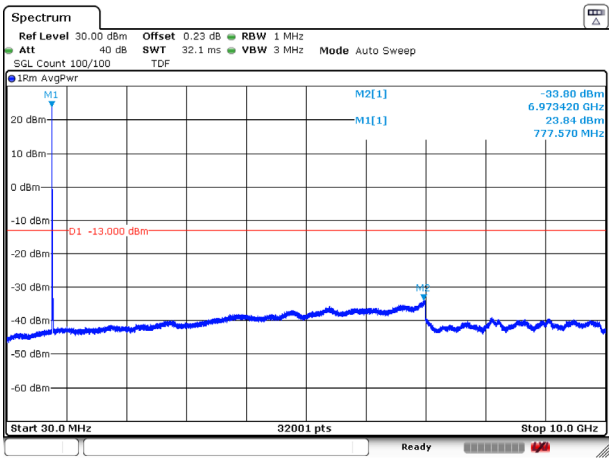
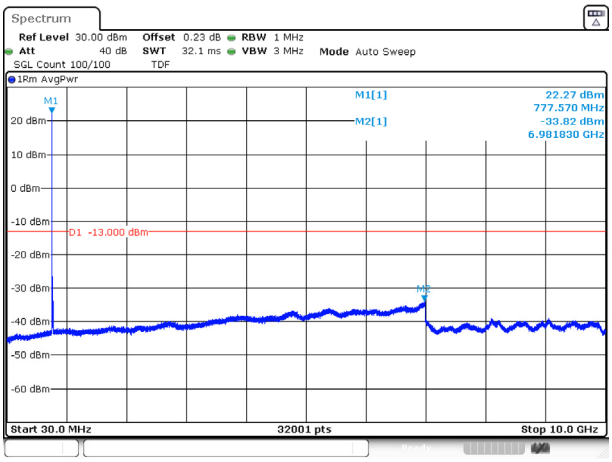
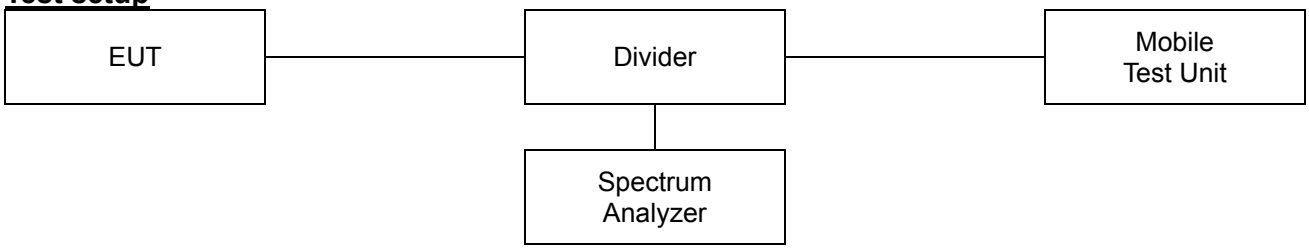
10M BW / QPSK / Mid ch.	10M BW / 16QAM / Mid ch.
	

7.4. Band Edge Emissions at Antenna Terminal

Test setup



Limit

According to §27.53(c)(2), on any frequency outside the 776-788 ㎒ band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10log($P_{[Watts]}$) ㏈.

According to §27.53(c)(4), on all frequencies between 763-775 ㎒ and 793-805 ㎒, by a factor not less than 65 + 10log($P_{[Watts]}$) ㏈ in a 6.25 ㎑ band segment, for mobile and portable stations.

Test procedure

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Test settings

1) Start frequency was set to 30 ㎒ and stop frequency was set to at least 10th the fundamental frequency.
2) Span was set large enough so as to capture all out of band emissions near the band edge.
3) Set the RBW > 1% of the emission bandwidth.
4) Set the VBW ≥ 3 x RBW.
5) Set the number of sweep points ≥ 2 x Span/RBW
6) Detector = RMS
7) Trace mode = trace average
8) Sweep time should be auto for peak detection. For RMS detection the sweep time should be set as follows:
   a) If the device can be configured to transmit continuously (duty cycle ≥ 98%), set the (sweep time) > (number of points in sweep) x (symbol period) (e.g., by a factor of 10 x symbol period x number of points)
   Increasing the sweep time (i.e., slowing the sweep speed) will allow for averaging over multiple symbols.
   b) If the device cannot transmit continuously (duty cycle < 98%), a gated sweep shall be used when possible (i.e., gate triggered such that the analyzer only sweeps when the device is transmitting at full power), set the sweep time > (number of points in sweep) x (symbol period) but the sweep time shall always be maintained at a value that is less than or equal to the minimum transmission time
   c) If the device cannot be configured to transmit continuously (duty cycle > 98%), and a free-running sweep must be used, set the sweep time so that the averaging is performed over multiple on/off cycles by setting the sweep time > (number of points in sweep) × (transmitter period) (i.e., the transmit on-time + the off-time). The spectrum analyzer readings shall subsequently be corrected by

[10 log (1/duty cycle)]. This assumes that the transmission period and duty cycle is relatively constant (duty cycle variation ≤ ±2%).

d) If the device cannot be configured to transmit continuously and a free-running sweep must be used, and if the transmissions exhibit a non-constant duty cycle (duty cycle variations > ±2%), set the sweep time so that the averaging is performed over the on-period by setting the sweep time > (symbol period) × (number of points), while also maintaining the sweep time < (transmitter on-time). The trace mode shall be set to max hold, since not every display point will be averaged only over just the on-time. Thus, multiple sweeps (e.g., 100) in maximum hold art necessary to ensure that the maximum power is measured.

9) Allow trace to fully stabilize.

Notes:

1. Per 27.53(c)(5), for operations in the 776-788 ㎒ band, in the 100 ㎑ bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 ㎑ may be employed.
2. Per 27.53(c)(6), for operations in the 763-775 ㎒ and 793-805 ㎒, the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 ㎑ segment.
3. The EUT was setup to maximum output power as its lowest and highest channel with all bandwidth, modulation and RB configurations.

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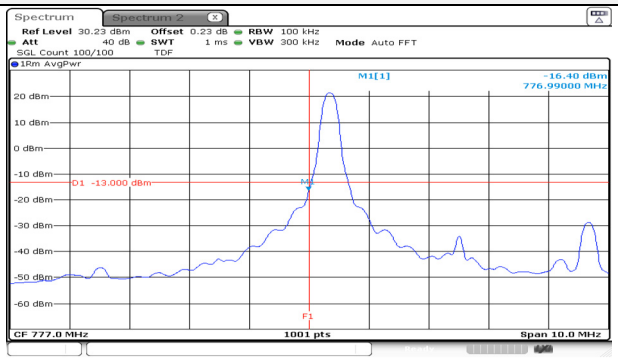
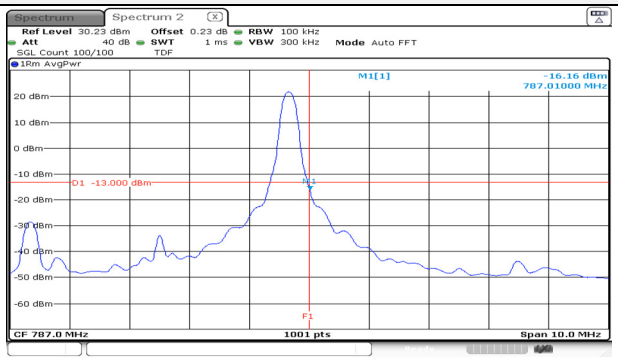
Test results

Test mode: LTE Band 13

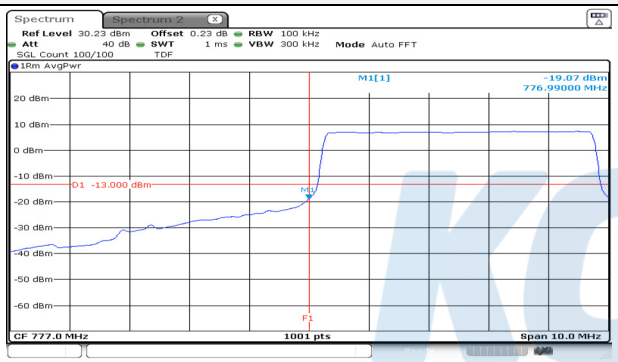
10M BW / QPSK / Lower / 1RB



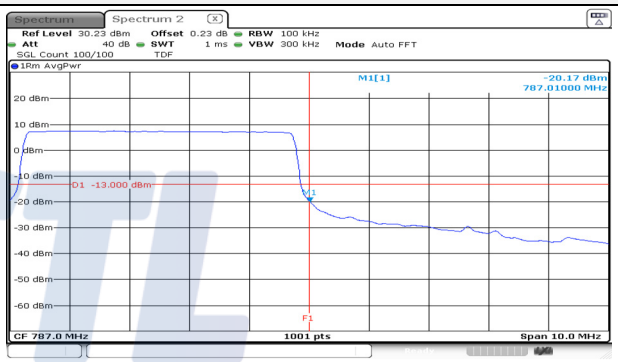
10M BW / QPSK / Upper / 1RB



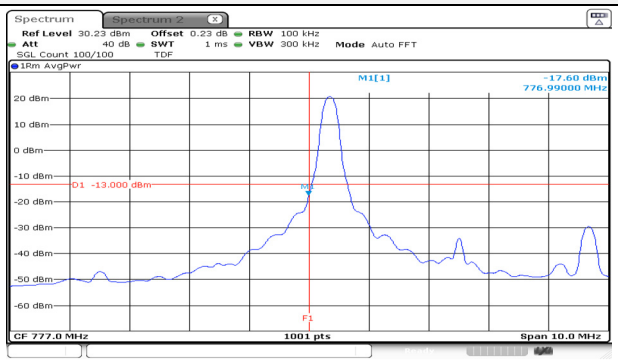
10M BW / QPSK / Lower / FRB



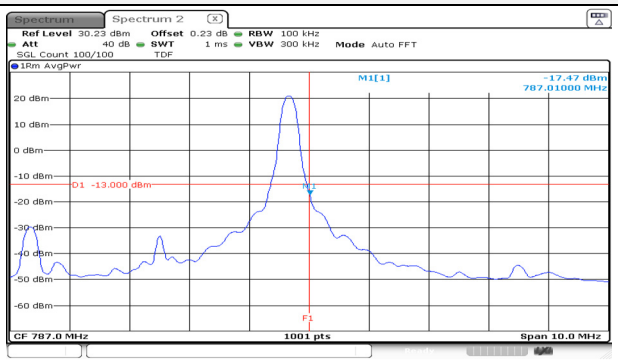
10M BW / QPSK / Upper / FRB



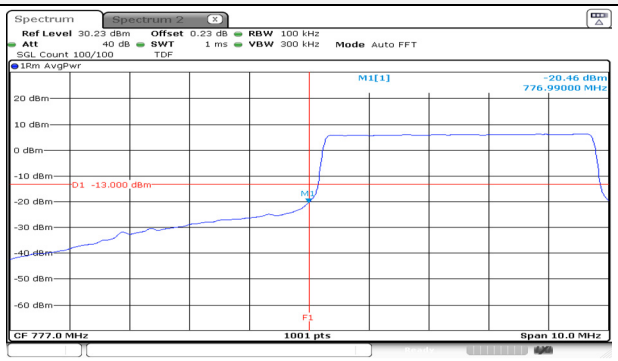
10M BW / 16QAM / Lower / 1RB



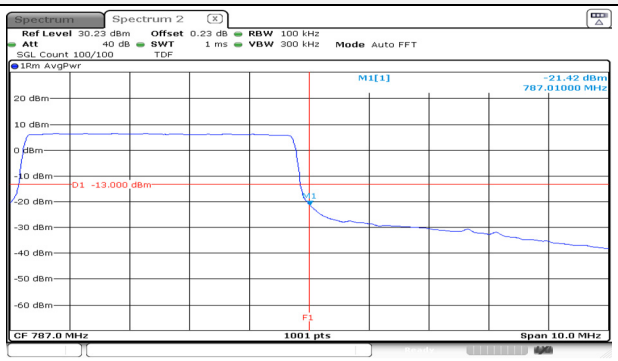
10M BW / 16QAM / Upper / 1RB



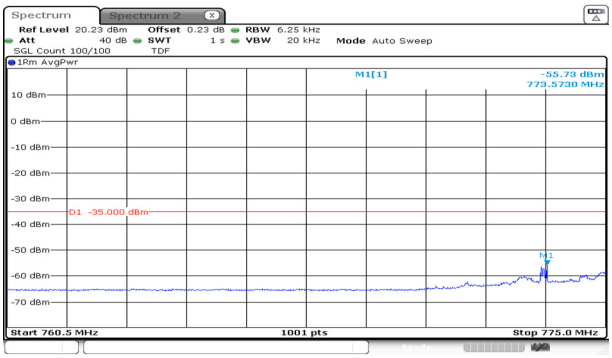
10M BW / 16QAM / Lower / FRB



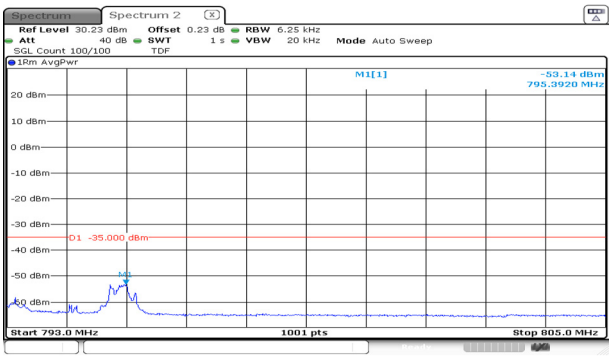
10M BW / 16QAM / Upper / FRB



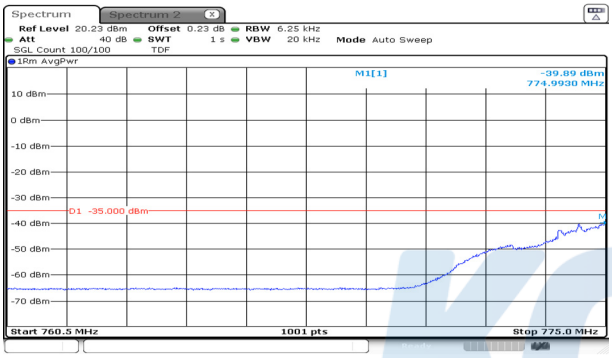
5M BW / QPSK / Lower extended / 1RB



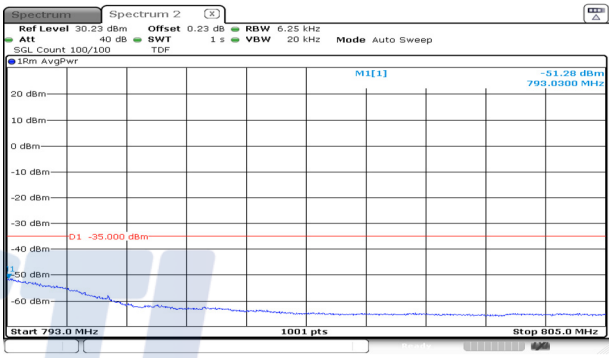
5M BW / QPSK / Upper extended / 1RB



5M BW / QPSK / Lower extended / FRB



5M BW / QPSK / Upper extended / FRB



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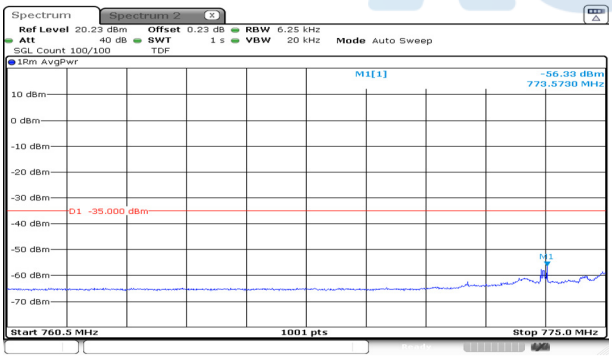

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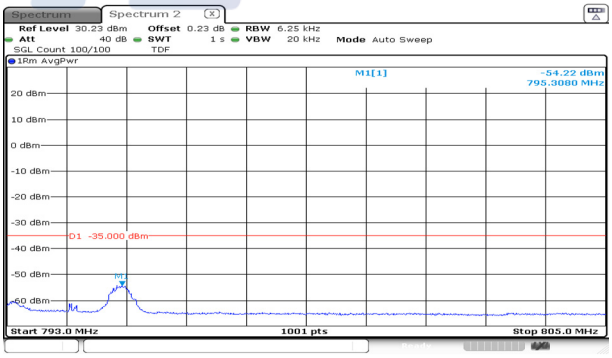
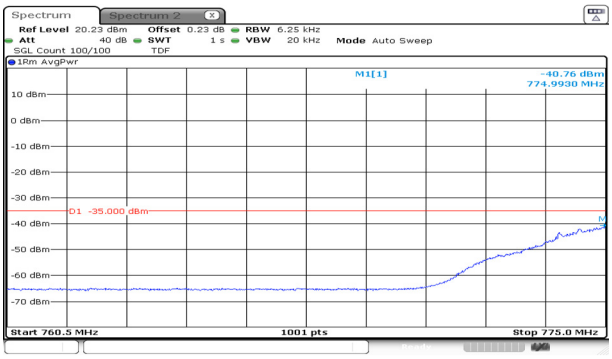


5M BW / 16QAM / Lower extended / FRB



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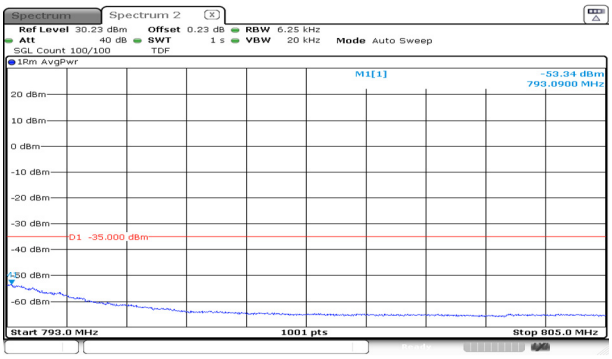
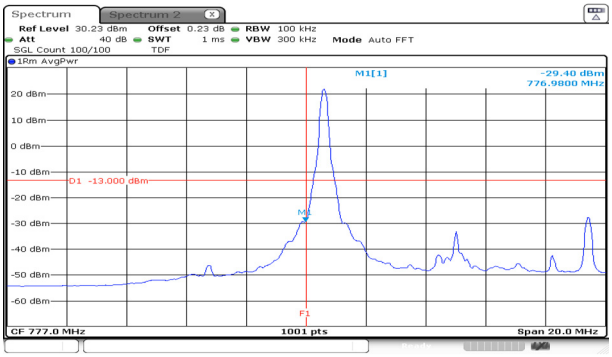


10M BW / QPSK / Lower / 1RB



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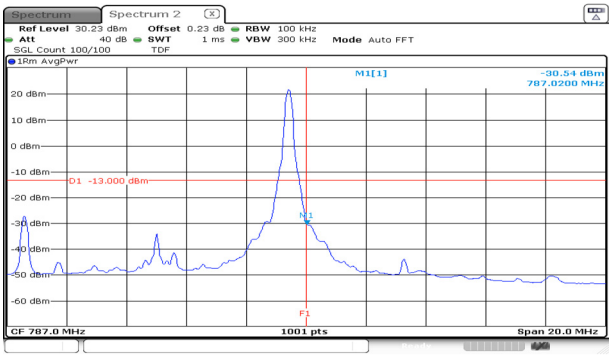

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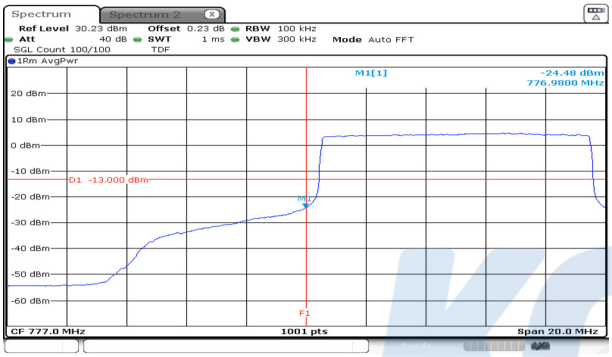
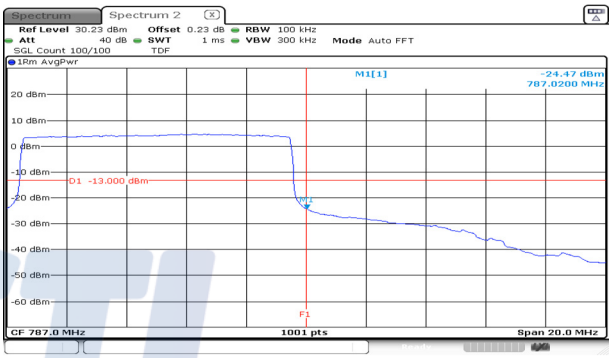


10M BW / QPSK / Upper / FRB



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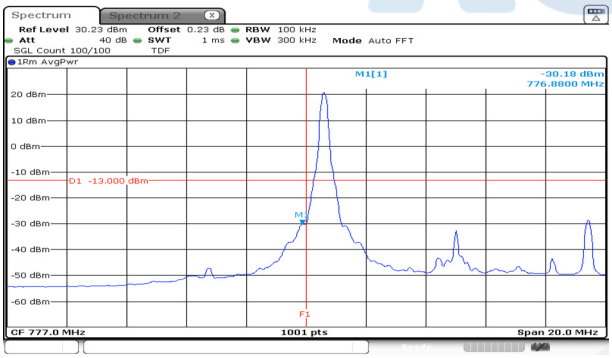
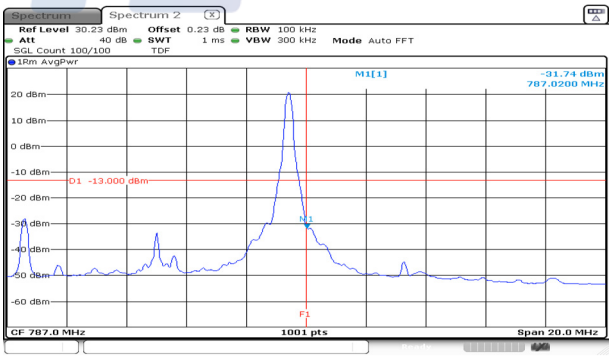
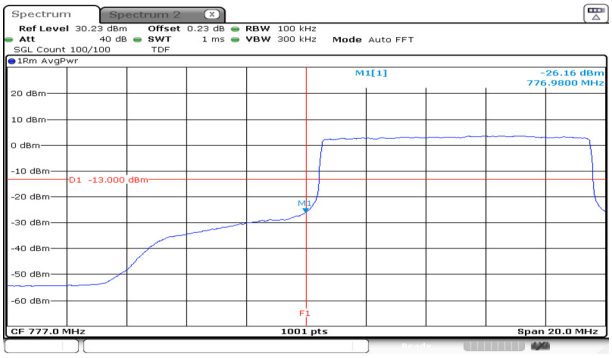


10M BW / 16QAM / Upper / 1RB



10M BW / 16QAM / Lower / FRB



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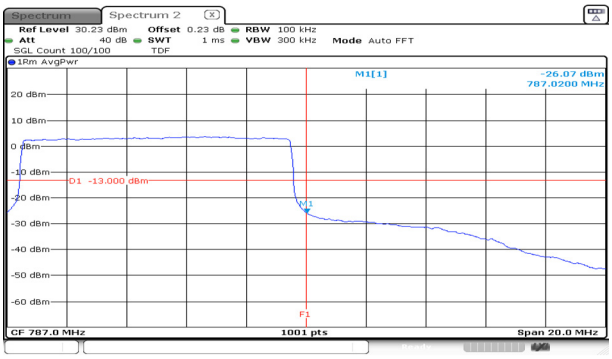
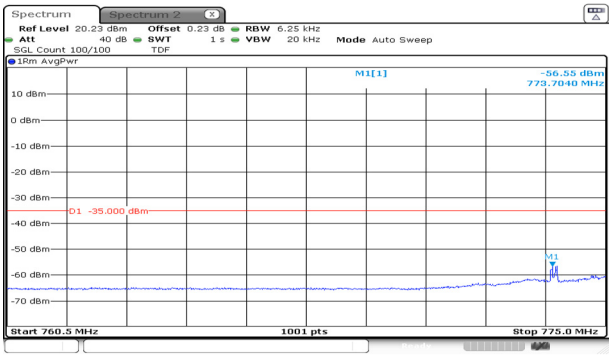


10M BW / QPSK / Lower extended / 1RB



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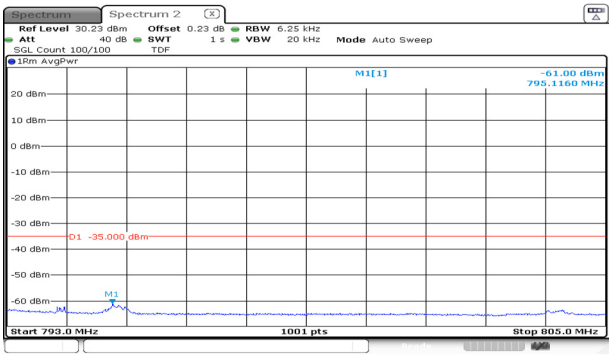

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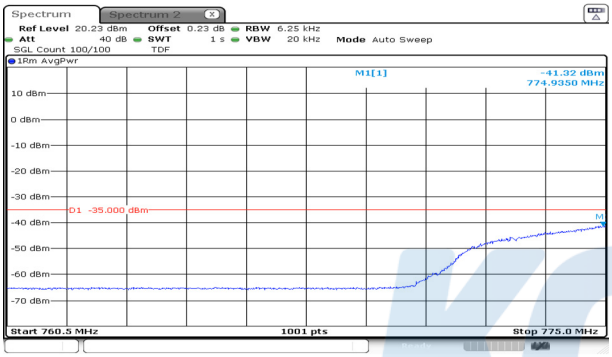
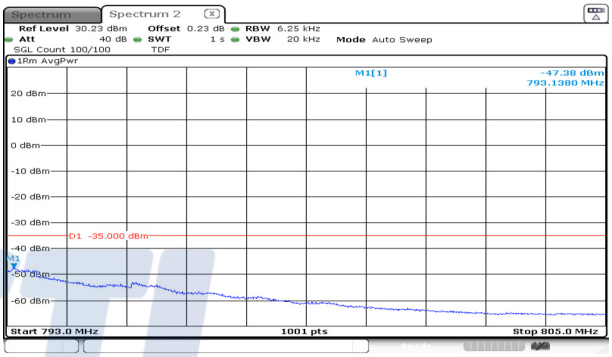
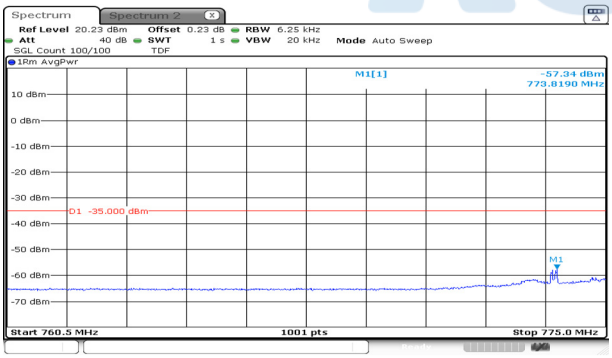


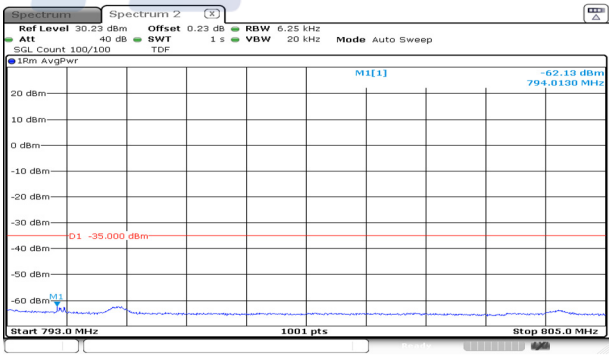
10M BW / QPSK / Upper extended / FRB



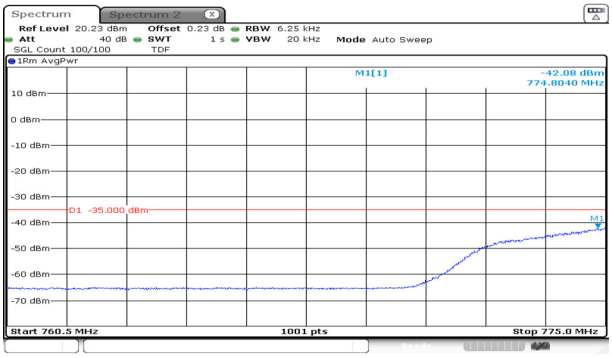
10M BW / 16QAM / Lower extended /1RB



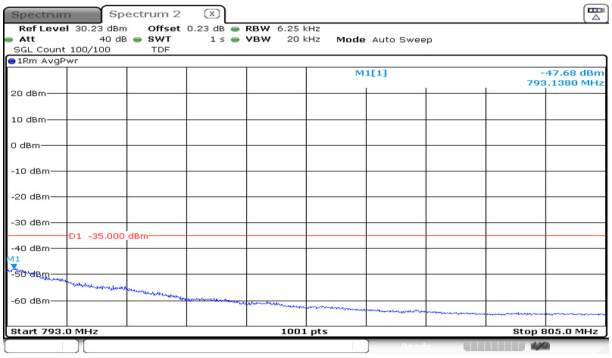
10M BW / 16QAM / Upper extended /1RB



10M BW / 16QAM /Lower extended/ FRB

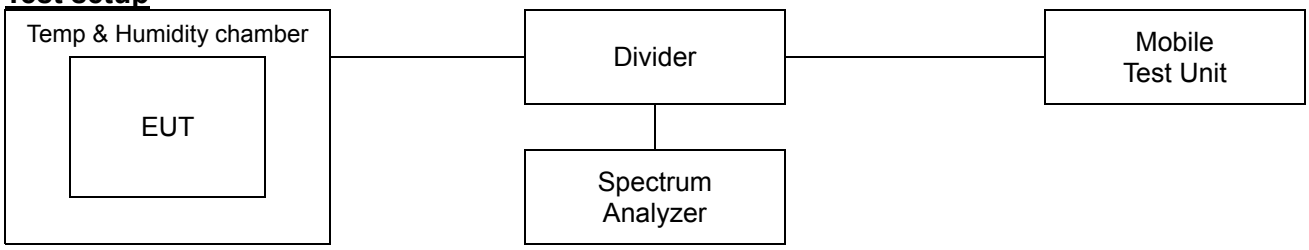


10M BW / 16QAM /Upper extended/ FRB



7.5. Frequency stability

Test setup



Limit

According to §2.1055(a),

The frequency stability shall be measured with variation of ambient temperature as follows:

1) From -30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
2) From -20° to + 50° centigrade for equipment to be licensed for use in the maritime services under part 80 of this chapter, except for class A, B, and S emergency position indicating radiobeacons (EPIRBS), and equipment to be licensed for use above 952 ㎒ at operational fixed stations in all services, stations in the local television transmission service and point-to-point microwave radio service under part 21 of this chapter, equipment licensed for use aboard aircraft in the aviation services under part 87 of this chapter, and equipment authorized for use in the family radio service under part 95 of this chapter.
3) From 0° to + 50° centigrade for equipment to be licensed for use in the radio broadcast Services under part 73 of this chapter.

According to §2.1055(d),

The frequency stability shall be measured with variation of primary supply Voltage as follows:

1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating and point which shall be specified by the manufacturer.
3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

According to §27.54,

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the Authorized bands of operation.

Test procedure

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Test settings

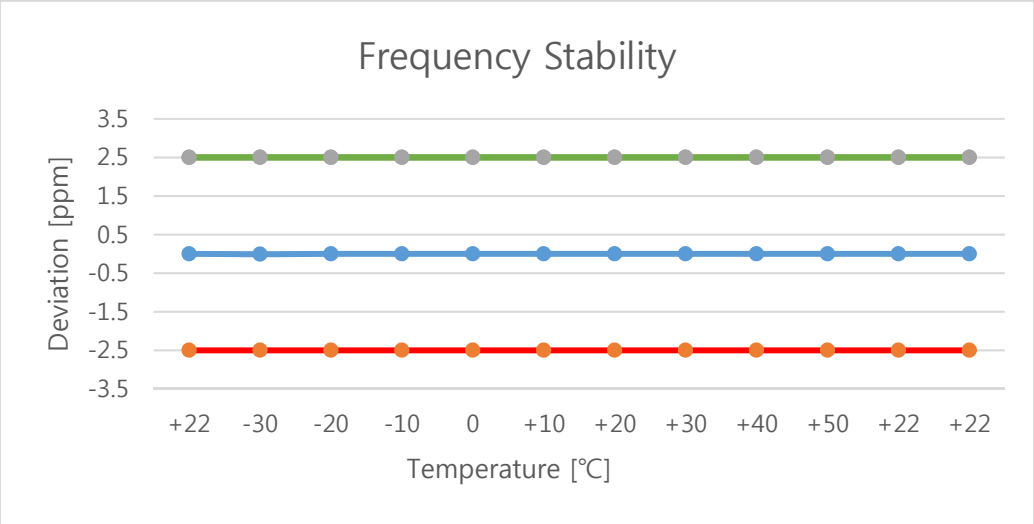
1) The carrier frequency of the transmitter is measured at room temperature. (20°C to provide a reference)
2) The equipment is turned on in a “standby” condition for one minute before applying power to the transmitter. Measurement of the carrier frequency of the transmitter is made within one minute after applying power to the transmitter.
3) Frequency measurements are made at 10°C intervals ranging from -30°C to +50°C. A period of at least one half-hour is provided to allow stabilization of the equipment at each Temperature level.

KCTL

Test results

Test mode : LTE Band 13
Frequency (Hz) : 782 000 000
Channel : 23230
Deviation limit : ±0.00025% or 2.5ppm

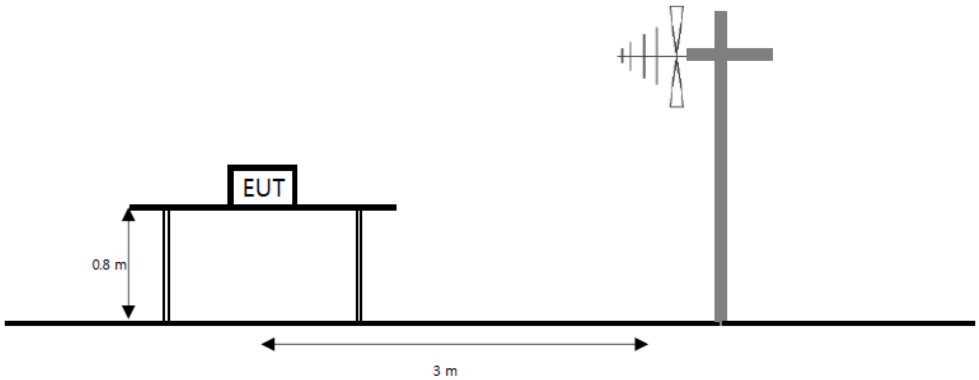
Voltage (%)	Power (V)	Temp. (°C)	Frequency (Hz)	Frequency error (Hz)	Deviation	
					(ppm)	(%)
100%	3.85	+22(Ref)	781,999,997	-2.96	0.0	0.000000
		-30	781,999,995	-4.73	0.0	-0.000001
		-20	781,999,997	-3.03	0.0	0.000000
		-10	781,999,997	-2.65	0.0	0.000000
		0	781,999,997	-3.28	0.0	0.000000
		+10	781,999,997	-3.16	0.0	0.000000
		+20	781,999,998	-1.96	0.0	0.000000
		+30	781,999,998	-1.89	0.0	0.000000
		+40	782,000,001	0.55	0.0	0.000000
		+50	782,000,002	2.26	0.0	0.000000
115%	4.43	+22	781,999,998	-2.09	0.0	0.000000
End point	2.55	+22	781,999,998	-2.32	0.0	0.000000



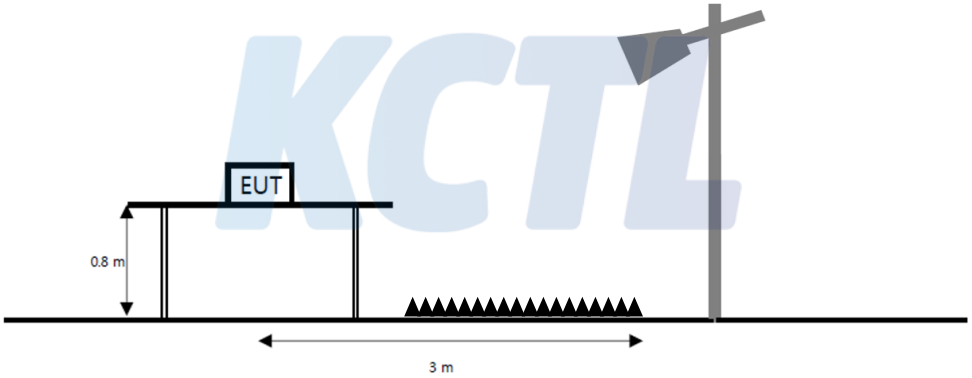
7.6. Radiated Power (ERP/EIRP)

Test setup

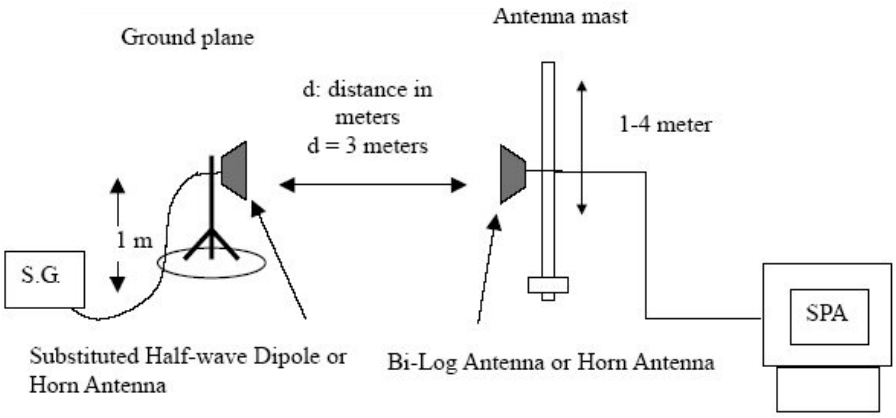
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



The diagram below shows the test setup for substituted method.



Limit

According to §27.50(b)(10), Portable stations (hand-held devices) in the 698 -746㎒, 746-757㎒, 776-788㎒, and 805-806 ㎒ bands are limited 3 watts ERP.

Test procedure

971168 D01 v03r01 - Section 5.2 and 5.8, 412172 D01 v01r01
ANSI 63.26-2015 – Section 5.2
ANSI/TIA-603-E-2016 - Section 2.2.17

Test settings

1) RBW = 1 % to 5 % of the OBW.
2) VBW ≥ 3 × RBW.
3) SPAN = 2 × to 3 × the OBW.
4) Number of measurement points in sweep ≥ 2 × span / RBW.
5) Sweep time :
   1) Auto couple, or
   2) ≥ [10 × (number of points in sweep) × (transmission period)] for single sweep (automation-compatible) measurement. Transmission period is the on and off time of the transmitter.
6) Detector = RMS
7) If the EUT can be configured to transmit continuously, then set the trigger to free run.
8) If the EUT cannot be configured to transmit continuously, then use a sweep trigger with the level set to enable triggering only on full power bursts and configure the EUT to transmit at full power for the entire duration of each sweep. Verify that the sweep time is less than or equal to the transmission burst duration. Time gating can also be used under similar constraints (i.e., configured such that measurement data is collected only during active full -power transmissions).
9) Trace mode = trace averaging (RMS) over 100 sweeps.
10) Compute the power by integrating the spectrum across the OBW of the signal using the instrument's band or channel power measurement function, with the band/channel limits set equal to the OBW band edges. If the instrument does not have a band or channel power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.
11) Allow trace to fully stabilize.

Notes:

1. On a test site, the EUT shall be placed at 80 cm height on a turn table, and in the position close To normal use as declared by the applicant.
2. The test antenna shall be oriented initially for vertical polarization located 3 m from EUT to Correspond to the fundamental frequency of the transmitter.
3. The turntable is rotated through 360°, and the receiving antenna scans in order to determine the Level of the maximized emission.
4. The test antenna shall be raised and lowered again through the specified range of height until the maximum signal level is detected by the measuring receiver.
5. The maximum signal level detected by the measuring receiver shall be noted.
6. The EUT was replaced by half-wave dipole (1 ㎓ below) or horn antenna (1 ㎓ above) connected to a signal generator.
   The power is calculated by the following formula;
   Pd(㏈m) = Pg(㏈m) – Cable loss (㏈) + Antenna gain (㏈)
   Note. Pd is the dipole equivalent power and Pg is the generator output power into the substitution antenna.
7. The test antenna shall be raised and lowered through the specified range of height to ensure that The maximum signal is received.
8. The input signal to the substitution antenna shall be adjusted to the level that produces a level Detected by the measuring corrected for the change of input attenuator setting of the measuring Receiver.
9. The input level to the substitution antenna shall be recorded as power level in ㏈m, corrected for Any change of input attenuator setting of the measuring receiver.
10. The measurement shall be repeated with the test antenna and the substitution antenna Orientated for horizontal polarization.

Test results

Test mode: LTE Band 13

Bandwidth	Modulation	Frequency	Pol.	Antenna Gain	C.L	Substitute Level	ERP	
		[㎒]	[V/H]	[dBi]	[dB]	[dBm]	[dBm]	[W]
5 M	QPSK	779.5	V	0.00	4.84	23.70	18.86	0.077
		782.0	V	0.10	4.93	23.48	18.65	0.073
		784.5	V	0.10	4.91	23.26	18.45	0.070
	16QAM	779.5	V	0.00	4.84	22.56	17.72	0.059
		782.0	V	0.10	4.93	22.56	17.73	0.059
		784.5	V	0.10	4.91	22.49	17.68	0.059
10 M	QPSK	782.0	V	0.10	4.93	23.86	**19.03**	**0.080**
	16QAM	782.0	V	0.10	4.93	22.85	18.02	0.063

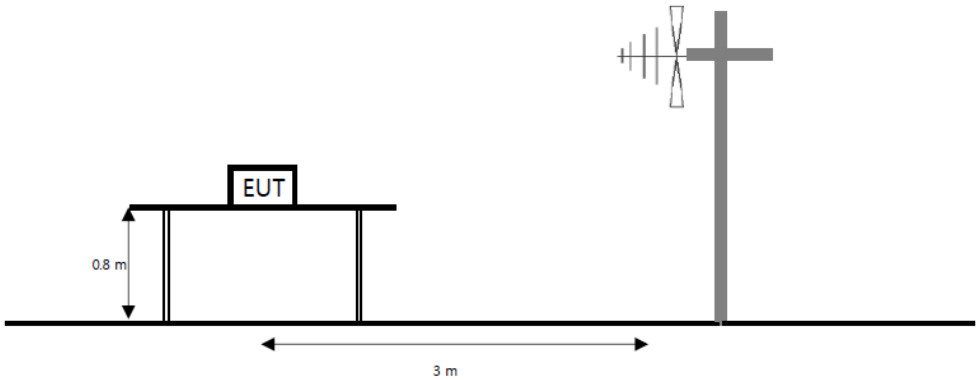
Note.
1. E.R.P & E.I.R.P(dBm) = Substitute Level(dB) + Antenna gain(dBi) - C.L(Cable loss) (dB)

KCTL

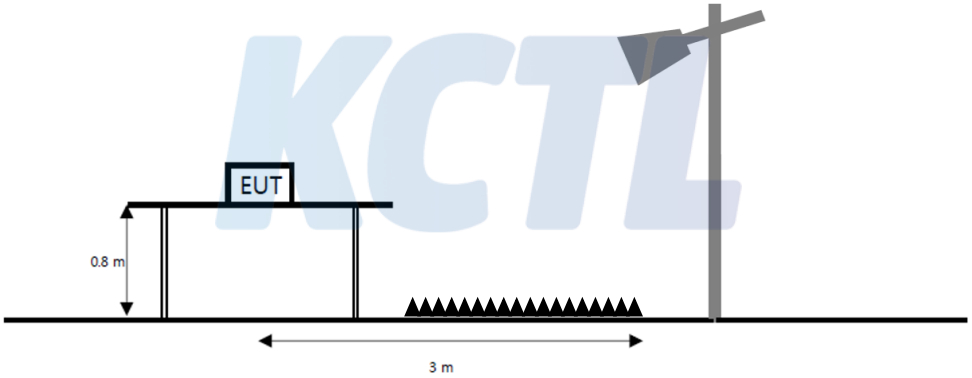
7.7. Radiated Spurious Emissions

Test setup

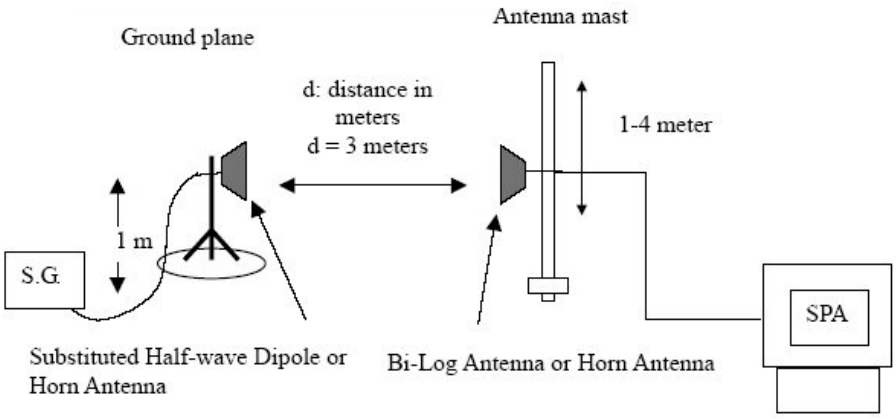
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



The diagram below shows the test setup for substituted method.



Limit

According to §27.53(c)(2), on any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10log($P_{[Watts]}$) dB and 27.53(f), for operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

Test procedure

971168 D01 v03r01 - Section 6.2
ANSI 63.26-2015 – Section 5.5
ANSI/TIA-603-E-2016 - Section 2.2.12

Test settings

1) RBW = 1 kHz for below 1 GHz and 1 MHz for above 1 GHz.
2) VBW ≥ 3 × RBW.
3) Detector = RMS
4) Trace mode = Max hold
5) Sweep time = Auto couple
6) Number of sweep points ≥ 2 × span / RBW
7) Allow trace to fully stabilize.

For the narrowband spurious settings:

1) RBW = 1 kHz
2) VBW = 3 kHz
3) Detector = RMS
4) Trace mode = Max hold
5) Sweep speed slow enough to maintain measurement calibration.

Notes:

1. On a test site, the EUT shall be placed at 80 ㎝ height on a turn table, and in the position close to normal use as declared by the applicant.
2. The test antenna shall be oriented initially for vertical polarization located 3 m from EUT to correspond to the fundamental frequency of the transmitter.
3. The turntable is rotated through 360°, and the receiving antenna scans in order to determine the level of the maximized emission.
4. The test antenna shall be raised and lowered again through the specified range of height until the maximum signal level is detected by the measuring receiver.
5. The maximum signal level detected by the measuring receiver shall be noted.
6. The EUT was replaced by half-wave dipole (1 ㎓ below) or horn antenna (1 ㎓ above) connected to a signal generator.
7. The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received.
8. The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring corrected for the change of input attenuator setting of the measuring receiver.
9. The input level to the substitution antenna shall be recorded as power level in ㏈m, corrected for any change of input attenuator setting of the measuring receiver.
10. The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

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Test results (Above 1 000 ㎒)

Test mode : LTE Band 13
Frequency(㎒) : 782.0
Channel : 23230
Bandwidth(㎒) : 10

Mode	Frequency	Pol.	Antenna Gain	Cable loss	Substitute Level	Level	Limit	Margin
	[㎒]	[V/H]	[dBi]	[dB]	[dBm]	[dBm]	[dBm]	[dB]
QPSK	1 554.04	V	6.54	5.20	-63.64	-62.30	-13.00	49.30
	2 333.08	H	6.00	6.44	-57.56	-58.00	-13.00	45.00
	3 108.63	V	6.94	7.43	-58.01	-58.50	-13.00	45.50
	3 886.18	V	8.42	8.35	-58.17	-58.10	-13.00	45.10

Test mode : LTE Band 13
Frequency(㎒) : 782.0 (1 559 – 1 610 ㎒)
Channel : 23230
Bandwidth(㎒) : 10

Mode	Frequency	Pol.	Antenna Gain	Cable loss	Substitute Level	Level	Limit	Margin
	[㎒]	[V/H]	[dBi]	[dB]	[dBm]	[dBm]	[dBm]	[dB]
QPSK	1 572.67	H	6.51	5.23	-99.48	-98.20	-50.00	48.20

Note.
1. Limit Calculation(dBm)= 43 + 10log($P_{[Watts]}$)
   Limit Calculation of wide-band (dBm/㎒) = -70dBW/㎒ (-40 dBm/㎒)
   Limit Calculation of narrow-band (dBm) = -80dBW (-50dBm)
2. ERP & E.I.R.P(dB m)= Substitute Level(dB) + Antenna gain(dBi) – Cable Loss(dB)

8. Measurement equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Spectrum Analyzer	R&S	FSV30	100808	20.07.30
Spectrum Analyzer	R&S	FSV30	100806	20.07.30
Spectrum Analyzer	AGILENT	N9040B	MY57010132	20.07.31
Vector Signal Generator	R&S	SMBV100A	257566	20.07.16
Signal Generator	R&S	SMR40	100007	20.05.13
Signal Generator	R&S	SMB100A	176206	21.01.21*
Wideband Radio Communication Tester	R&S	CMW500	141780	20.04.18
Wideband Radio Communication Tester	R&S	CMW500	137524	20.07.17
DC Power Supply	AGILENT	E3632A	MY40001543	20.05.13
DC Power Supply	AGILENT	E3632A	MY40018781	20.05.13
Power Divider	AGILENT	11636B	54456	21.01.06
Power Divider	Aeroflex/Weinschel, Inc.	1580-1	RZ184	21.01.06
Temp & Humid Chamber	ESPEC CORP.	SH-661	92004048	21.01.03
Biconical VHF-UHF Broadband Antenna	SCHWARZBECK	VUBA9117	275	20.04.13
Bilog Antenna	Teseq GmbH	CBL 6143A	35039	21.05.21
Horn Antenna	ETS.lindgren	3115	62589	20.05.09
Horn Antenna	ETS.lindgren	3117	161225	20.05.22
Horn Antenna	ETS.lindgren	3116	00086632	20.02.15
Horn Antenna	ETS.lindgren	3116	00086635	20.05.09
High pass Filter	Wainwright Instruments GmbH	WHKX3.0/18G-12SS	44	21.01.21*
High pass Filter	Wainwright Instruments GmbH	WHKX1.0/1.5S-10SS	14	21.01.21*
Attenuator	Weinschel ENGINEERING	10	AJ1239	20.05.14
Attenuator	API Inmet	40AH2W-10	12	20.05.15
Amplifier	SONOMA INSTRUMENT	310N	186280	20.04.04
Amplifier	L-3 Narda-MITEQ	AMF-7D-01001800-22-10P	2031196	20.02.21
Amplifier	L-3 Narda-MITEQ	JS44-18004000-33-8P	2000997	20.08.01
Antenna Mast	MATURO	EAS 1.5	042/8941211	N/A
Antenna Mast	MATURO	EAS 1.5	043/8941211	N/A
Turn Table	MATURO	TT 0.8 PF	041/8941211	N/A

*The equipment was used after finished calibration.

End of test report

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