7. Band Edge Spectrum (CELL)

7.1 Test Specification

FCC Part 22 section 917(a), FCC Part 2.1051

7.2 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 at the low and high channels of each modulation:
LTE 64QAM, GSM, WCDMA.

7.3 Test Results

Modulation	Operation Frequency (MHz)	Band Edge Frequency (MHz)	Reading (dBm)	Specification (dBm)	Margin (dB)
LTE 64QAM	874.0	869.0	-39.5	-13.0	-26.5
	889.0	894.0	-34.0	-13.0	-21.0
GSM	870.2	869.0	-48.4	-13.0	-35.4
	892.8	894.0	-47.9	-13.0	-34.9
WCDMA	871.5	869.0	-44.4	-13.0	-31.4
	891.5	894.0	-43.2	-13.0	-30.2

Figure 49 Band Edge Spectrum Results CELL

See additional information in *Figure 50* to *Figure 55.*

JUDGEMENT: Passed by 21.0 dB

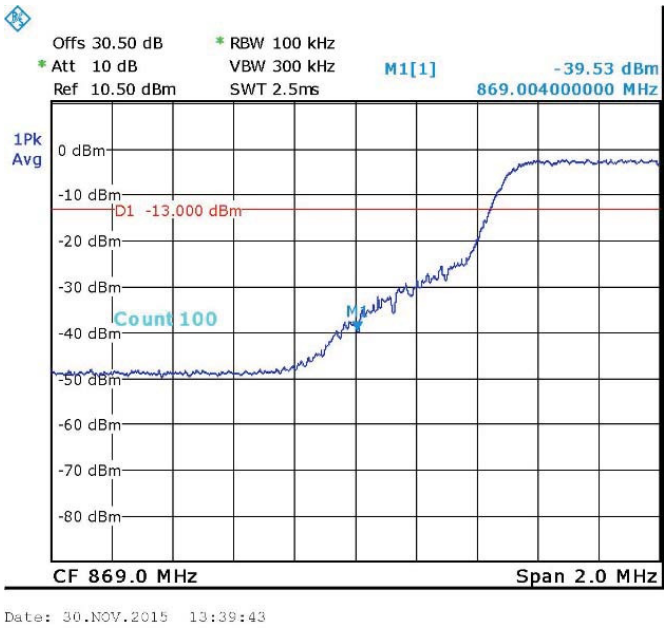


Figure 50. LTE 64QAM - 874.0 MHz

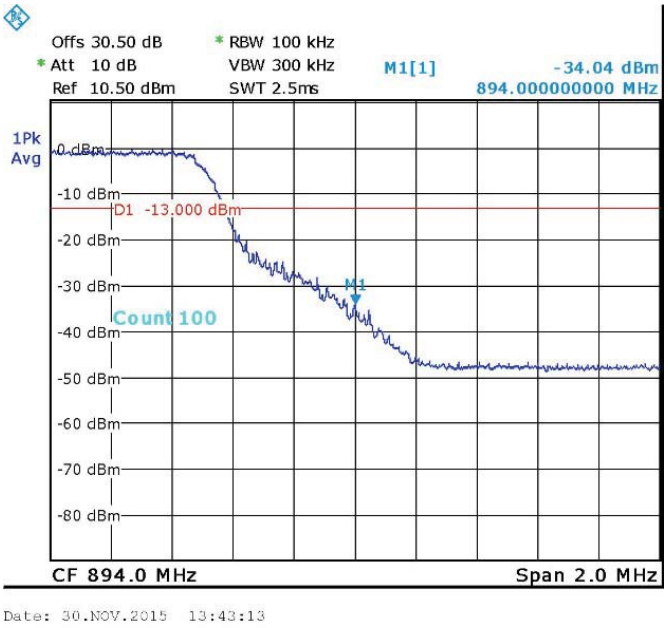
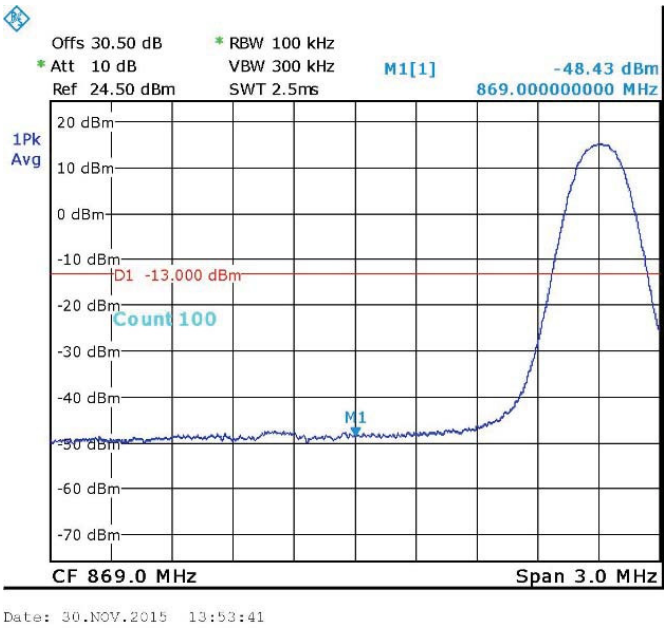
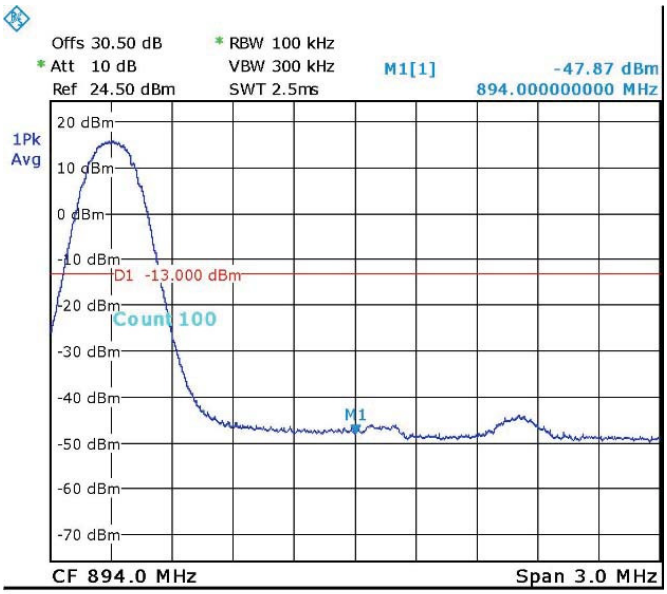


Figure 51. LTE 64QAM - 889.0 MHz



Date: 30.NOV.2015 13:53:41

Figure 52. GSM - 870.2 MHz



Date: 30.NOV.2015 13:56:10

Figure 53. GSM - 892.8 MHz

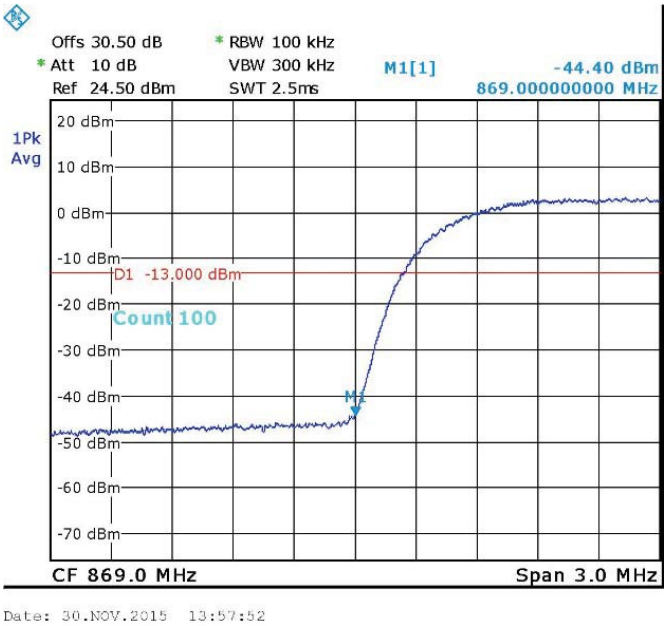


Figure 54. WCDMA - 871.5 MHz

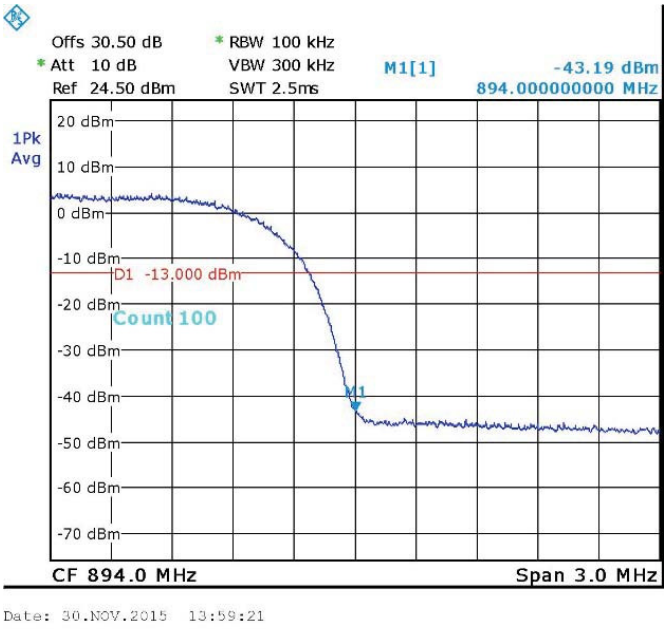


Figure 55. WCDMA - 891.5 MHz

7.4 Test Equipment Used; Band Edge Spectrum CELL

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 56 Test Equipment Used

8. Out of Band Emissions (Radiated) (CELL)

8.1 Test Specification

FCC Part 22, Section 917(a); FCC Part 2.1053

8.2 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.

(a) The E.U.T. operation mode and test set-up are as described in Section 2 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 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 1GHz -22GHz 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.

(b) 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.

8.3 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)
870.2	1432.1	V	39.8	-59.6	0.5	6.0	-54.1	-13.0	-41.1
870.2	1150.0	H	38.5	-61.1	0.5	6.0	-55.6	-13.0	-42.6
881.0	1432.1	V	41.7	-57.6	0.5	6.0	-52.1	-13.0	-39.1
881.0	1150.0	H	40.5	-59.6	0.5	6.0	-54.1	-13.0	-41.1
892.8	1432.1	V	41.6	-57.7	0.5	6.0	-52.2	-13.0	-39.2
892.8	1150.0	H	40.5	-59.6	0.5	6.0	-54.1	-13.0	-41.1

Figure 57 Out of Band Radiated (CELL) Test Results Table

The E.U.T met the requirements of the FCC Part 22, Section 917; FCC Part 2.1053 specifications.

JUDGEMENT; Passed by 39.1 dB

8.4 Test Instrumentation Used, Radiated Measurements CELL

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 58 Test Equipment Used

9. Peak Output Power (ESMR)

9.1 Test Specification

FCC Rule Part 20.21

9.2 Test Procedure

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through a 30 dB external attenuator and an appropriate coaxial cable (Loss = 30.5 dB). RBW was set to 1%-5% from the OBW. Special attention was taken to prevent Spectrum Analyzer RF input overload.
The E.U.T was evaluated at the low, mid and high channels (874.0, 8881.0 and 889.0) of the 3 modulations: LTE 64QAM, GSM, WCDMA.

9.3 Test Results

Modulation	Operation Frequency (MHz)	Reading (dBm)
LTE 64QAM	864.5	16.8
	866.5	16.5
GSM	863.2	16.6
	867.8	15.6
WCDMA	864.5	16.7
	866.5	16.6

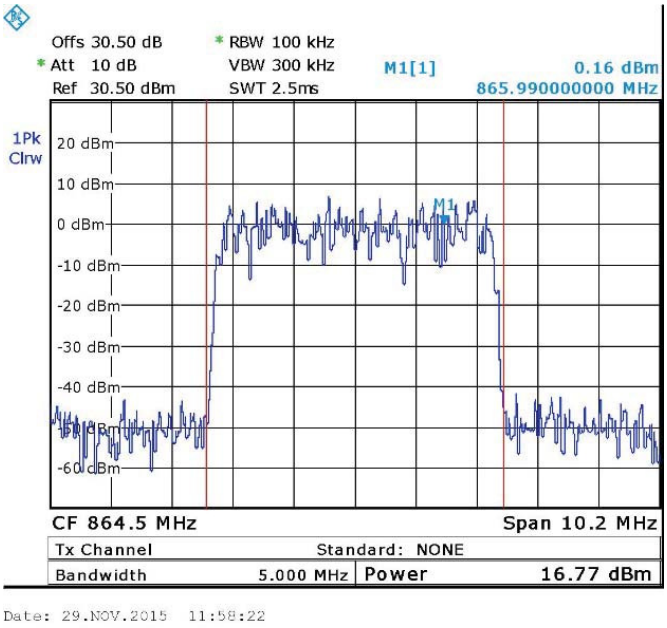
Figure 59 Peak Output Power Test Results Table

See additional information in *Figure 60* to *Figure 65.*

JUDGEMENT: Passed

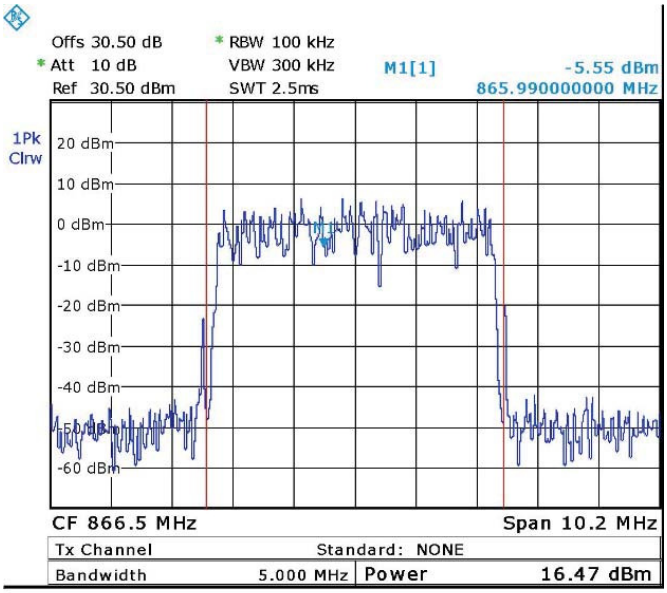
Peak Output Power (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated



Date: 29.NOV.2015 11:58:22

Figure 60. LTE 64QAM - 864.5 MHz



Date: 29.NOV.2015 12:00:12

Figure 61. LTE 64QAM - 866.5 MHz

Peak Output Power (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

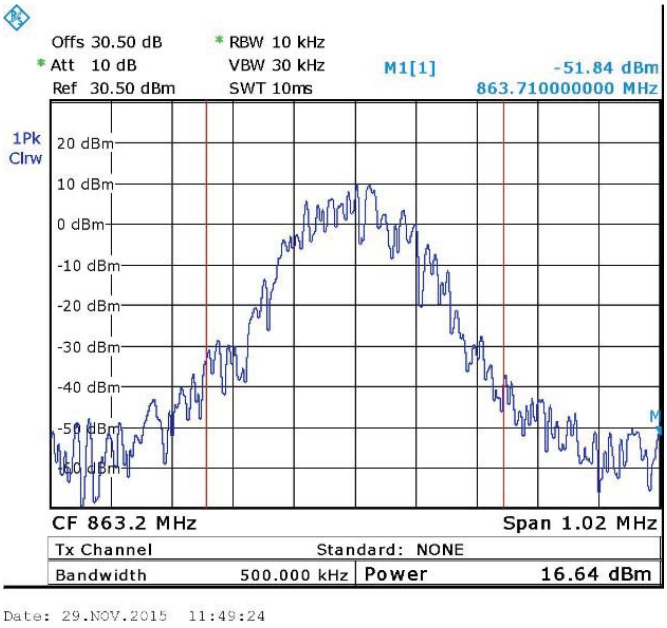


Figure 62. GSM - 863.2 MHz

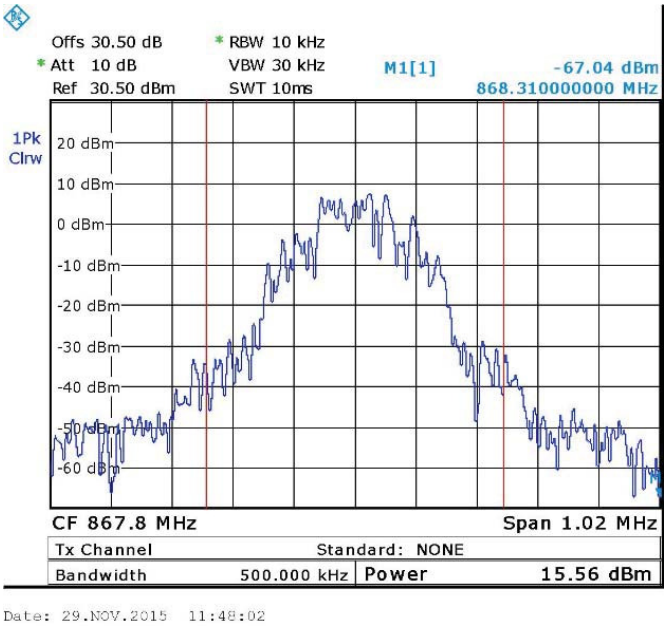


Figure 63. GSM - 867.8 MHz

Peak Output Power (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

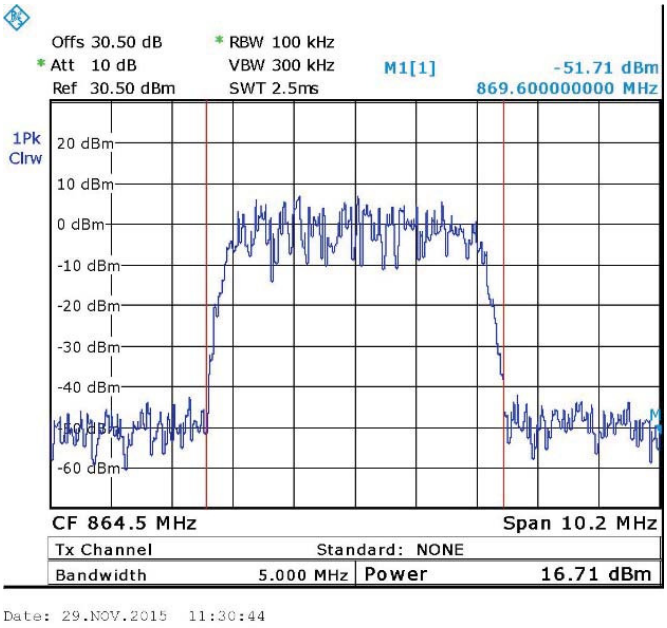


Figure 64. WCDMA - 864.5 MHz

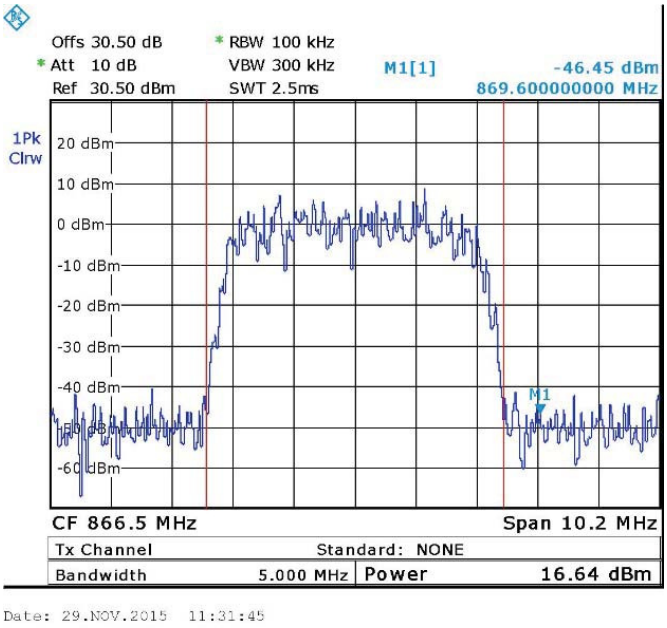


Figure 65. WCDMA - 866.5 MHz

9.4 Test Equipment Used; Peak Power (ESMR)

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 66 Test Equipment Used Peak Output Power (ESMR)

10. Occupied Bandwidth (ESMR)

10.1 Test Specification

FCC Parts 2.1049; 90.209

10.2 Test Procedure

The E.U.T. was set to the applicable test frequency with modulation. The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator (at the output port test) and an appropriate coaxial cable. RBW was set to 1%-5% from OBW.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limit, the mean powers radiated are each equal to 0.5% of the total mean power radiated by a given emission.

The function 99% power bandwidth was used for this evaluation.

Occupied bandwidth measured was repeated in the input terminal of the E.U.T. The E.U.T was evaluated at the low, mid and high channels of the 3 modulations: LTE 64QAM, GSM and WCDMA.

10.3 Test Results

Modulation	port	Operating Frequency	Reading (MHz)
LTE 64QAM	Input	864.5	4.53
LTE 64QAM	Output	864.5	4.53
LTE 64QAM	Input	866.5	4.55
LTE 64QAM	Output	866.5	4.53
GSM	Input	863.2	0.24
GSM	Output	863.2	0.24
GSM	Input	867.8	0.24
GSM	Output	867.8	0.24
WCDMA	Input	864.5	4.19
WCDMA	Output	864.5	4.17
WCDMA	Input	866.5	4.17
WCDMA	Output	866.5	4.15

Figure 67 Occupied Bandwidth Test Results Table (ESMR)

See additional information in *Figure 68* to *Figure 75*.

JUDGEMENT: Passed

Occupied Bandwidth (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

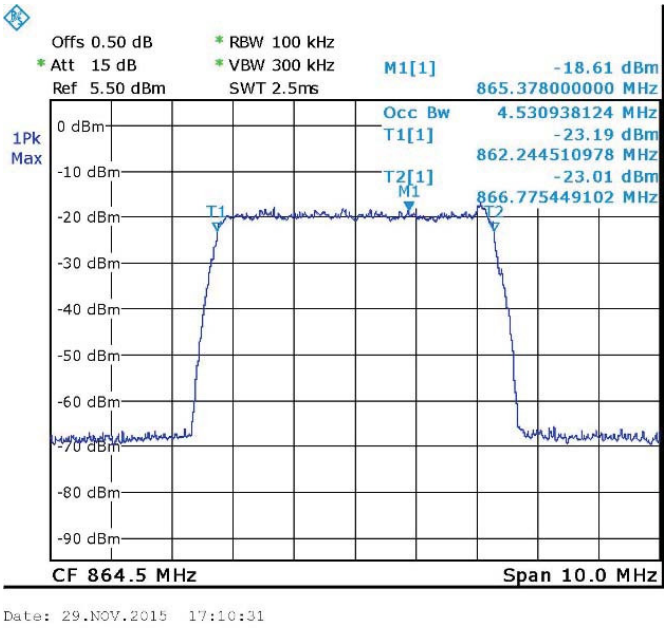


Figure 68. LTE 64QAM - 864.5MHz Input

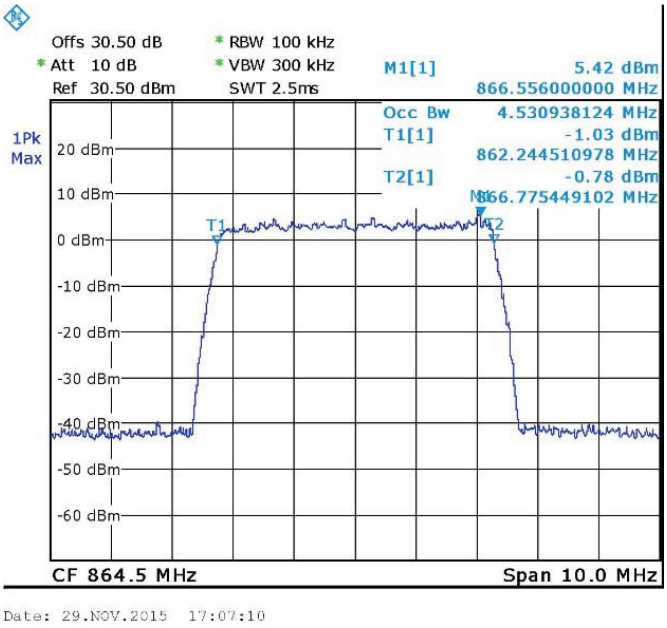


Figure 69. LTE 64QAM - 864.5MHz Output

Occupied Bandwidth (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

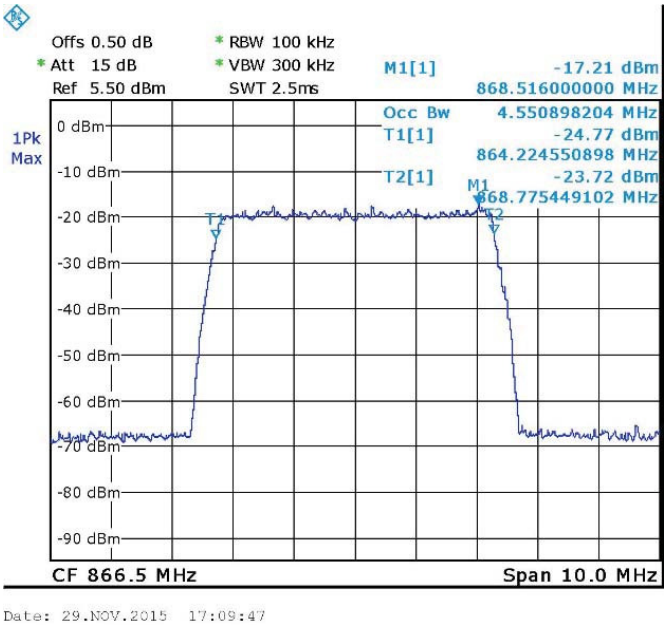


Figure 70. LTE 64QAM - 866.5MHz Input

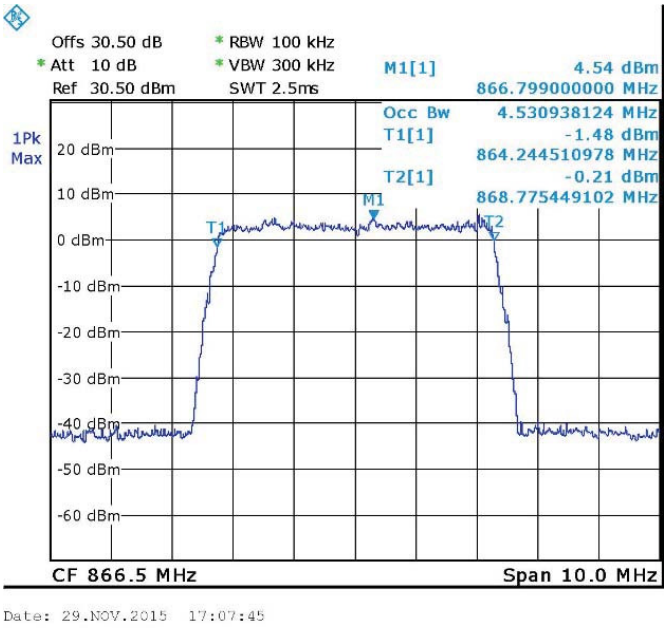


Figure 71. LTE 64QAM - 866.5MHz Output

Occupied Bandwidth (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

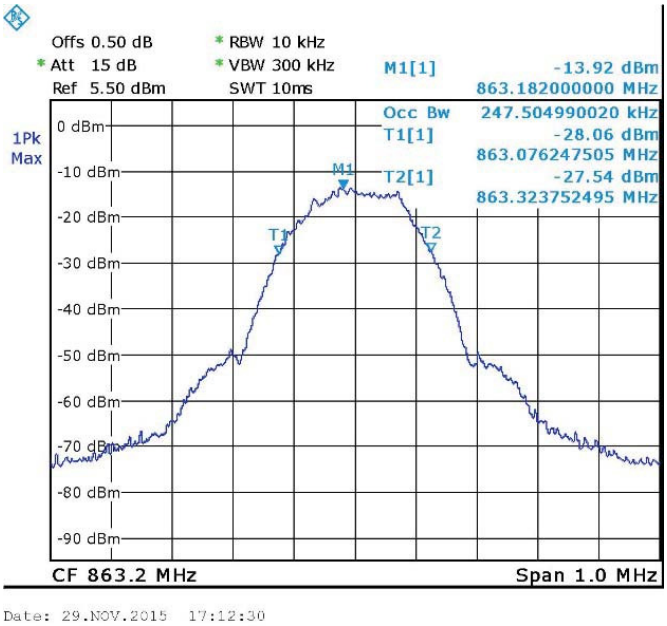


Figure 72. GSM - 863.2MHz Input

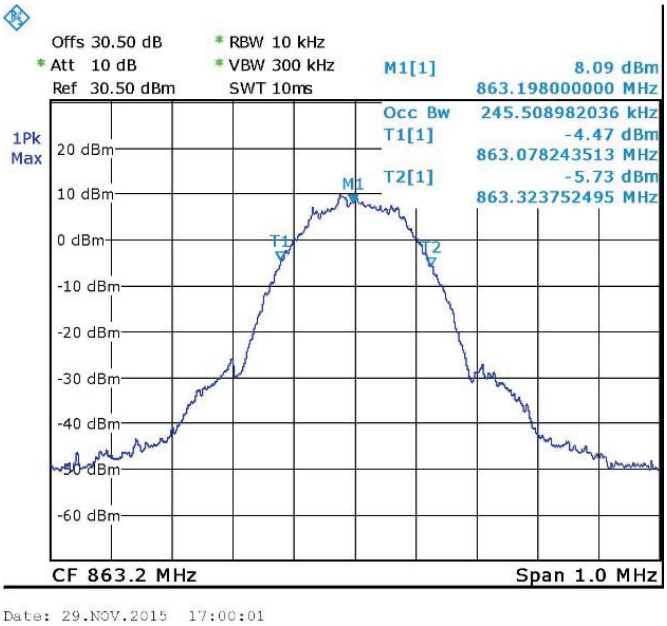


Figure 73. GSM - 863.2MHz Output

Occupied Bandwidth (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

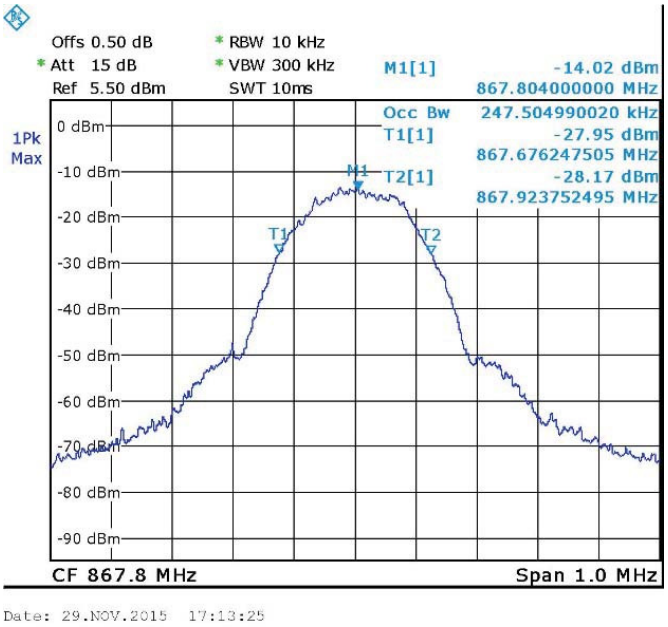


Figure 74. GSM - 867.8MHz Input

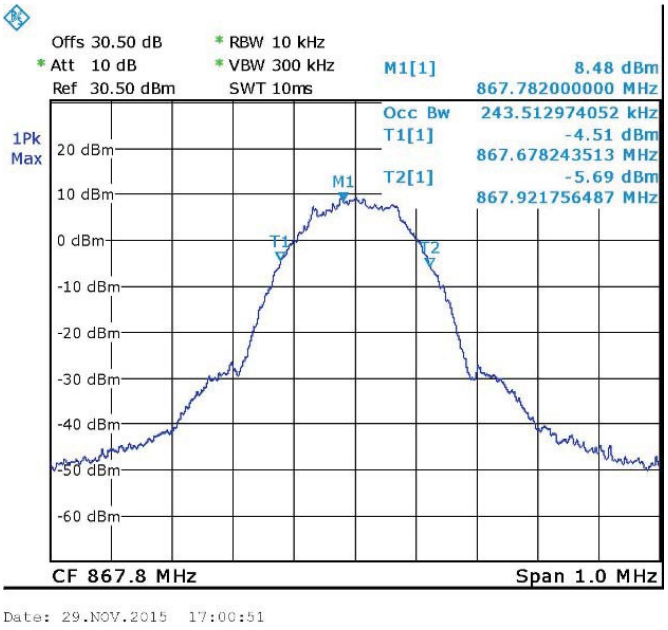


Figure 75. GSM - 867.8MHz Output

Occupied Bandwidth (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

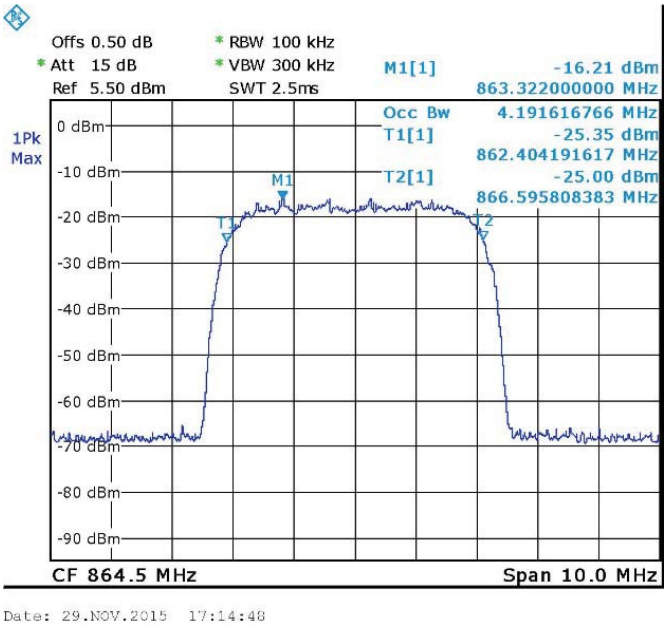


Figure 76. WCDMA - 864.5MHz Input

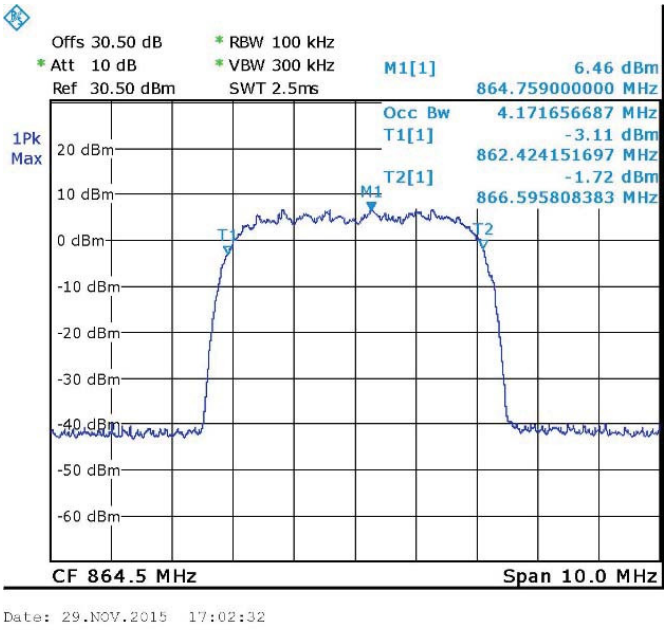


Figure 77. WCDMA - 864.5MHz Output

Occupied Bandwidth (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

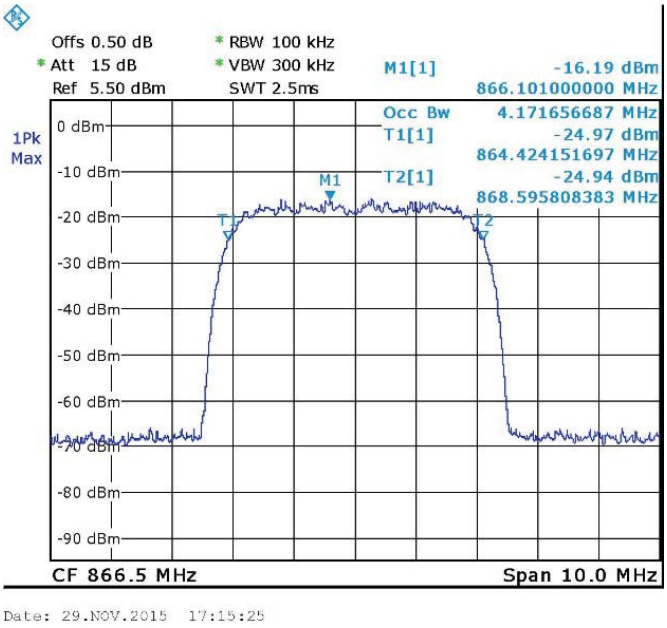


Figure 78. WCDMA - 866.5MHz Input

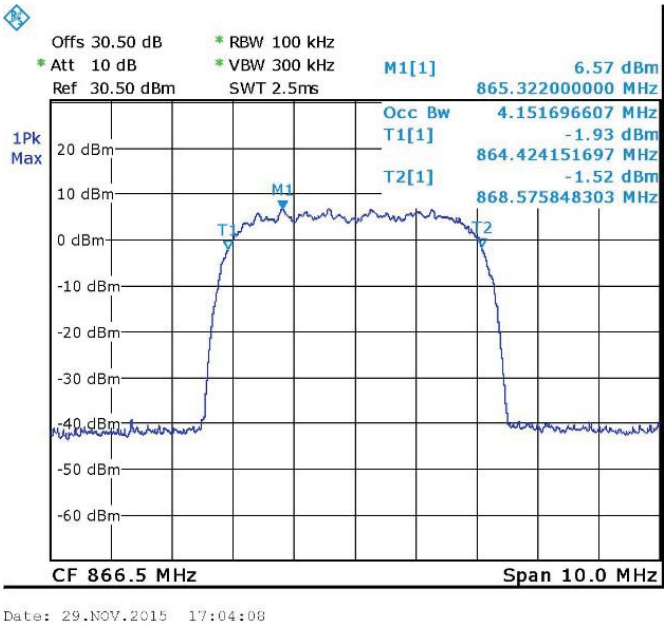


Figure 79. WCDMA - 866.5MHz Output

10.4 Test Equipment Used; Occupied Bandwidth (ESMR)

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 80 Test Equipment Used Occupied Bandwidth (ESMR)

n

11. Out of Band Emissions at Antenna Terminals (ESMR)

11.1 Test Specification

FCC Part 90, Section 90.210

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 at the low, mid and high channels of each of the 3 modulations: LTE 64QAM, GSM, WCDMA.

11.3 Test Results

See additional information in *Figure 81* to *Figure 86.*

JUDGEMENT: Passed

Out of Band Emissions at Antenna Terminals (ESMR)

E.U.T Description	ONE- Optical Network Evolution DAS
Type	RAU-5x Remote Antenna Unit PN: RAU5xUS/RAU5xUS-A
Serial Number:	Not Designated

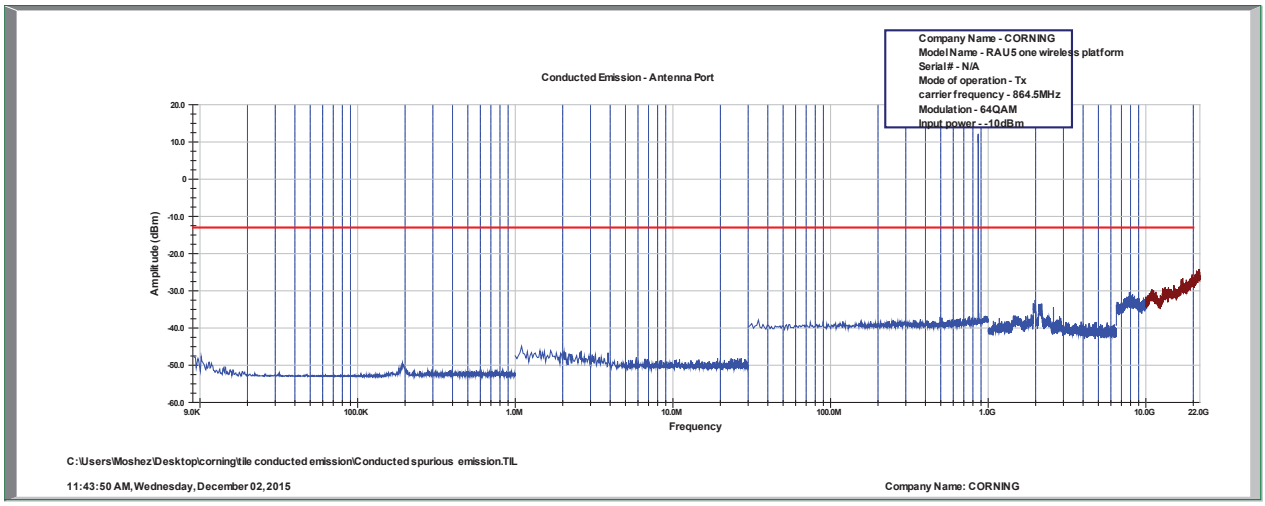


Figure 81. LTE 64QAM - 864.5 MHz

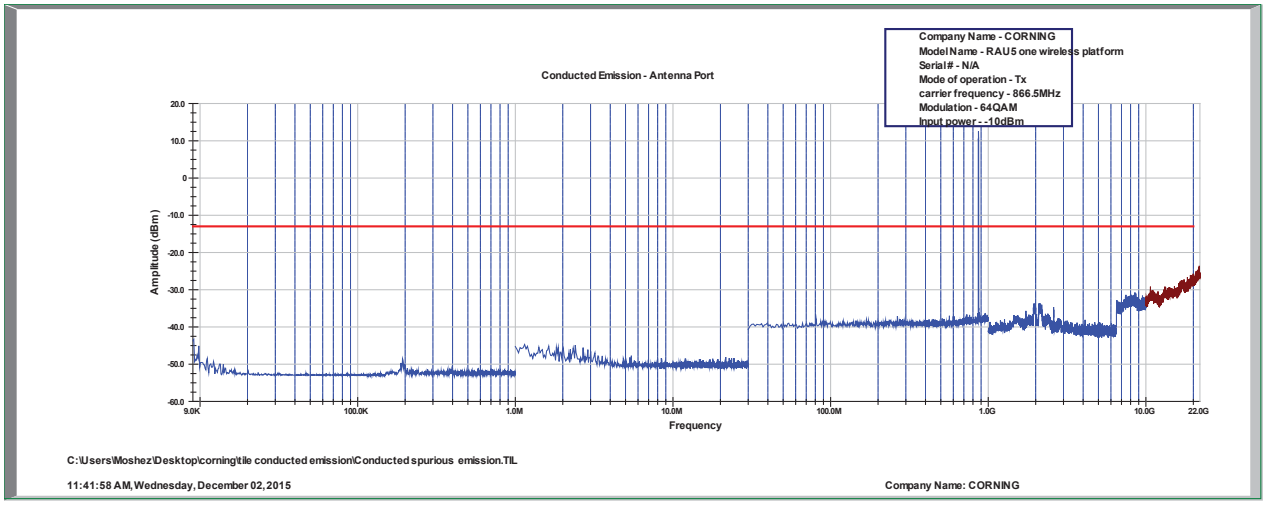


Figure 82. LTE 64QAM - 866.5 MHz

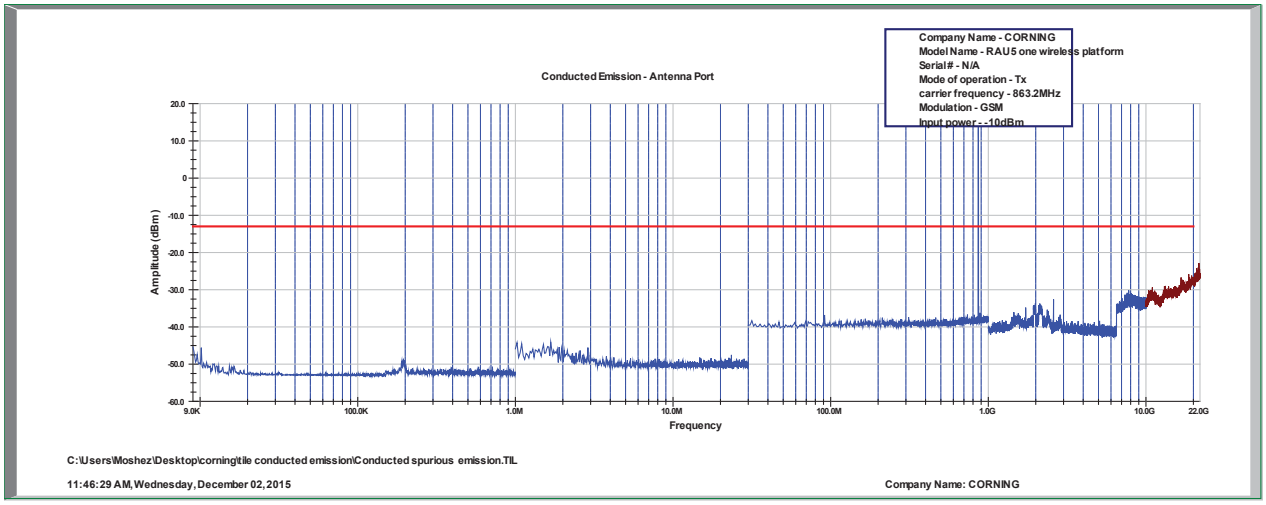


Figure 83. GSM - 863.2 MHz

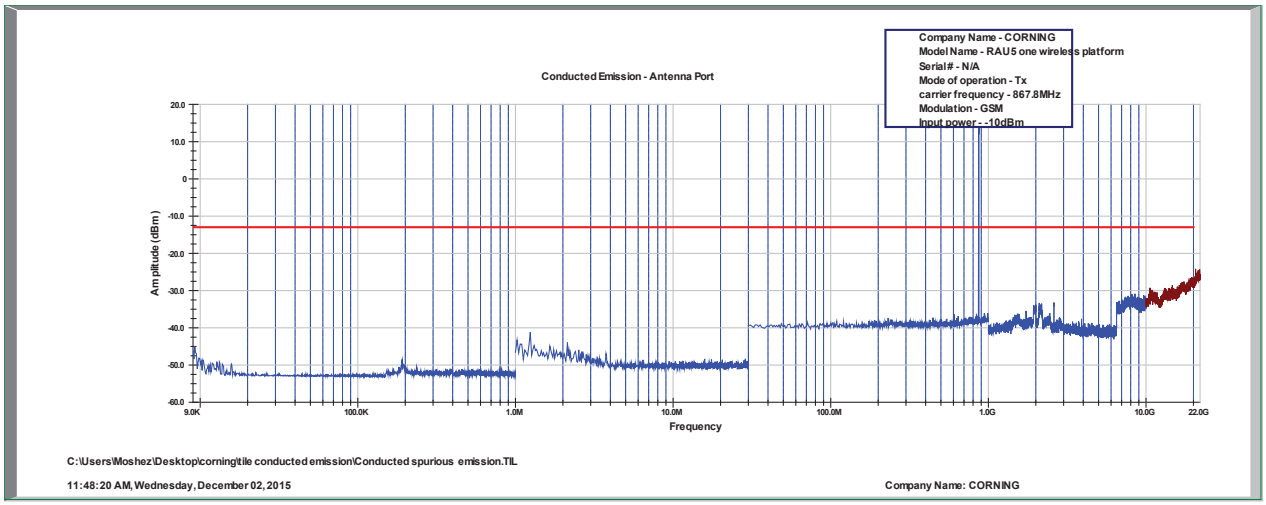


Figure 84. GSM - 867.8 MHz

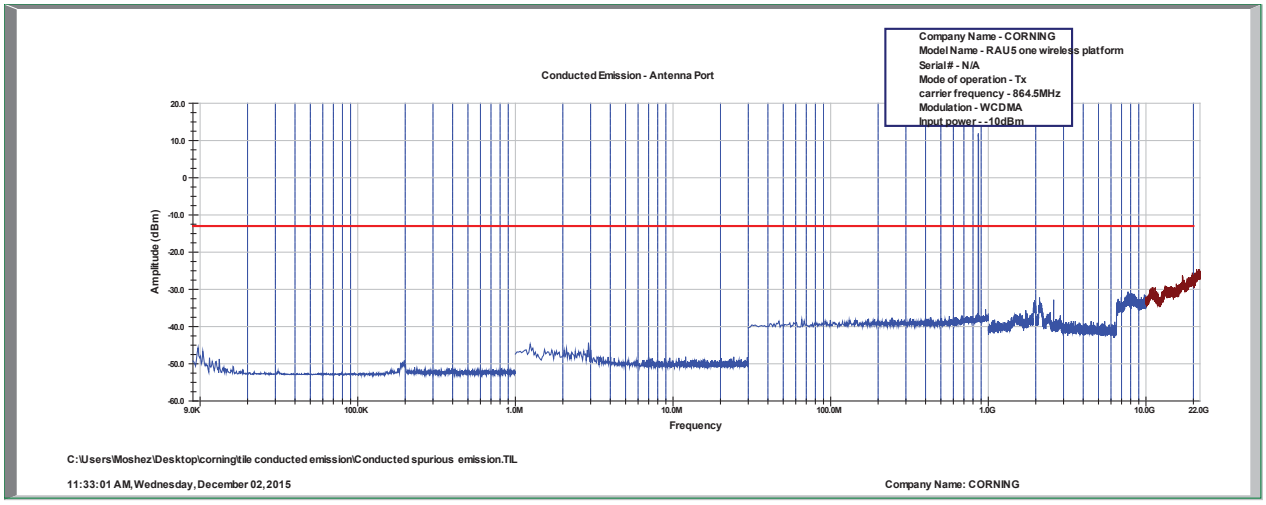


Figure 85. WCDMA - 864.5 MHz

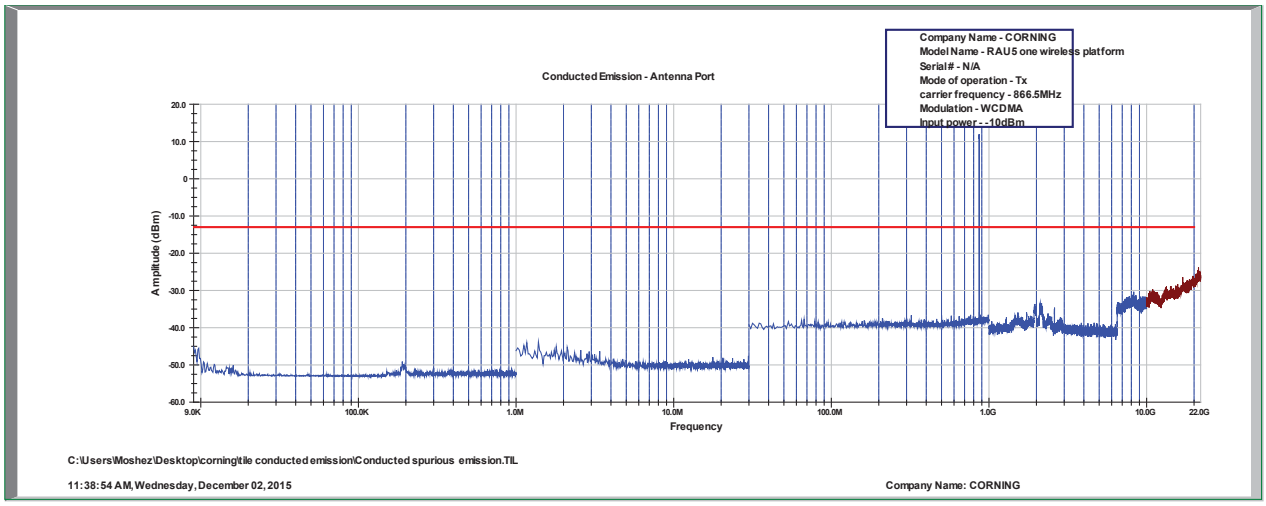


Figure 86. WCDMA - 866.5 MHz

11.4 Test Equipment Used; Out of Band Emissions at Antenna Terminals (ESMR)

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 87 Test Equipment Used Out of Band Emissions at Antenna Terminals (ESMR)

12. Band Edge Spectrum (ESMR)

12.1 Test Specification

FCC Part 2.1051

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 at the low and high channels of each modulation: LTE 64QAM, GSM, WCDMA.

12.3 Test Results

Modulation	Operation Frequency (MHz)	Band Edge Frequency (MHz)	Reading (dBm)	Specification (dBm)	Margin (dB)
LTE 64QAM	864.5	862.0	-30.4	-13.0	-17.4
	866.5	869.0	-29.1	-13.0	-16.1
GSM	863.2	862.0	-48.9	-13.0	-35.9
	867.8	869.0	-47.7	-13.0	-34.7
W-CDMA	864.5	862.0	-44.0	-13.0	-31.0
	866.5	869.0	-42.9	-13.0	-29.9

Figure 88 Band Edge Spectrum Results ESMR

See additional information in *Figure 89* to *Figure 94*.

JUDGEMENT: Passed by 16.1 dB

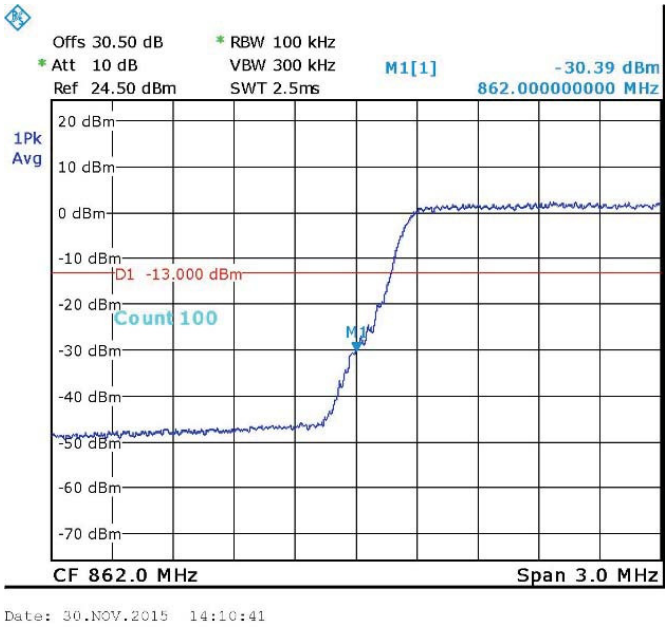


Figure 89— LTE 64QAM - 864.5MHz

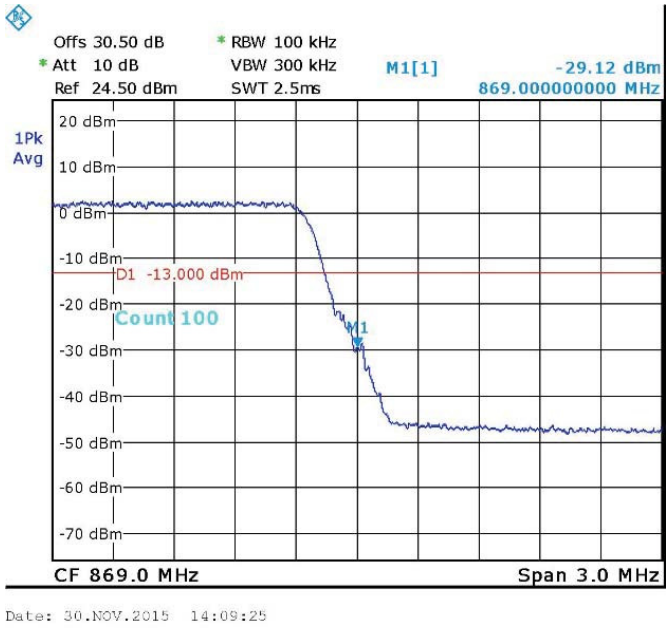


Figure 90— LTE 64QAM - 866.5 MHz

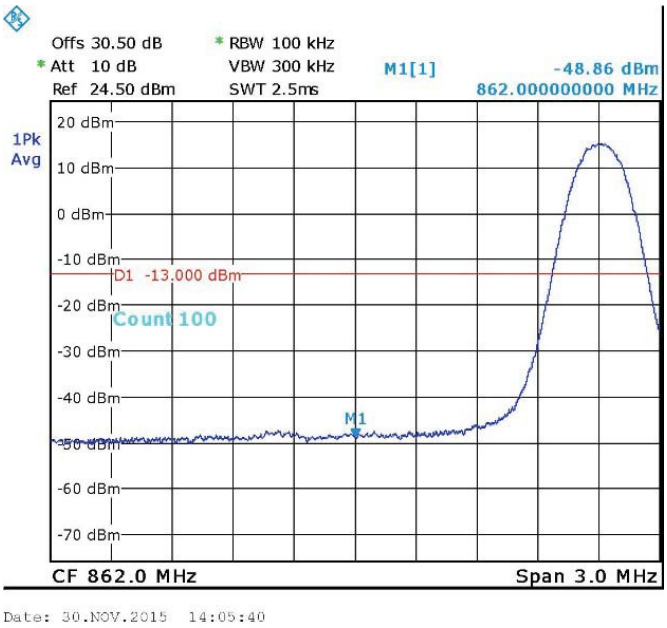


Figure 91—GSM - 863.2MHz

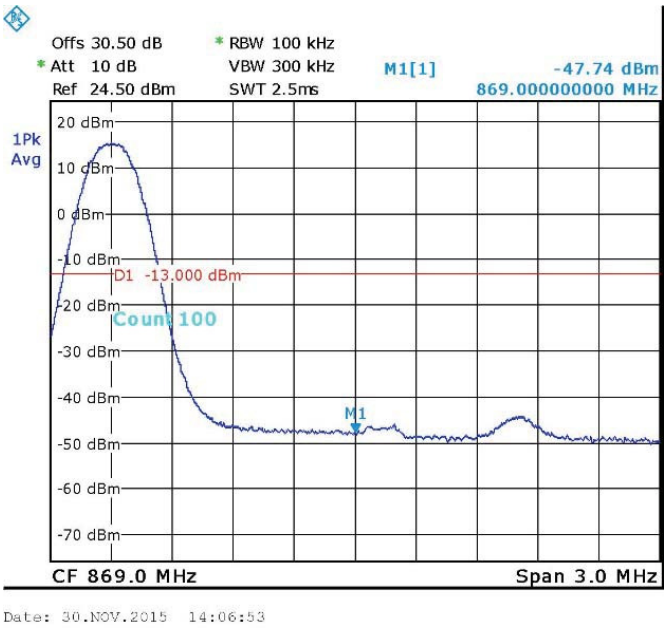


Figure 92—GSM - 867.8 MHz

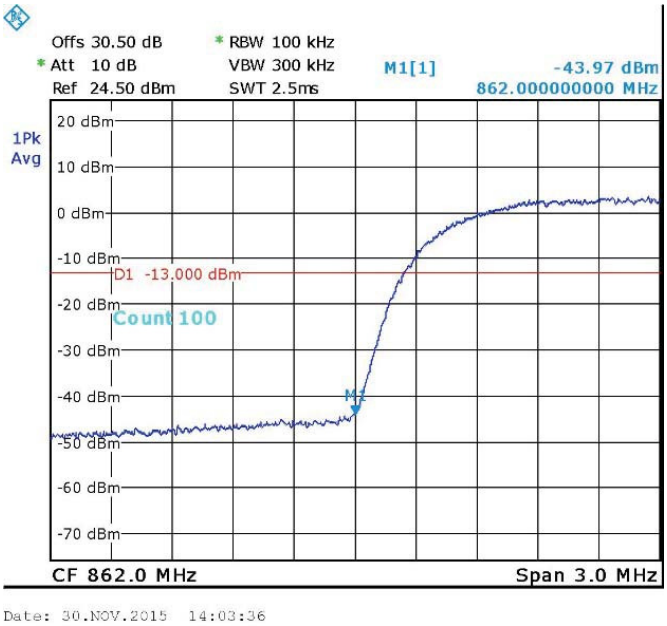


Figure 93—WCDMA - 864.5 MHz

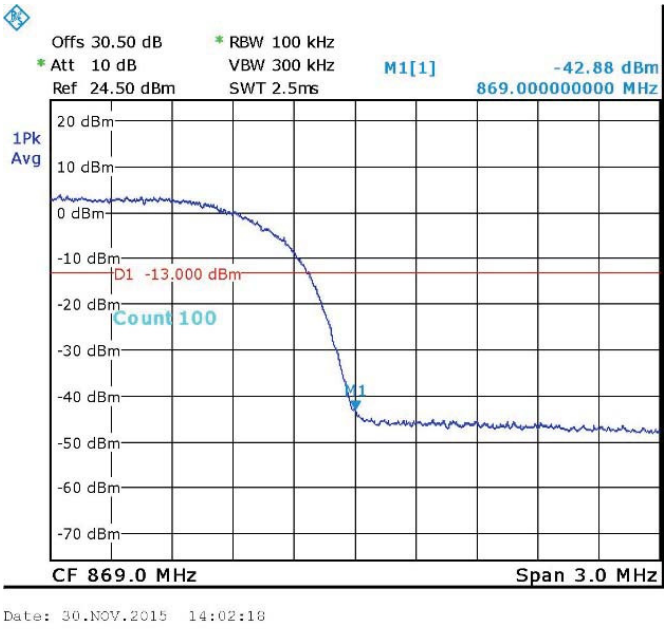


Figure 94—WCDMA - 866.5 MHz

12.4 Test Equipment Used; Band Edge Spectrum ESMR

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 95 Test Equipment Used

13. Out of Band Emissions (Radiated) (ESMR)

13.1 Test Specification

FCC, Part 90, Section 90.210

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.

(a) The E.U.T. operation mode and test set-up are as described in Section 2 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 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 1GHz -22GHz 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.

(b) 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

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)
863.2	1150.0	V	38.5	-61.1	0.5	6.0	-55.6	-13.0	-42.6
863.2	1150.0	H	40.1	-59.5	0.5	6.0	-54.0	-13.0	-41.0
867.8	1150.0	V	38.3	-61.0	0.5	6.0	-55.8	-13.0	-42.8
867.8	1150.0	H	40.5	-59.1	0.5	6.0	-53.6	-13.0	-40.6

Figure 96 Out of Band Radiated (ESMR) Test Results Table

JUDGEMENT: Passed by 40.6 dB

The E.U.T met the requirements of the FCC, Part 90, Section 90.210 specifications.

13.4 Test Equipment Used; Out of Band Emissions (Radiated) (ESMR)

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 97 Test Equipment Used Out of Band Emissions (Radiated) (ESMR)

14. Peak Output Power (PCS)

14.1 Test Specification

FCC Part 24, Subpart E

14.2 Test Procedure

Peak Power Output must not exceed 100 Watts (50dBm).

The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (loss = 30.5 dB). The RBW was set to 1%-5% from the OBW. Special attention was taken to prevent Spectrum Analyzer RF input overload. RF output was modulated with LTE 64QAM GSM and WCDMA at low, mid and high channels of each modulation.

14.3 Test Results

Modulation	Operation Frequency (MHz)	Reading (dBm)	Specification (dBm)	Margin (dB)
LTE 64QAM	1935.0	21.8	50.0	-28.2
	1962.5	21.4	50.0	-28.6
	1990.0	21.6	50.0	-28.4
GSM	1931.2	20.6	50.0	-29.4
	1960.0	20.7	50.0	-37.3
	1993.8	20.5	50.0	-29.5
WCDMA	1932.5	21.8	50.0	-28.2
	1960.0	21.8	50.0	-28.2
	1992.5	21.2	50.0	-28.8

Figure 98 Peak Output Power PCS

See additional information in *Figure 99* to *Figure 107.*

JUDGEMENT: Passed by 28.2 dB

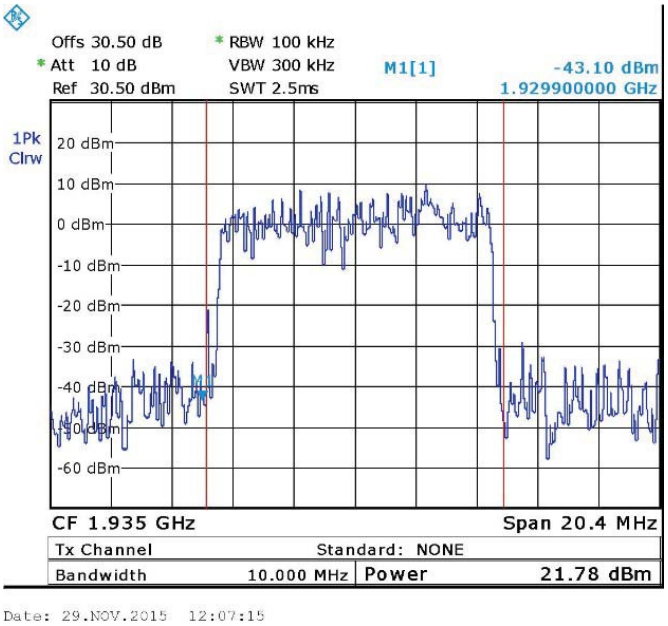


Figure 99. 64QAM - 1935.0 MHz

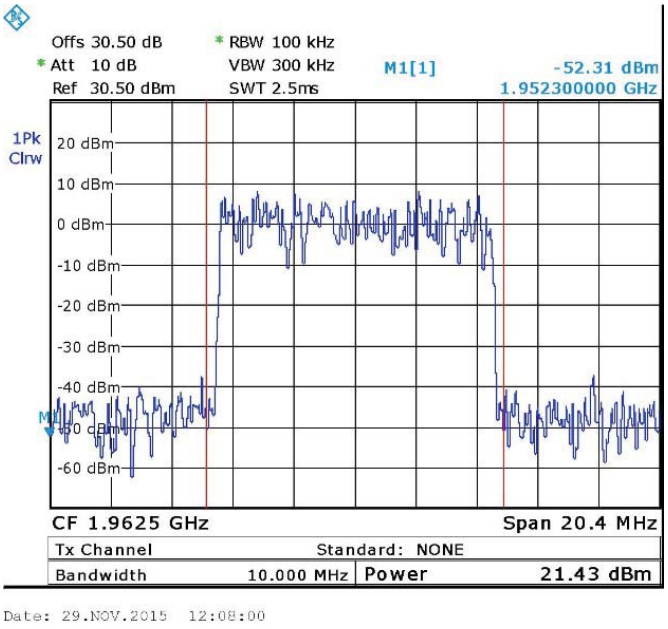


Figure 100. 64QAM - 1962.5 MHz

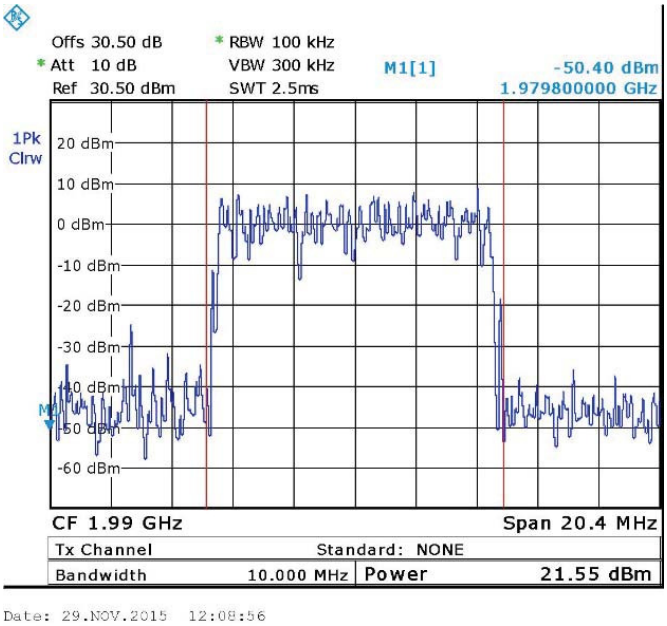


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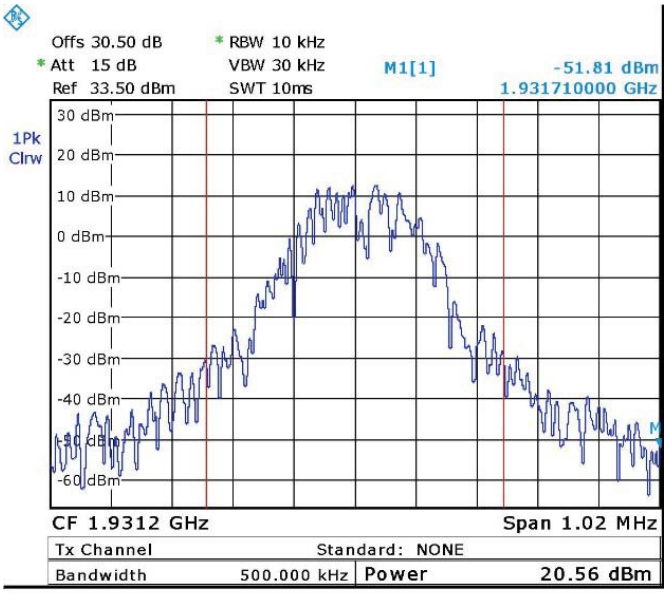
Figure 101. 64QAM - 1990.00 MHz



Date: 29.NOV.2015 12:12:21

Figure 102. GSM -1931.2 MHz

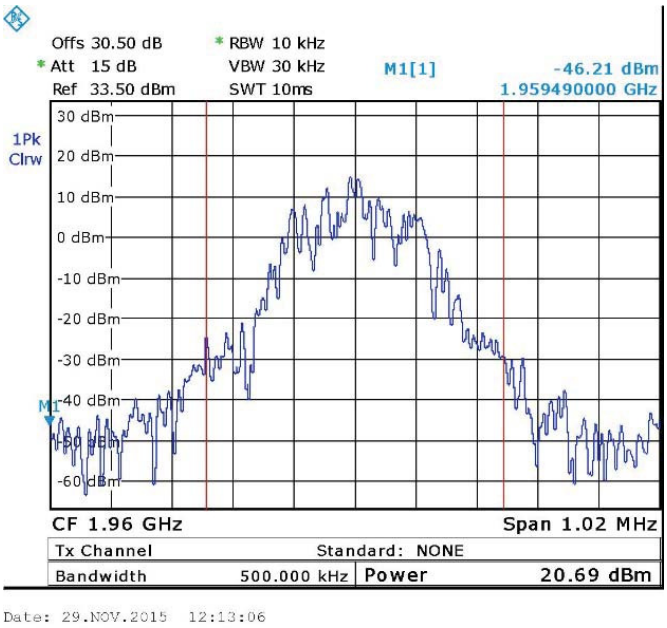


Figure 103. GSM - 1960.0 MHz

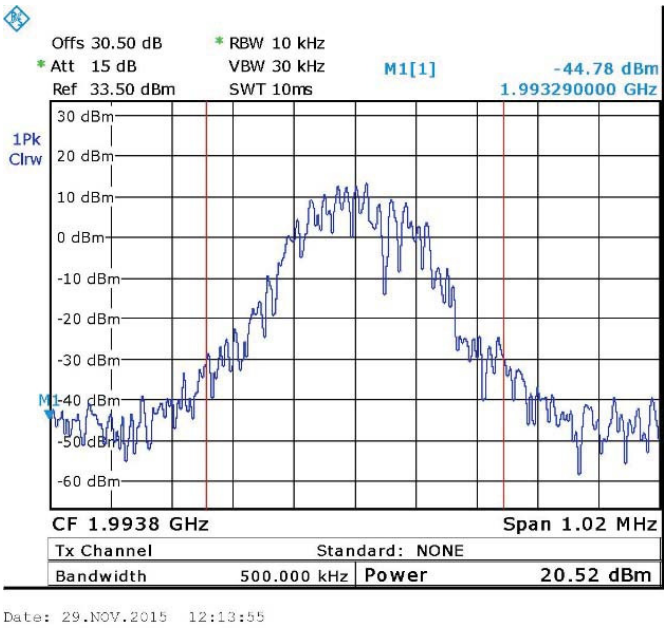


Figure 104.GSM - 1993.8 MHz

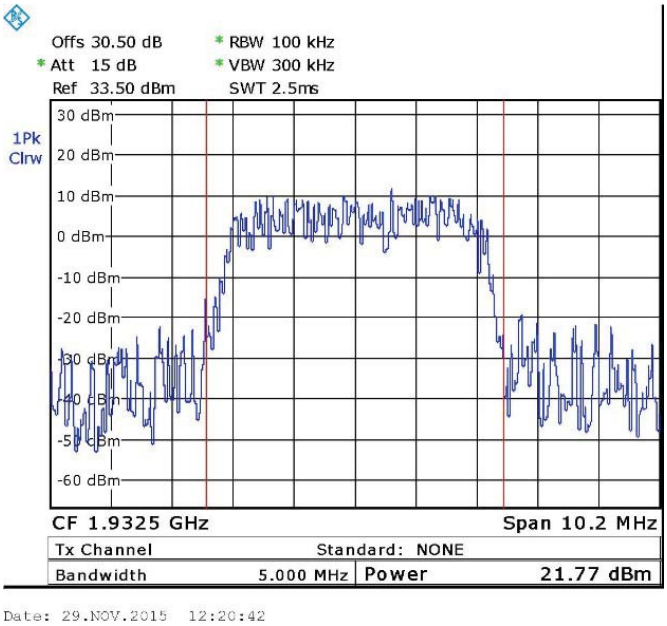


Figure 105.WCDMA - 1932.5 MHz

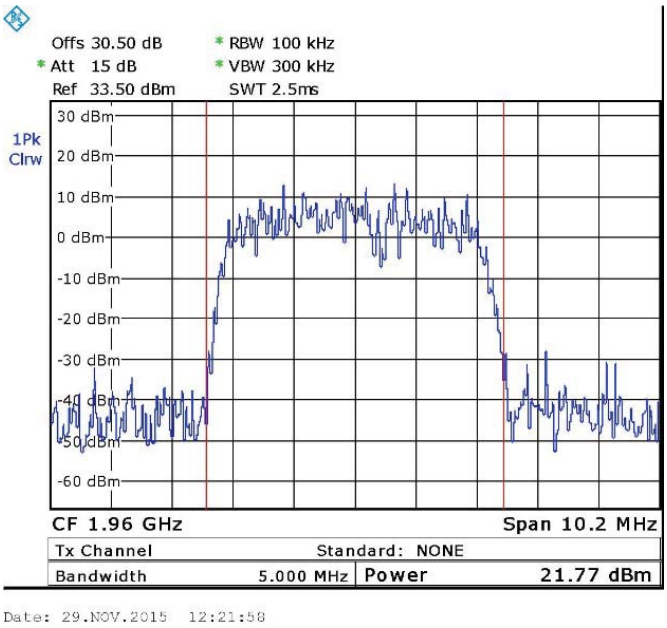


Figure 106. WCDMA- 1960.0 MHz

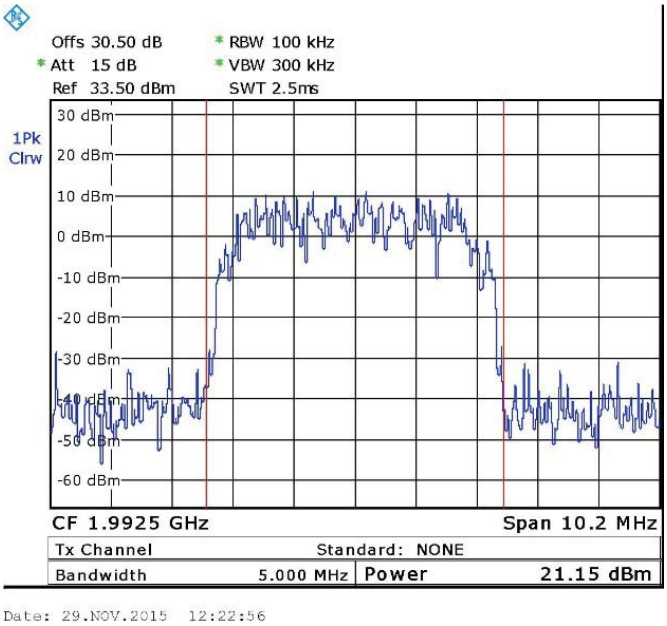


Figure 107. WCDMA - 1992.5 MHz

14.4 Test Equipment Used; Peak Output Power PCS

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

15. Occupied Bandwidth (PCS)

15.1 Test Specification

FCC Part 2, Section 1049

15.2 Test Procedure

The E.U.T. was set to the applicable test frequency with modulation. The E.U.T. antenna terminal was connected to the spectrum analyzer through an external attenuator (at the output port test) and an appropriate coaxial cable. RBW was set to 1%-5% from OBW.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limit, the mean powers radiated are each equal to 0.5% of the total mean power radiated by a given emission.

The function 99% power bandwidth was used for this evaluation.

Occupied bandwidth measured was repeated in the input terminal of the E.U.T. The E.U.T was evaluated at the low, mid and high channels of the 3 modulations: LTE 64QAM, GSM and WCDMA.

15.3 Test Results

Modulation	port	Operating Frequency (MHz)	Reading (MHz)
LTE 64QAM	Input	1935.0	8.98
	Output	1935.0	8.98
	Input	1962.5	8.98
	Output	1962.5	8.98
	Input	1990.0	8.98
	Output	1990.0	8.98
GSM	Input	1931.2	0.24
	Output	1931.2	0.24
	Input	1960.0	0.24
	Output	1960.0	0.24
	Input	1993.8	0.24
	Output	1993.8	0.24
WCDMA	Input	1932.5	4.17
	Output	1932.5	4.15
	Input	1960.0	4.17
	Output	1960.0	4.19
	Input	1992.5	4.17
	Output	1992.5	4.15

Figure 109 Occupied Bandwidth PCS

See additional information in *Figure 110* to *Figure 127*.

JUDGEMENT: Passed

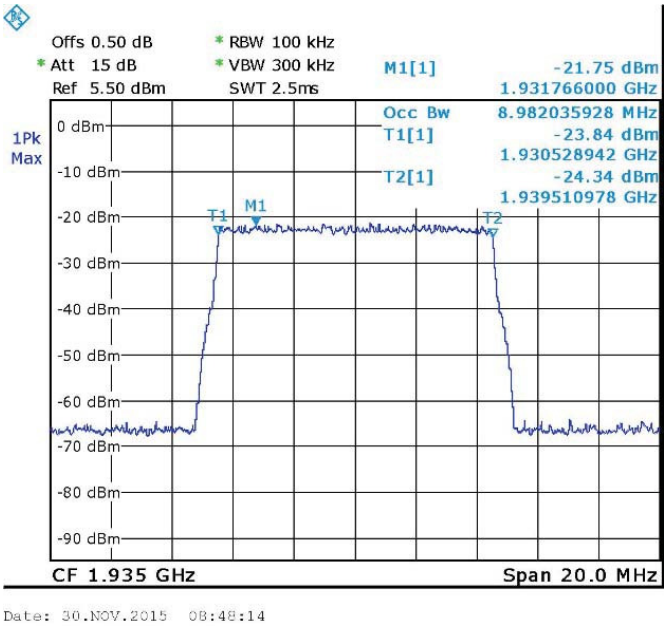


Figure 110. LTE 64QAM - 1935.0 MHz Input

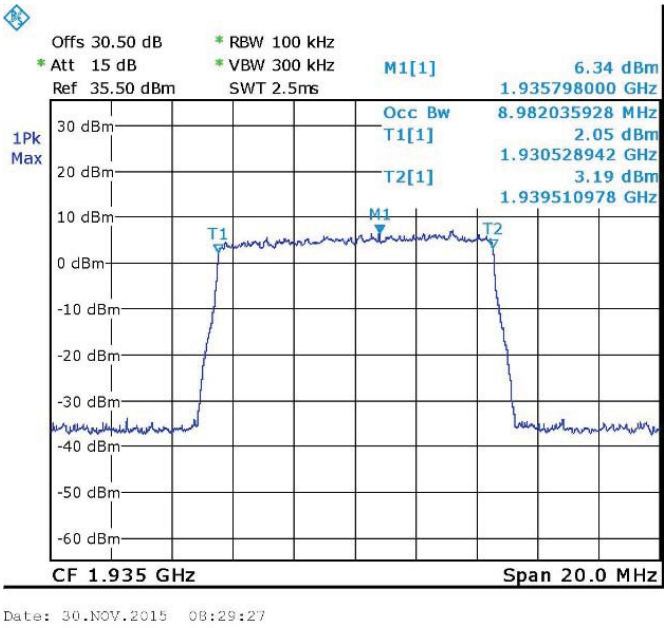


Figure 111. LTE 64QAM - 1935.0 MHz Output

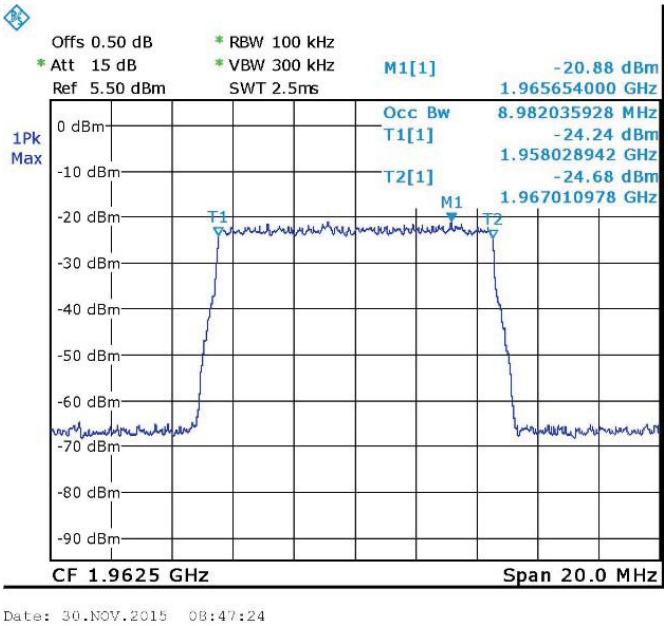


Figure 112.LTE 64QAM - 1962.5 MHz Input

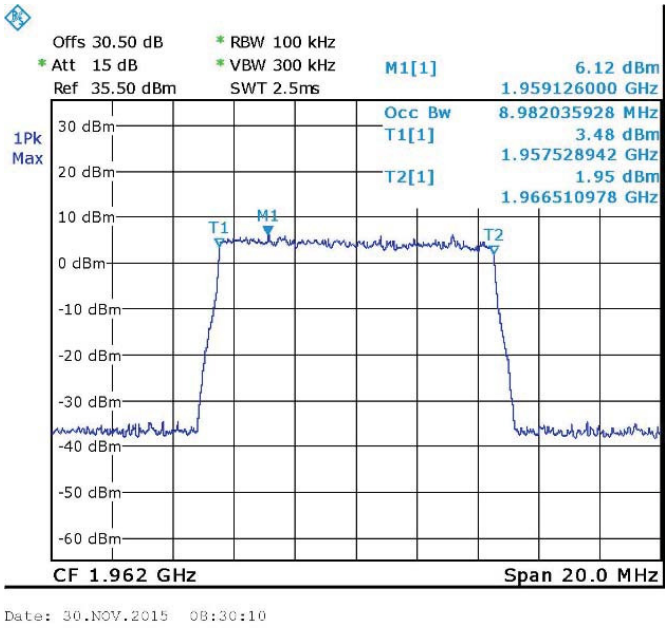
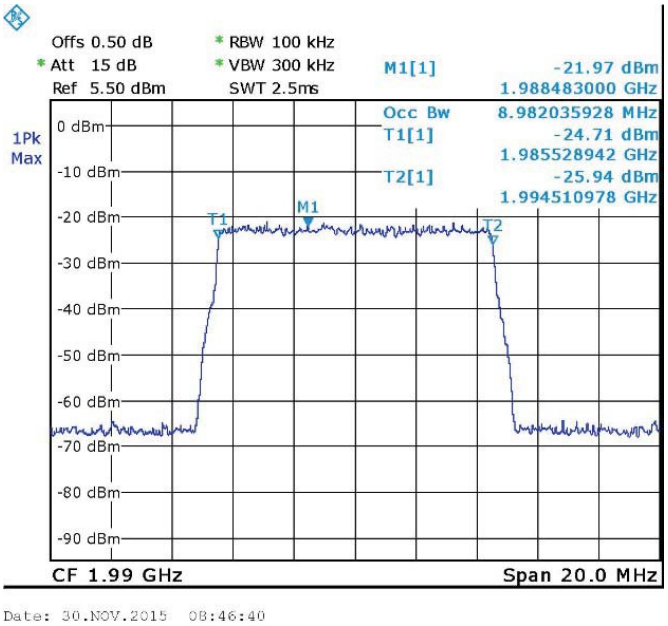


Figure 113. LTE 64QAM - 1962.5 MHz Output



Date: 30.NOV.2015 08:46:40

Figure 114. LTE 64QAM - 1990.0 MHz Input

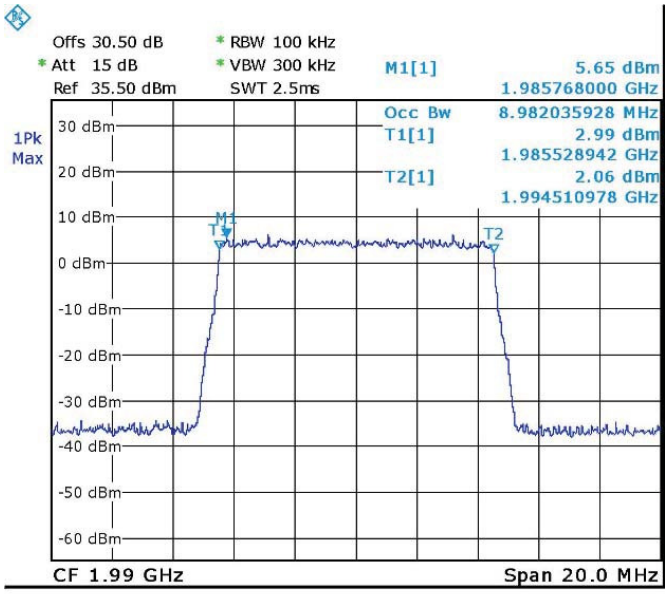


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Figure 115. LTE 64QAM - 1990.0 MHz Output

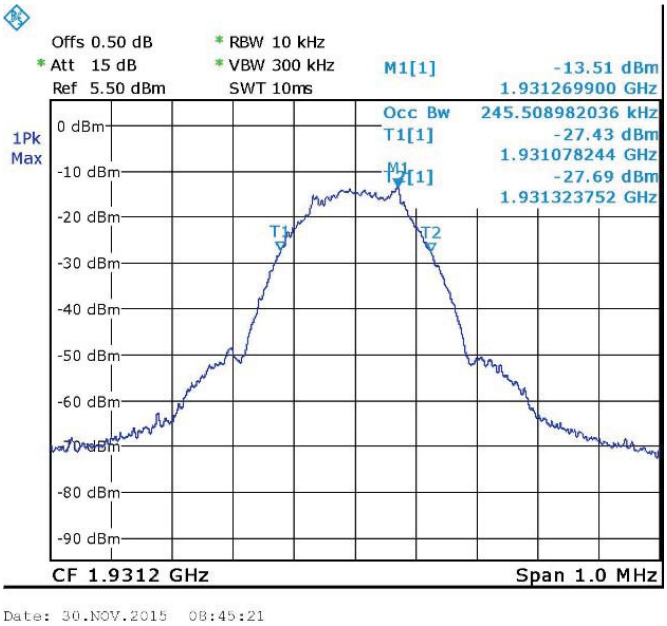


Figure 116. GSM - 1931.2 MHz Input

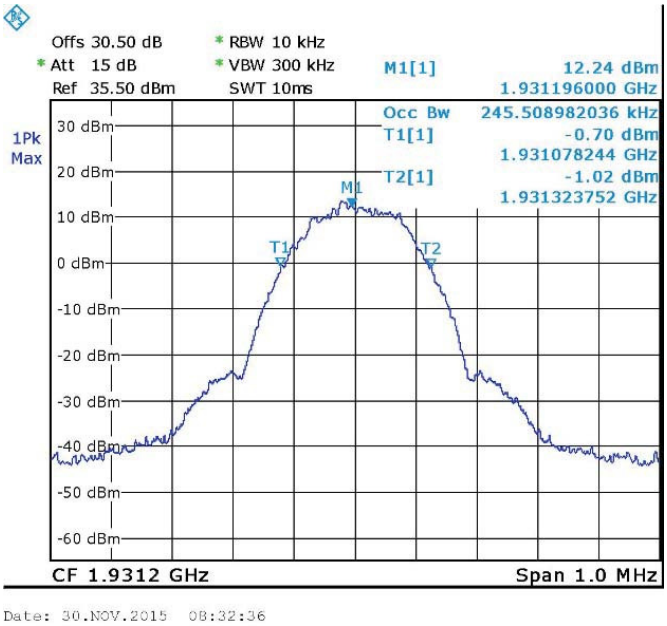
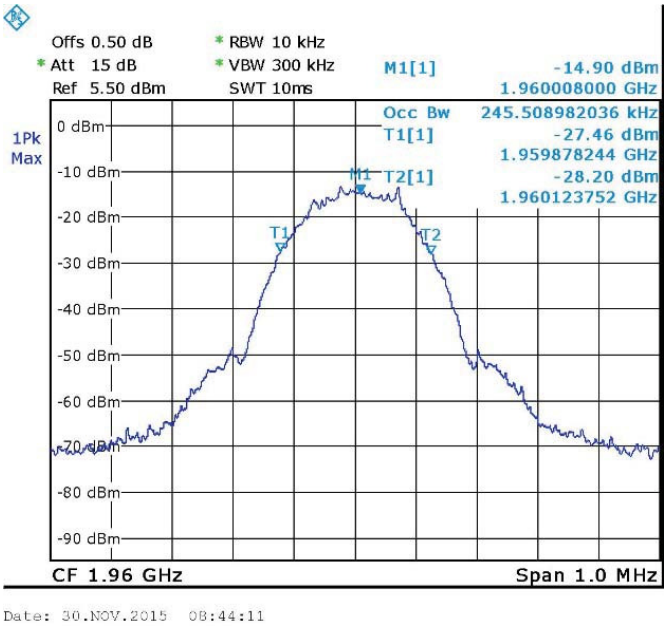
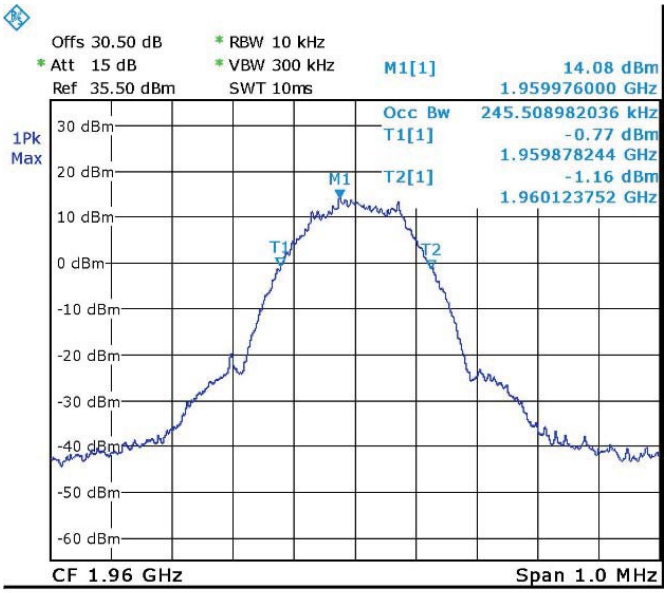


Figure 117.GSM - 1931.2 MHz Output



Date: 30.NOV.2015 08:44:11

Figure 118. GSM - 1960.00 MHz Input



Date: 30.NOV.2015 08:33:53

Figure 119. GSM - 1960.00 MHz Output

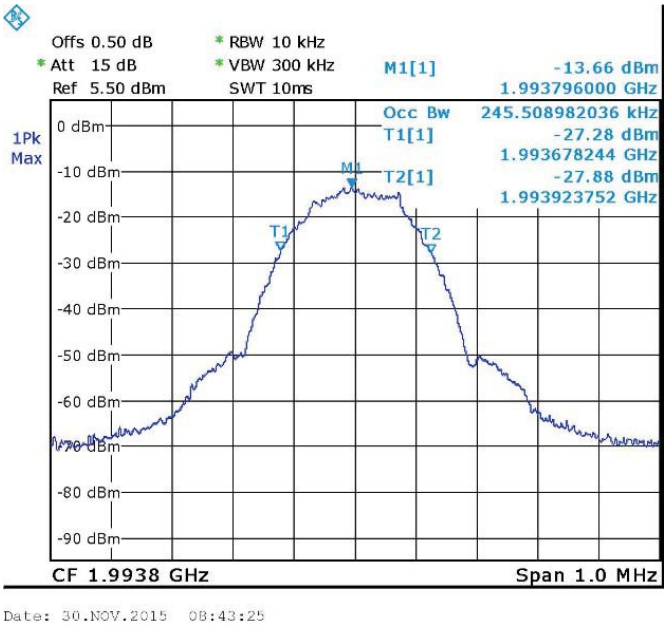


Figure 120. GSM - 1993.8 MHz Input

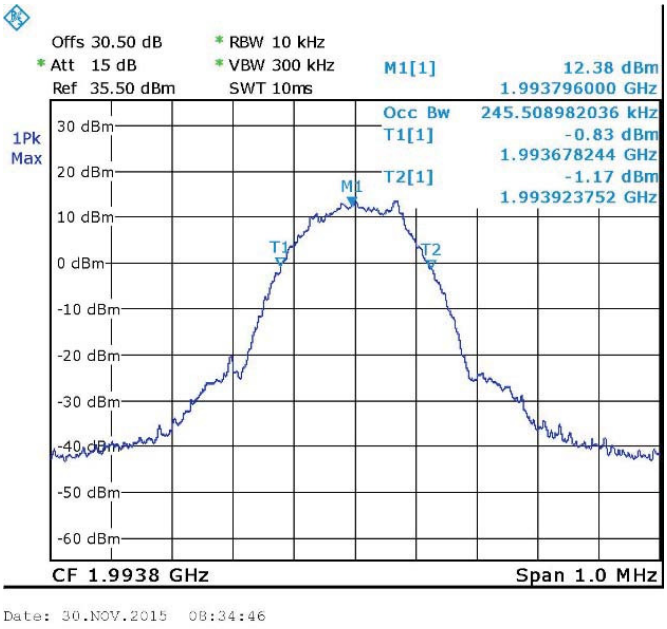
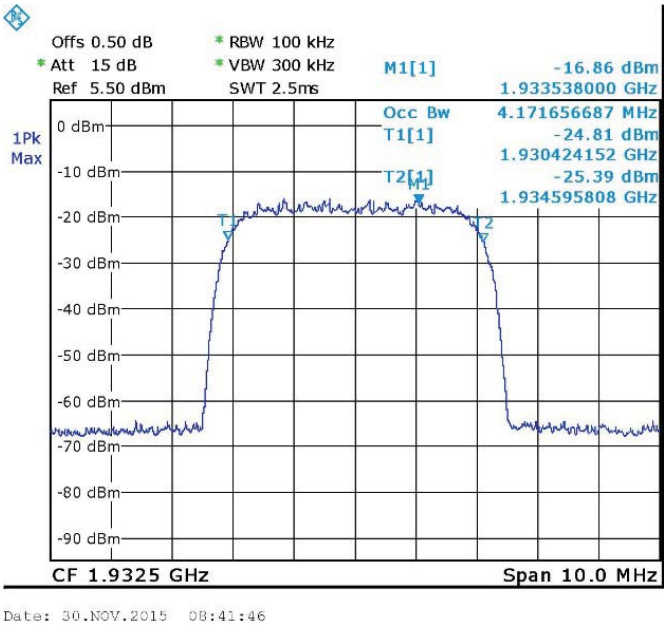
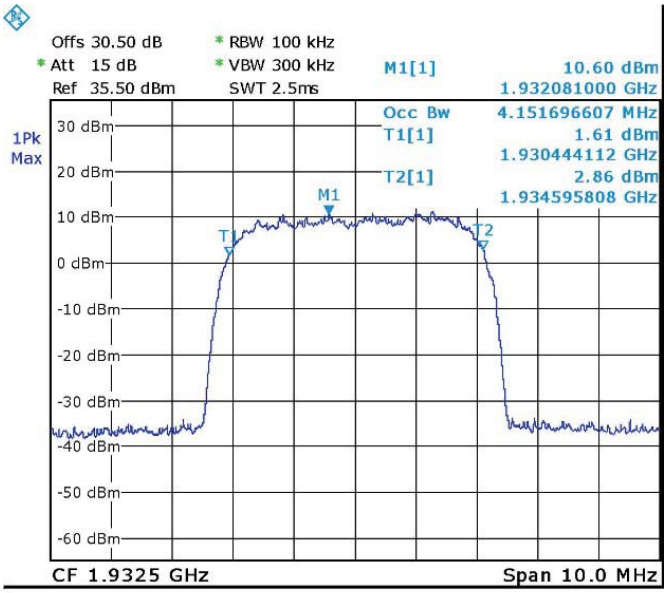


Figure 121.GSM - 1993.8 MHz Output



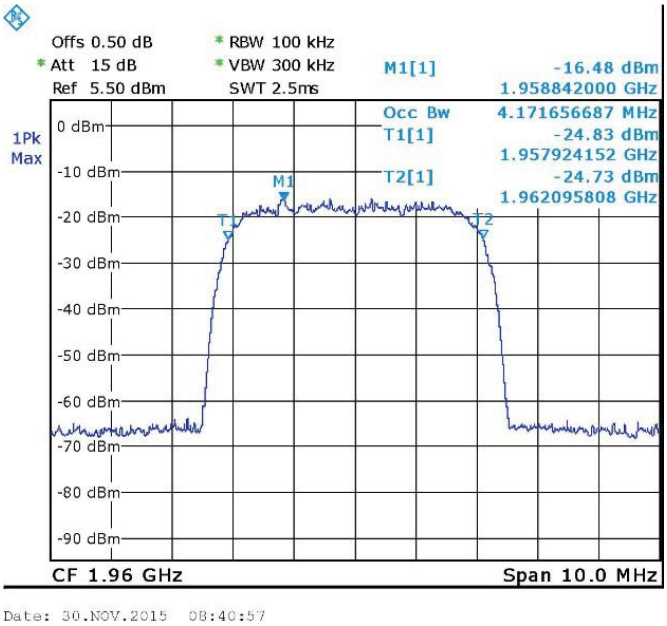
Date: 30.NOV.2015 08:41:46

Figure 122.WCDMA - 1932.5 MHz Input



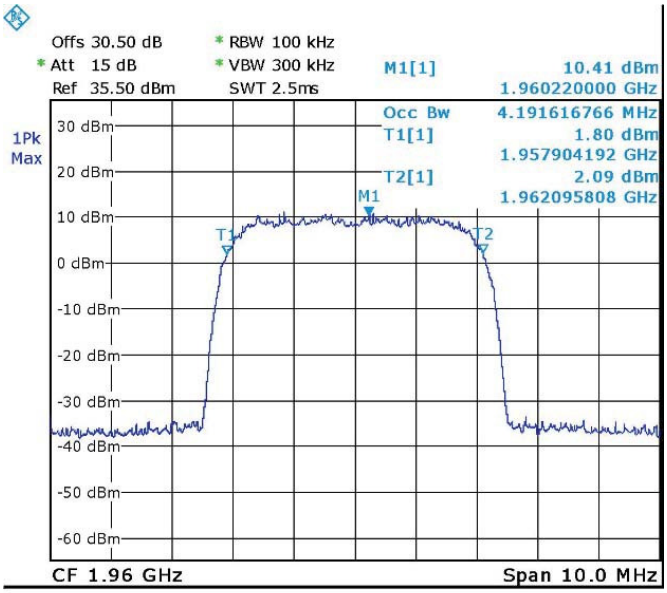
Date: 30.NOV.2015 08:36:28

Figure 123. WCDMA - 1932.5 MHz Output



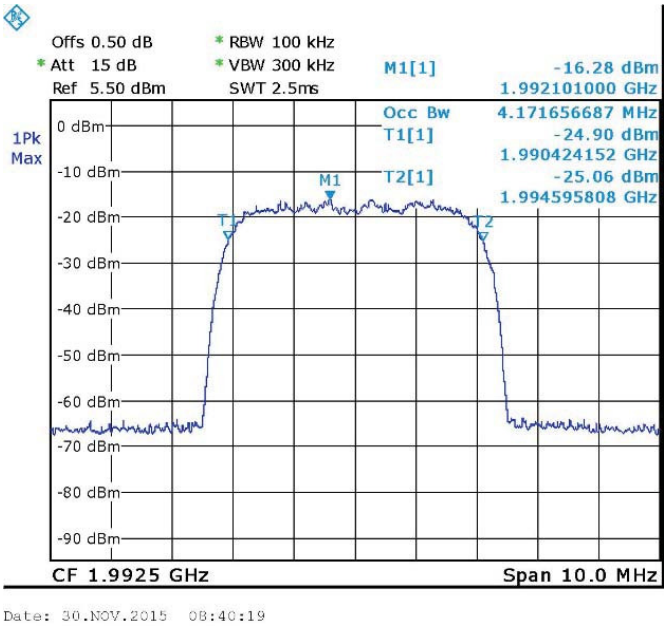
Date: 30.NOV.2015 08:40:57

Figure 124. WCDMA- 1960.0 MHz Input



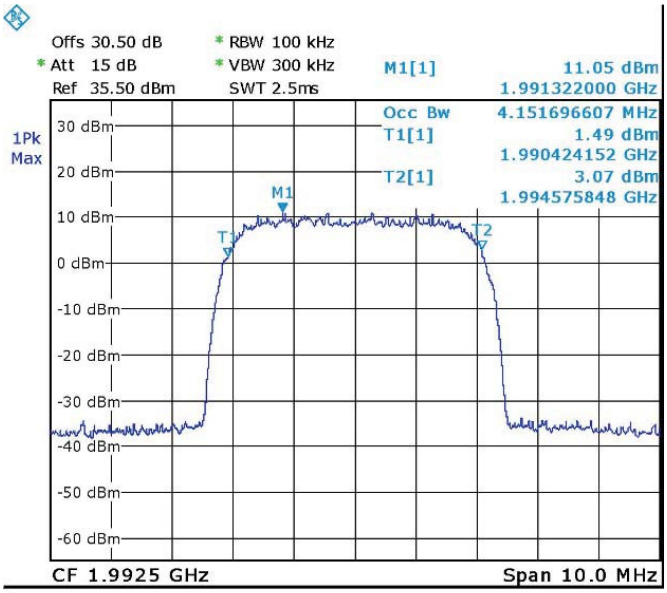
Date: 30.NOV.2015 08:37:06

Figure 125. WCDMA - 1960.0 MHz Output



Date: 30.NOV.2015 08:40:19

Figure 126. WCDMA - 1992.5 MHz Input



Date: 30.NOV.2015 08:37:47

Figure 127. WCDMA - 1992.5 MHz Output

15.4 Test Equipment Used; Occupied Bandwidth PCS

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 128 Test Equipment Used

16. Out of Band Emissions at Antenna Terminals (PCS)

16.1 Test Specification

FCC Part 24, Subpart E, Section 238; FCC Part 2.1051

16.2 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 at the low, mid and high channels of each of the 3 modulations: LTE 64QAM, GSM, WCDMA.

16.3 Test Results

See additional information in *Figure 129* to *Figure 137.*

JUDGEMENT: Passed

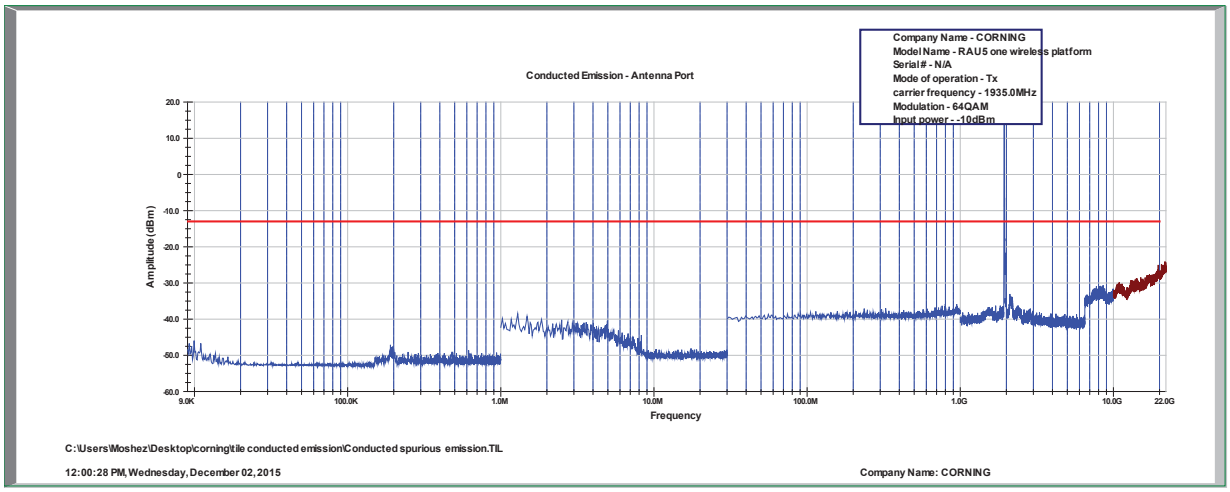


Figure 129 64QAM - 1935.0 MHz

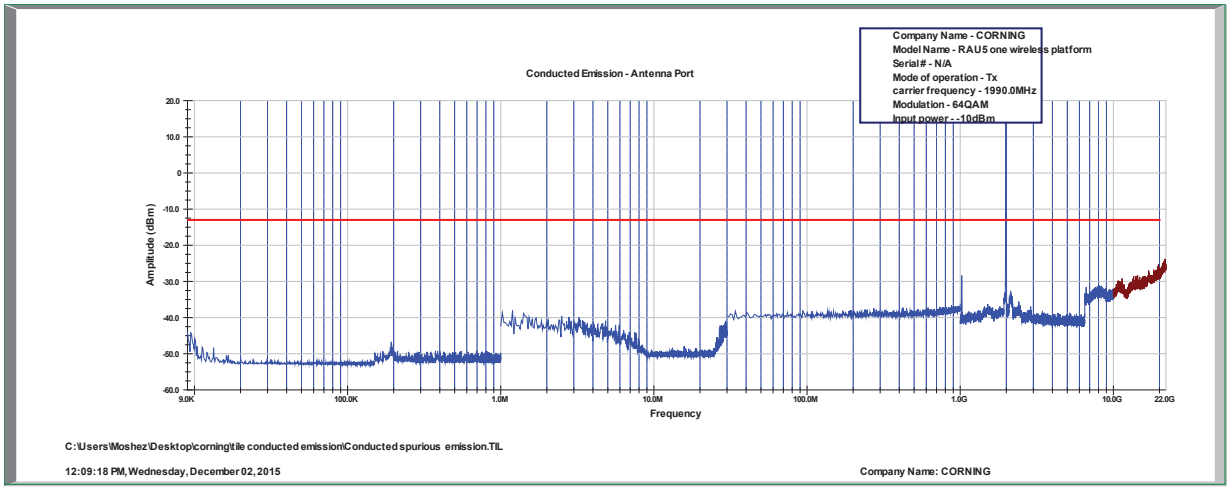


Figure 130 64QAM - 1962.5 MHz

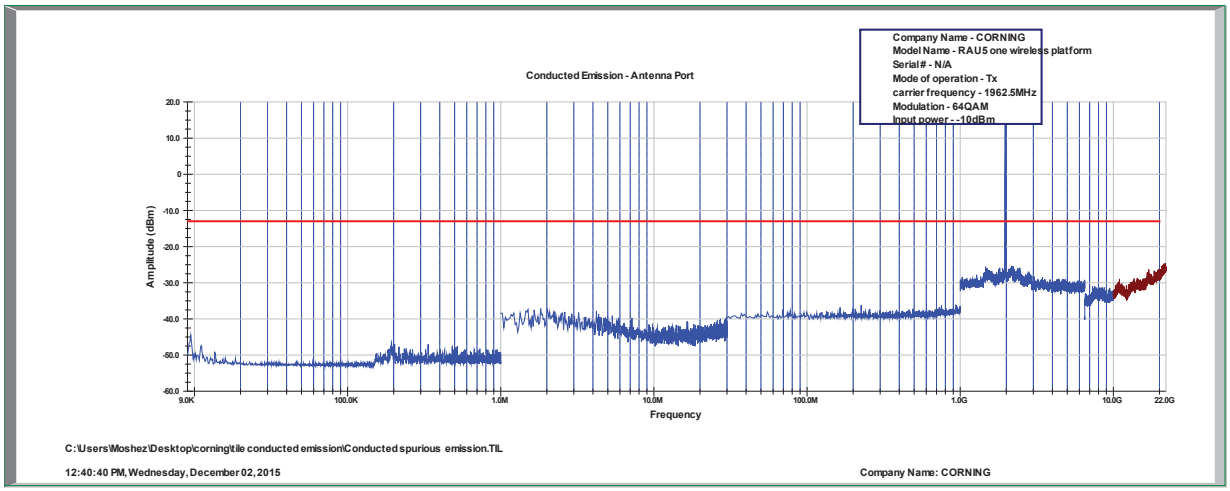


Figure 131 64QAM - 1990.0 MHz

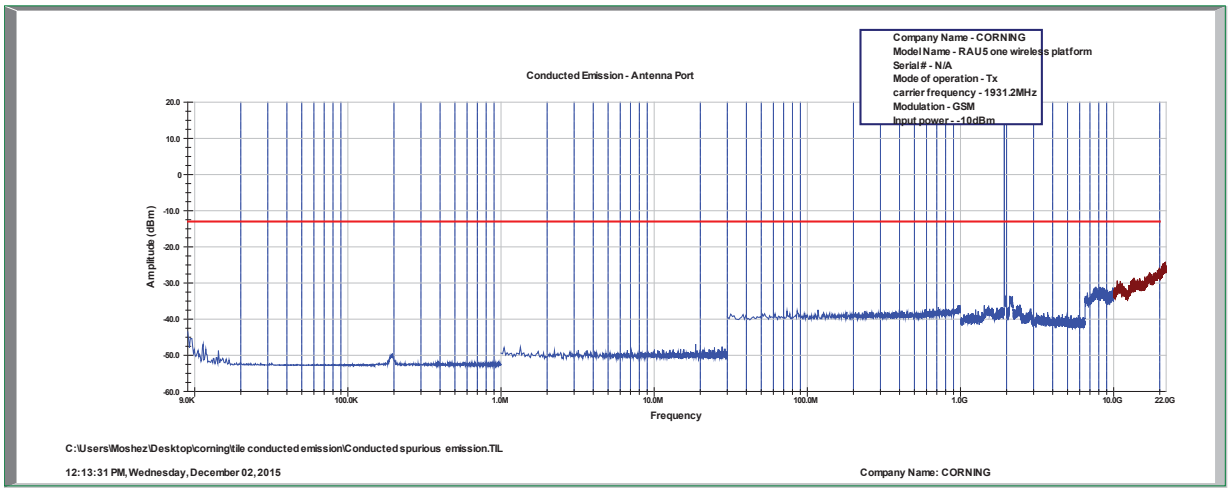


Figure 132 GSM - 1931.2 MHz

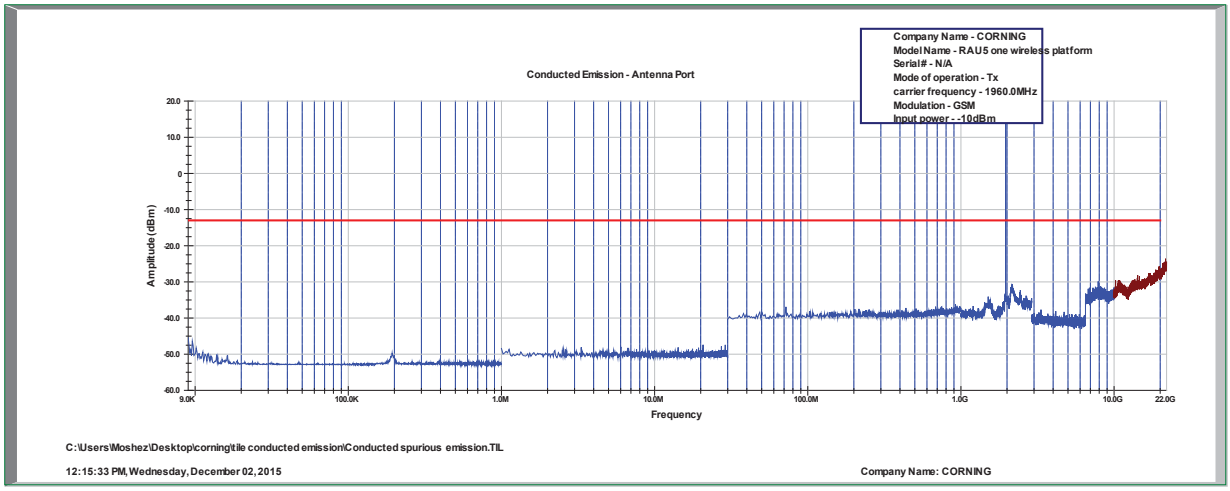


Figure 133GSM - 1960.0 MHz

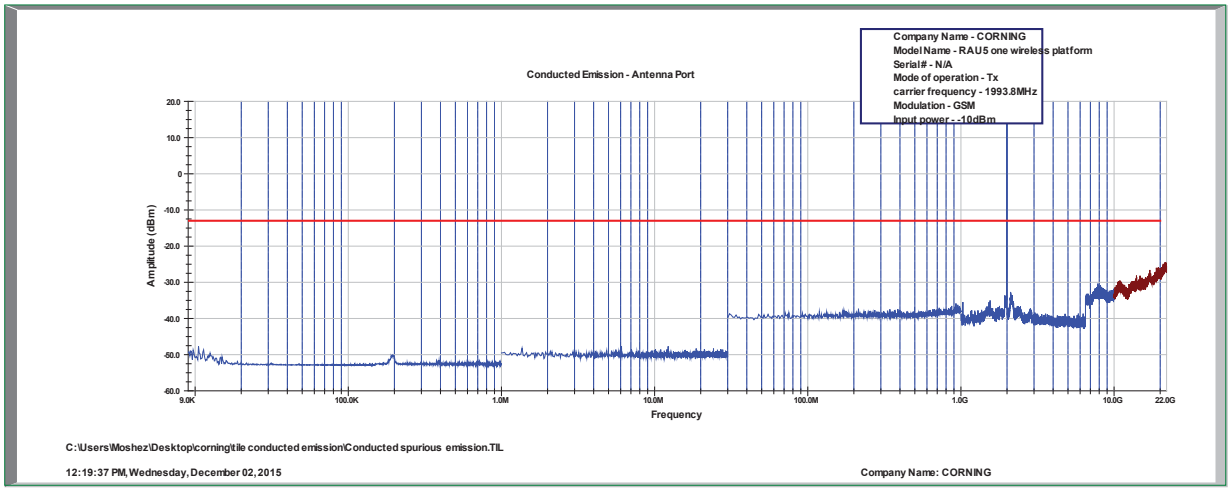


Figure 134 GSM - 1993.8 MHz

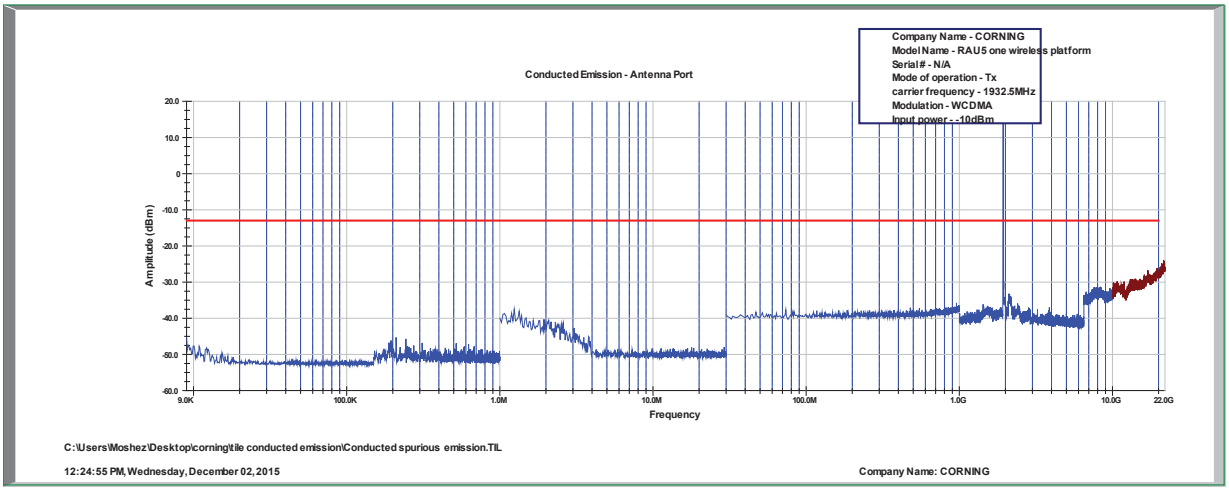


Figure 135 WCDMA - 1932.5 MHz

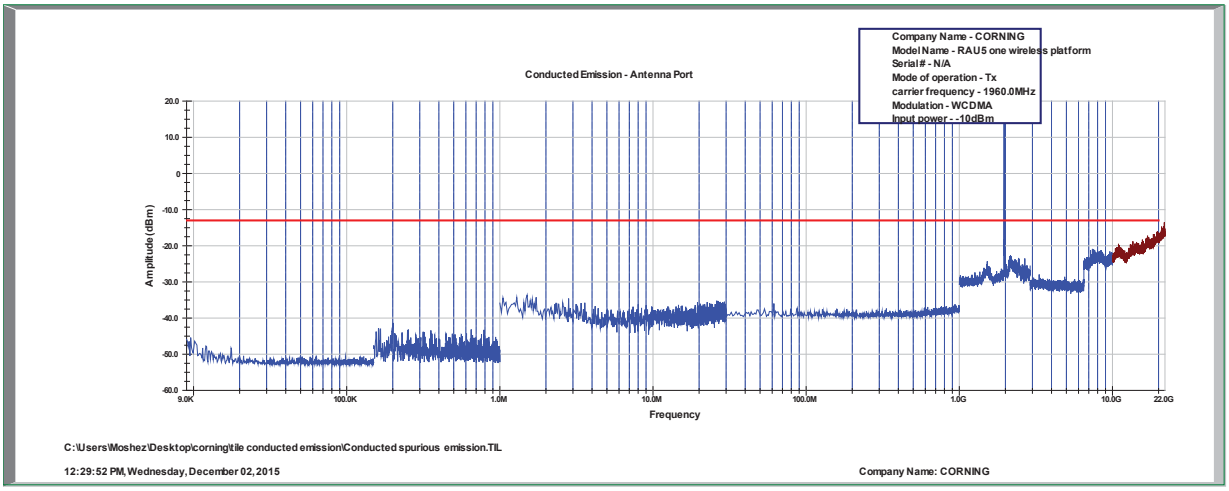


Figure 136 WCDMA - 1960.0 MHz

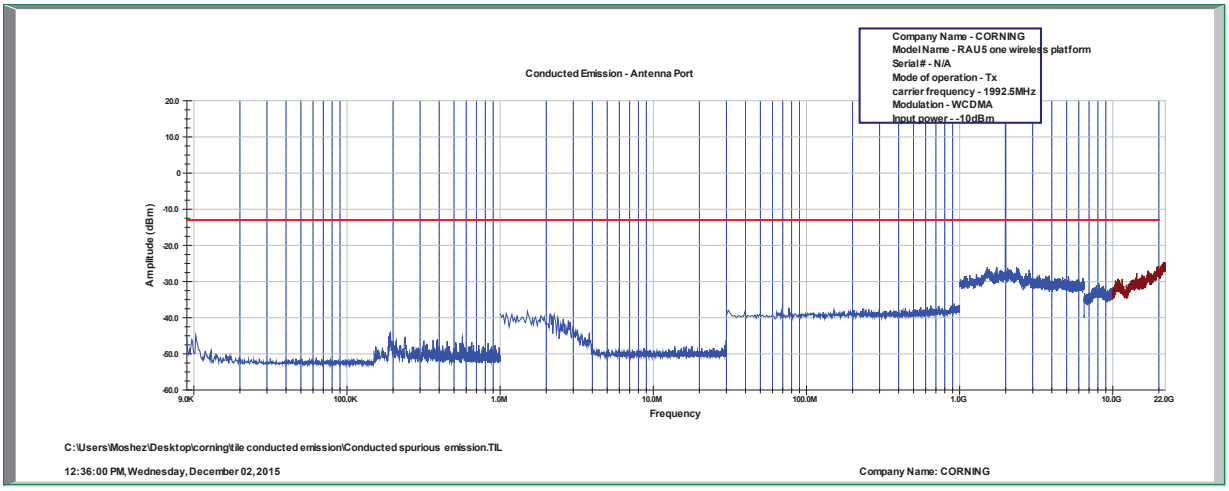


Figure 137 WCDMA - 1992.5 MHz

16.4 Test Equipment Used; Out of Band Emission at Antenna Terminals PCS

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 138 Test Equipment Used

17. Band Edge Spectrum (PCS)

17.1 Test Specification

FCC Part 24, Subpart E, Section 238; FCC Part 2.1051

17.2 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 100kHz.

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

17.1 Test Results

Modulation	Operation Frequency (MHz)	Band Edge Frequency (MHz)	Reading (dBm)	Specification (dBm)	Margin (dB)
LTE 64QAM	1935.0	1930.0	-27.9	-13.0	-14.9
	1990.0	1995.0	-31.1	-13.0	-18.1
GSM	1931.2	1930.0	-43.4	-13.0	-30.4
	1993.8	1995.0	-42.5	-13.0	-29.5
WCDMA	1932.5	1930.0	-25.4	-13.0	-12.4
	1992.5	1995.0	-30.8	-13.0	-17.8

Figure 139 Band Edge Spectrum Results PCS

See additional information in *Figure 140* to *Figure 145*.

JUDGEMENT: Passed by 12.4dB

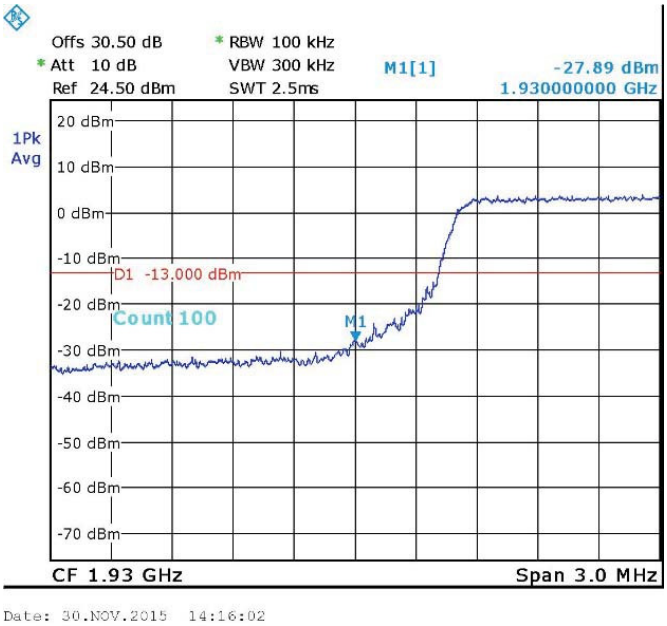


Figure 140— LTE 64QAM - 1935.0 MHz

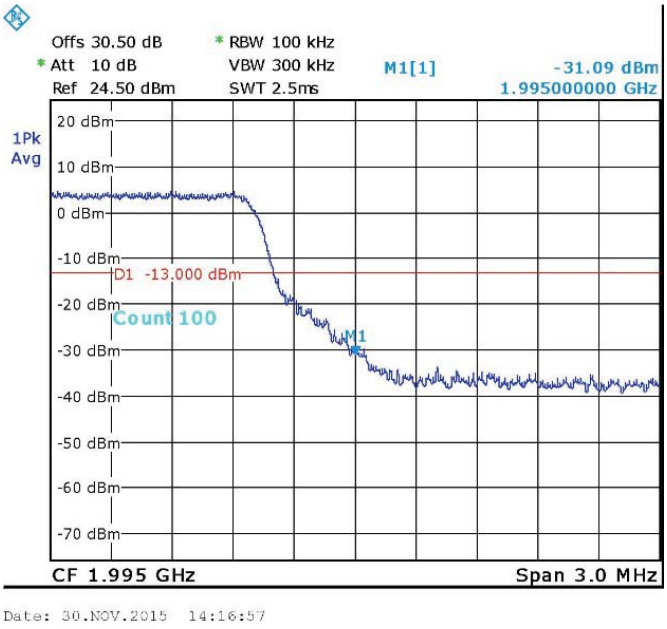


Figure 141— LTE 64QAM - 1990.0 MHz

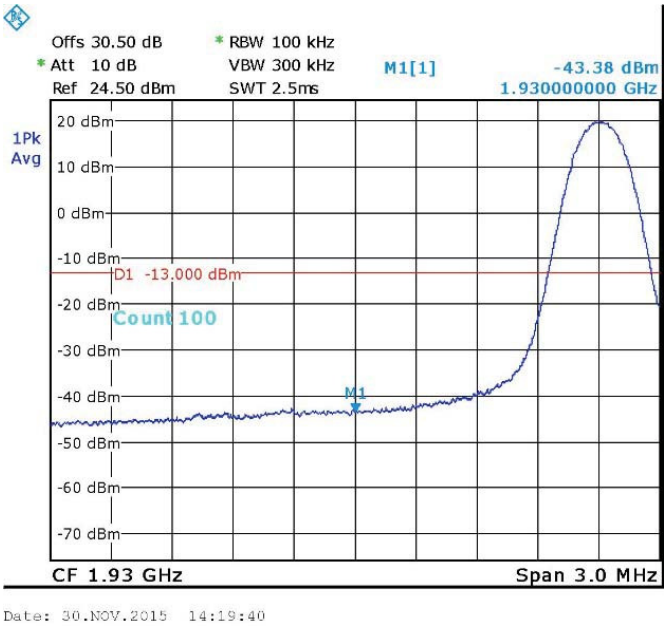


Figure 142—GSM - 1931.2 MHz

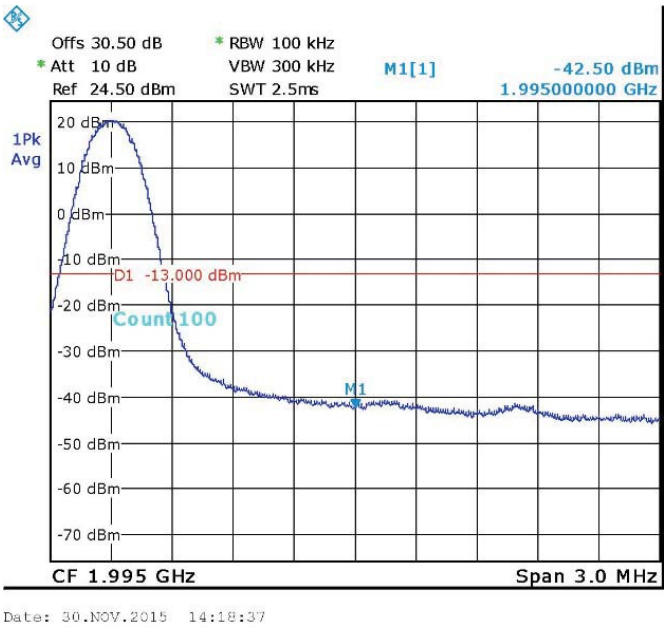
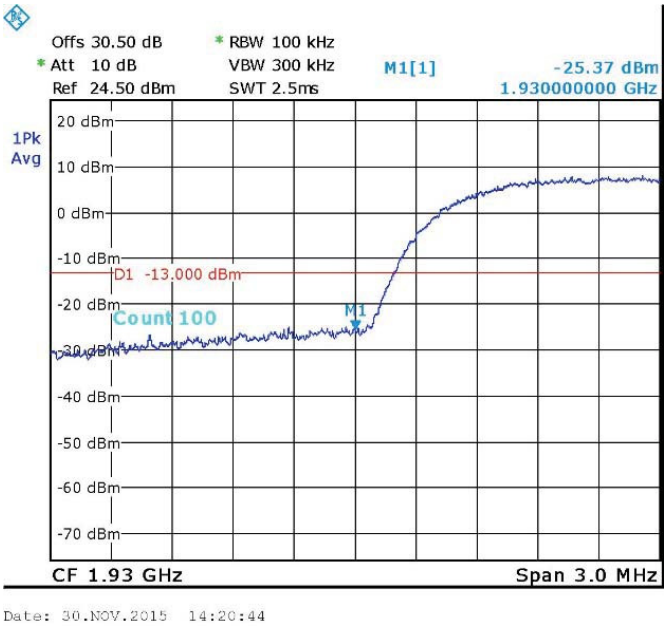
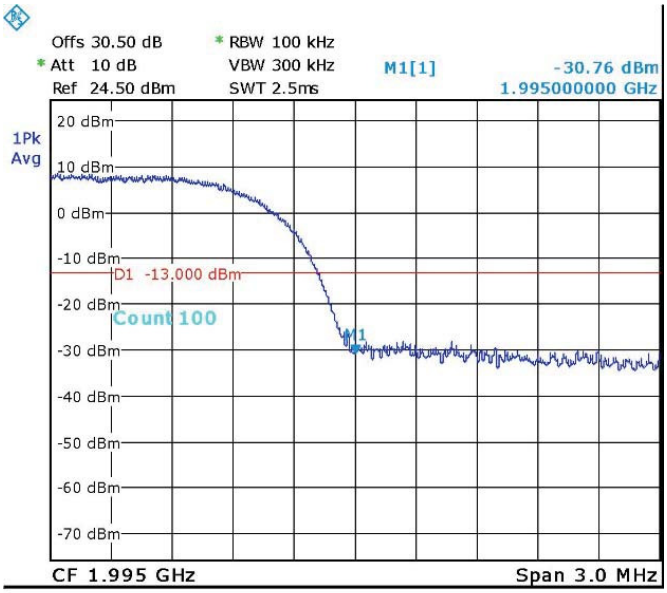


Figure 143— GSM - 1993.8 MHz



Date: 30.NOV.2015 14:20:44

Figure 144— WCDMA - 1932.5 MHz



Date: 30.NOV.2015 14:21:32

Figure 145—WCDMA - 1992.5 MHz

17.2 Test Equipment Used; Band Edge Spectrum PCS

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 146 Test Equipment Used

18. Out of Band Emissions (Radiated) (PCS)

18.1 Test Specification

FCC, Part 24, Subpart E Section 238, FCC Part 2.1053

18.2 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.

(a)The E.U.T. operation mode and test set-up are as described in Section 2 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 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 1GHz -22G 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.

(b)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.

18.3 Results Table

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)
1931.2	3862.4	V	41.2	-57.9	0.5	9.5	-48.9	-13.0	-35.9
1931.2	3862.4	H	39.0	-59.5	0.5	9.5	-50.5	-13.0	-37.5
1960.0	3920.0	V	38.2	-60.9	0.5	9.5	-51.9	-13.0	-38.9
1960.0	3920.0	H	39.2	-59.7	0.5	9.5	-50.7	-13.0	-37.7
1993.8	3987.6	V	38.9	-60.2	0.5	9.5	-51.2	-13.0	-38.2
1993.8	3987.6	H	39.2	-59.7	0.5	9.5	-50.7	-13.0	-37.7

Figure 147 Out of Band (Radiated) PCS

The E.U.T met the requirements of the FCC, Part 24, Subpart E, Section 238; FCC Part 2.1053 specifications.

JUDGEMENT: Passed by 35.9 dB

18.4 Test Instrumentation Used, Radiated Measurements (PCS)

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 148 Test Equipment Used

19. APPENDIX A - CORRECTION FACTORS

19.1 Correction factors for CABLE

from EMI receiver to test antenna at 3 meter range.

Frequency (MHz)	Cable Loss (dB)	Frequency (MHz)	Cable Loss (dB)
0.010	0.4	50.00	1.2
0.015	0.2	100.00	0.7
0.020	0.2	150.00	2.1
0.030	0.3	200.00	2.3
0.050	0.3	300.00	2.9
0.075	0.3	500.00	3.8
0.100	0.2	750.00	4.8
0.150	0.2	1000.00	5.4
0.200	0.3	1500.00	6.7
0.500	0.4	2000.00	9.0
1.00	0.4	2500.00	9.4
1.50	0.5	3000.00	9.9
2.00	0.5	3500.00	10.2
5.00	0.6	4000.00	11.2
10.00	0.8	4500.00	12.1
15.00	0.9	5000.00	13.1
20.00	0.8	5500.00	13.5
		6000.00	14.5

NOTES:

1. The cable type is SPUMA400 RF-11N(X2) and 39m long

2. The cable is manufactured by Huber + Suhner

19.2 Correction factors for Double Ridged Waveguide 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

19.3 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

19.4 Correction factors for Biconical Antenna Model 3104 Serial No 2606

CALIBRATION DATA

Frequency, MHz	Near free space antenna factor, dB/m	Geometry specific correction factor, dB	Free space antenna factor, dB/m [1)]
30	12.97	0.13	12.84
35	12.34	0.09	12.25
40	12.03	0.06	11.97
45	11.42	0.02	11.40
50	11.91	0.03	11.88
60	11.92	0.37	11.55
70	9.60	0.25	9.35
80	6.99	-0.45	7.44
90	10.87	-0.34	11.21
100	11.51	-0.06	11.57
120	13.30	0.20	13.10
140	12.56	-0.01	12.57
160	14.49	-0.12	14.61
180	16.53	0.05	16.48
200	15.30	0.15	15.15

[1)] The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

19.5 Correction factors for Log Periodic
Model 3146
Serial No: 9505-4081

CALIBRATION DATA

Frequency, MHz	Antenna factor, dB/m [1]
200	11.55
250	11.60
300	14.43
400	15.38
500	17.98
600	18.78
700	21.17
800	21.16
900	22.67
1000	24.09

[1] The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

19.6 Correction factors for Active Loop Antenna

Model 6502
Serial No: 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