014	1 year
Log Periodic Antenna	EMCO	3146	9505-4081	December 28, 2014	1 year
Horn Antenna	ETS	3115	29845	May 19, 2015	3 years
Horn Antenna	ARA	SWH-28	1007	March 3, 2014	2 years
Vector Signal Generator	Agilent	N5182A	MY48180244	July 16, 2015	1 year
Low Noise Amplifier	Sophia Wireless	LNA 28-B	232	March 1, 2015	1 year
Low Noise Amplifier	DBS MICROWAVE	LNA-DBS-0411N313	013	March 1, 2015	1 year
Antenna Mast	ETS	2070-2	-	N/A	N/A
Turntable	ETS	2087	-	N/A	N/A
Mast & Table Controller	ETS/EMCO	2090	9608-1456	N/A	N/A

Figure 110 Test Equipment Used

14. Intermodulation Conducted

14.1 Test Procedure

The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator and an appropriate coaxial cable (max total loss = 33.0dB). The spectrum analyzer was set to 1 kHz resolution BW for the frequency range 9.0-150.0 kHz, 10 kHz for the frequency range 150 kHz–1.0 MHz, 100 kHz for the frequency range 1.0 MHz –1 GHz and 1MHz for the frequency range 1 GHz - 22.0 GHz.

5 input signals were sent simultaneously to the E.U.T. as follows:

LTE: 747.0 MHz CW 0dBm

ESMR: 865.5 MHz CW 0dBm

CELL: 881.0 MHz CW 0dBm

PCS: 1960.0 MHz CW 0dBm

AWS: 2145.0 MHz CW 0dBm

The frequency range of 9 kHz – 22.0 GHz was scanned for unwanted signals.

14.2 Test Results

See additional information in Figure 111.

JUDGEMENT: Passed

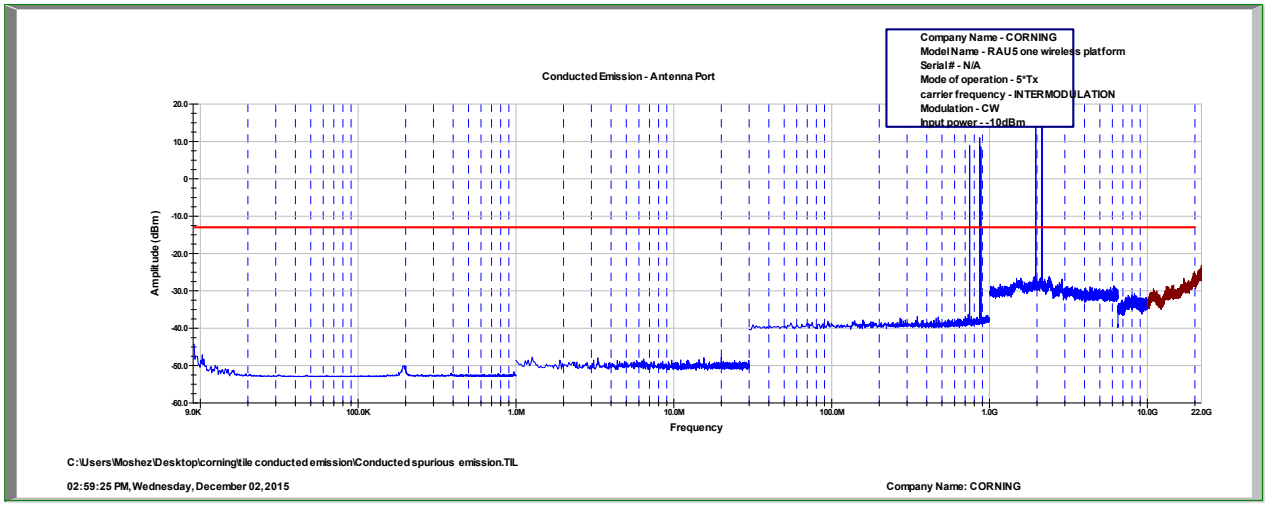

Figure 111 Conducted Spurious Intermodulation

14.3 Test Equipment Used; Intermodulation Conducted

Instrument	Manufacturer	Model	Serial Number	Calibration	Period
Spectrum Analyzer	HP	8592L	3826A01204	March 4, 2015	1 year
Signal Generator	HP	E4432B	GB40050998	April 20, 2015	2 years
Signal Generator	HP	E4421B	US40051102	March 13, 2014	2 years
Vector Signal Generator	Agilent	N5182A	MY48180244	July 16, 2015	1 year
Vector Signal Generator	Agilent	N5172B	MY51350584	May 7, 2013	3 years
Signal Generator	Agilent	E4436B	US39260774	January 7, 2015	2 years
Splitter	Mini-circuits	15542	ZB8PD-2	January 10, 2015	2 years
30 dB Attenuator	Weinschel Engineering	49-30-34	PD426	January 14, 2015	1 year

Figure 112 Test Equipment Used

15. Intermodulation Radiated

15.1 Test Procedure

The test method was based on ANSI/TIA-603-C: 2004, Section 2.2.12 Unwanted Emissions: Radiated Spurious.
The power of any emission outside of the all 5 authorized operating frequencies ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB, yielding –13dBm.

(b) The E.U.T. operation mode and test set-up are as described in Section 3 of this report.

For measurements between 0.009MHz-30MHz:

The E.U.T was tested inside the shielded room at a distance of 3 meters and the E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The frequency range 0.009MHz-30MHz was scanned. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

For measurements between 30MHz-1GHz:
A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and loop/broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.0 meters above the ground. The frequency range 30MHz -1GHz was scanned and the list of the highest emissions was verified and updated accordingly.
The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

For measurements between 1GHz-22GHz:

The E.U.T was evaluated inside the shielded room at a distance of 3 meters and The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The frequency range 1GHz -22G was scanned and the readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

(c) The E.U.T. was replaced by a substitution antenna driven by a signal generator. The height was readjusted for maximum reading. The signal generator level was adjusted to obtain the same reading on the EMI receiver as in step (a).
The signals observed in step (a) were converted to radiated power using:
P_d(dBm) = P_g(dBm) – Cable Loss (dB) + Substitution Antenna Gain (dB)
P_d = Dipole equivalent power (result).
P_g = Signal generator output level.

5 input signals were sent simultaneously to the E.U.T. as follows:

LTE: 747.0 MHz CW 0dBm

ESMR: 865.5 MHz CW 0dBm

CELL: 881.0 MHz CW 0dBm

PCS: 1960.0 MHz CW 0dBm

AWS: 2145.0 MHz CW 0dBm

15.2 Test Results

JUDGEMENT: Passed

Freq.	Antenna Pol.	Maximum Peak Level	Signal Generator RF Output	Cable Loss	Antenna Gain	EIRP	Spec.	Margin
(MHz)	(V/H)	(dBµV/m)	(dBm)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
1015.0	V	30.9	-59.6	0.5	6.0	-54.1	-13.0	-41.1
1015.0	H	30.7	-59.6	0.5	6.0	-54.1	-13.0	-41.1
1841.0	V	31.5	-68.7	0.5	7.0	-62.2	-13.0	-49.2
1841.0	H	34.1	-66.0	0.5	7.0	-59.5	-13.0	-46.5
2078.0	V	33.7	-66.7	0.5	7.0	-60.2	-13.0	-47.2
2078.0	H	33.3	-67.4	0.5	7.0	-60.9	-13.0	-47.9
2279.0	V	34.7	-65.7	0.5	7.0	-59.2	-13.0	-46.2
2279.0	H	32.5	-67.0	0.5	7.0	-60.5	-13.0	-47.5
2330.0	V	32.8	-67.7	0.5	7.0	-61.2	-13.0	-48.2
2330.0	H	33.5	-66.0	0.5	7.0	-59.5	-13.0	-46.5
3156.0	V	34.6	-69.9	0.5	10.0	-60.4	-13.0	-47.4
3156.0	H	39.6	-64.5	0.5	10.0	-55.0	-13.0	-42.0
3409.0	V	41.5	-63.4	0.5	10.0	-53.9	-13.0	-40.9
3409.0	H	40.8	-63.7	0.5	10.0	-54.2	-13.0	-41.2
3543.0	V	41.0	-63.0	0.5	10.0	-53.5	-13.0	-40.5
3543.0	H	41.5	-63.9	0.5	10.0	-54.4	-13.0	-41.1
6020.0	V	41.1	-59.5	1.0	9.7	-50.8	-13.0	-37.8
6020.0	H	41.7	-59.4	1.0	9.7	-50.7	-13.0	-37.7
6709.0	V	45.3	-58.3	1.0	10.0	-49.3	-13.0	-36.3
6709.0	H	46.8	-57.1	1.0	10.0	-48.1	-13.0	-35.1

Figure 113 3rd order Intermodulation Radiated Results

15.3 Test Instrumentation Used; Radiated Measurements Intermodulation

Instrument	Manufacturer	Model	Serial Number	Calibration	Period
EMC Analyzer	HP	8593EM	3536A00120ADI	February 24, 2015	1 year
EMI Receiver	HP	8542E	3906A00276	March 11, 2015	1 year
RF Filter Section	HP	85420E	3705A00248	March 19, 2015	1 year
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	N/A	N/A
Active Loop Antenna	EMCO	6502	9506-2950	November 4, 2015	1 year
Biconical Antenna	EMCO	3104	2606	December 28, 2014	1 year
Log Periodic Antenna	EMCO	3146	9505-4081	December 28, 2014	1 year
Horn Antenna	ETS	3115	29845	May 19, 2015	3 years
Horn Antenna	ARA	SWH-28	1007	March 3, 2014	2 years
Signal Generator	HP	E4432B	GB40050998	April 20, 2015	2 years
Signal Generator	HP	E4421B	US40051102	March 13,2014	2 years
Vector Signal Generator	Agilent	N5182A	MY48180244	July 16, 2015	1 year
Vector Signal Generator	Agilent	N5172B	MY51350584	May 7, 2013	3 years
Signal Generator	Agilent	E4436B	US39260774	January 7, 2015	2 years
Splitter	Mini-circuits	15542	ZB8PD-2	January 10, 2015	2 years
30dB Attenuator	Weinschel Engineering	49-30-34	PD426	January 14, 2015	1 year
Low Noise Amplifier	Sophia Wireless	LNA 28-B	232	March 1, 2015	1 year
Low Noise Amplifier	DBS MICROWAVE	LNA-DBS-0411N313	013	March 1, 2015	1 year
Antenna Mast	ETS	2070-2	-	N/A	N/A
Turntable	ETS	2087	-	N/A	N/A
Mast & Table Controller	ETS/EMCO	2090	9608-1456	N/A	N/A

Figure 114 Test Equipment Used

16. APPENDIX A - CORRECTION FACTORS

16.1 Correction factors for CABLE

from EMI receiver to test antenna at 3 meter range.

FREQUENCY (MHz)	CORRECTION FACTOR (dB)
10.0	0.3
20.0	0.6
30.0	0.8
40.0	0.9
50.0	1.1
60.0	1.2
70.0	1.3
80.0	1.4
90.0	1.6
100.0	1.7
150.0	2.0
200.0	2.3
250.0	2.7
300.0	3.1
350.0	3.4
400.0	3.7
450.0	4.0
500.0	4.3
600.0	4.7
700.0	5.3
800.0	5.9
900.0	6.3
1000.0	6.7

FREQUENCY (MHz)	CORRECTION FACTOR (dB)
1200.0	7.3
1400.0	7.8
1600.0	8.4
1800.0	9.1
2000.0	9.9
2300.0	11.2
2600.0	12.2
2900.0	13.0

NOTES:

1. The cable type is RG-214.

2. The overall length of the cable is 27 meters.

3. The above data is located in file 27MO3MO.CBL on the disk marked "Radiated Emission Tests EMI Receiver".

16.2 Correction factors for Bilog ANTENNA

Model: 3142
Antenna serial number: 1250
3 meter range

FREQUENCY (MHz)	AFE (dB/m)	FREQUENCY (MHz)	AFE (dB/m)
30	18.4	1100	25
40	13.7	1200	24.9
50	9.9	1300	26
60	8.1	1400	26.1
70	7.4	1500	27.1
80	7.2	1600	27.2
90	7.5	1700	28.3
100	8.5	1800	28.1
120	7.8	1900	28.5
140	8.5	2000	28.9
160	10.8		
180	10.4		
200	10.5		
250	12.7		
300	14.3		
400	17		
500	18.6		
600	19.6		
700	21.1		
800	21.4		
900	23.5		
1000	24.3		

16.3 Correction factors for Horn ANTENNA

Model: 3115
Antenna serial number:29845
10 meter range

FREQUENCY (MHz)	AFE (dB/m)	FREQUENCY (MHz)	AFE (dB/m)
1000	22.4	10000	36.1
2000	25.2	11000	37.0
3000	31.1	12000	41.3
4000	30.2	13000	38.1
5000	34.2	14000	41.7
6000	31.6	15000	39.0
7000	34.7	16000	38.8
8000	34.8	17000	43.2
9000	36.2	18000	43.7

16.4 Correction factors for Horn ANTENNA

Model: SWH-28
Antenna serial number: 1007
1 meter range

FREQUENCY (GHz)	AFE (dB /m)	Gain (dB1)
18.0	40.3	16.1
19.0	40.3	16.3
20.0	40.3	16.1
21.0	40.3	16.3
22.0	40.4	16.8
23.0	40.5	16.4
24.0	40.5	16.6
25.0	40.5	16.7
26.0	40.6	16.4

16.5 Correction factors forACTIVE LOOP ANTENNA

Model 6502
S/N 9506-2950

FREQUENCY	Magnetic Antenna Factor	Electric Antenna Factor
(MHz)	(dB)	(dB)
.009	-35.1	16.4
.010	-35.7	15.8
.020	-38.5	13.0
.050	-39.6	11.9
.075	-39.8	11.8
.100	-40.0	11.6
.150	-40.0	11.5
.250	-40.0	11.6
.500	-40.0	11.5
.750	-40.1	11.5
1.000	-39.9	11.7
2.000	-39.5	12.0
3.000	-39.4	12.1
4.000	-39.7	11.9
5.000	-39.7	11.8
10.000	40.2	11.3
15.000	-40.7	10.8
20.000	-40.5	11.0
25.000	-41.3	10.2
30.000	42.3	9.2