TEST REPORT

Part 95(A/B) & IC RSS-210(Issue 8)

Equipment under test	GMRS / FRS 2-way Radio
Model name	T35
FCC ID	MMAT35
IC Certification	3690A-T35
Applicant	Midland Radio Corporation
Manufacturer	Global Link Corporation Ltd.
Date of test(s)	2014.11.10~2014.11.19
Date of issue	2014.11.24

Issued to

Midland Radio Corporation

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Issued by

KES Co., Ltd.

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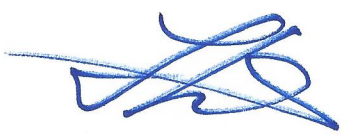
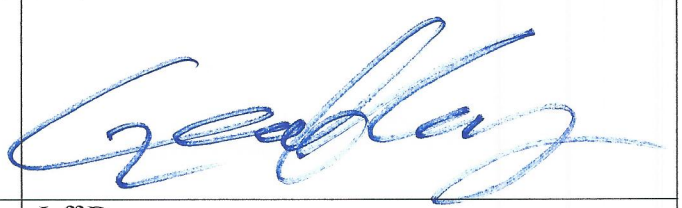
Test and report completed by :	**Report approval by :**
	
Hyeon-Su Jang Test engineer	Jeff Do Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2014.11.24	KES-RF-14T0050	Initial

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1. General information

Applicant:	Midland Radio Corporation
Applicant address:	5900 Parretta Drive, Kansas City, Missouri United States 64120
Test site:	KES Co., Ltd.
Test site address:	C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si, Gyeonggi-do,431-716, Korea 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
FCC rule part(s):	FCC Part 95
IC rule part(s):	RSS-210
Model:	T35
FCC ID:	MMAT35
IC Certification:	3690A-T35
Test device serial No.:	☐ Production ☒ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	FRS / GMRS
Serial number	S1409000001
Frequency range	462.562 5 ㎒ ~ 462.712 5 ㎒ (GMRS Channels 1 ~7) 467.562 5 ㎒ ~ 467.712 5 ㎒ (FRS Channels 8 ~ 14) 462.550 0 ㎒ ~ 462.725 0 ㎒ (GMRS Channels 15 ~ 22)
Type of Emission	11K0F3E
E.R.P.	GMRS: 0.101 W// FRS: 0.063 W
Number of channels	22
Power source	DC 3.6 V

1.2. Test configuration

The GMRS / FRS 2-way Radio FCC ID: MMAT35 was tested per the guidance of ANSI C63.10-2009, ANSI/TIA 603C: 2004 and RSS-210 (Issue 8) was used to reference the appropriate EUT setup for radiated spurious emissions testing.

1.3. Frequency/channel operations

Mode	Ch.	Frequency (㎒)
GMRS	1	462.562 5
	2	462.587 5
	3	462.612 5
	4	462.637 5
	5	462.662 5
	6	462.687 5
	7	462.712 5
FRS	8	467.562 5
	9	467.587 5
	10	467.612 5
	11	467.637 5
	12	467.662 5
	13	467.687 5
	14	467.712 5
GMRS	15	462.550 0
	16	462.575 0
	17	462.600 0
	18	462.625 0
	19	462.650 0
	20	462.675 0
	21	462.700 0
	22	462.725 0

1.4. Information about derivative model

N/A

1.5. Conclusion of worst-case for each mode of representative channel respectively

The EUT has 2 type of mode (GMRS and FRS). Each conducted output power as following;

Mode	Channel No.	Frequency(㎒)	Conducted output power	
			dBm	W
GMRS	1	462.562 5	25.94	0.393
	2	462.587 5	25.95	0.394
	3	462.612 5	25.95	0.394
	4	462.637 5	25.96	0.394
	5	462.662 5	25.97	0.395
	6	462.687 5	25.98	0.396
	7	462.712 5	25.96	0.394
FRS	**8**	**467.562 5**	**26.05**	**0.403**
	9	467.587 5	26.04	0.402
	10	467.612 5	26.03	0.401
	11	467.637 5	26.04	0.402
	12	467.662 5	26.03	0.401
	13	467.687 5	26.04	0.402
	14	467.712 5	26.04	0.402
GMRS	15	462.550 0	25.96	0.394
	16	462.575 0	25.97	0.395
	17	462.600 0	25.97	0.395
	18	462.625 0	25.97	0.396
	19	462.650 0	25.98	0.396
	20	**462.675 0**	**25.99**	**0.397**
	21	462.700 0	25.98	0.396
	22	462.725 0	25.98	0.396

Therefore all applicable requirements were tested to the two channels, the 20th for GMRS and the 8th for FRS.

DC input into the final amplifier

Mode	Voltage(V)	Current(A)	Power(W)
GMRS	3.6	0.32	1.15
FRS	3.6	0.33	1.19

2. Summary of tests

Reference	Test description	Test results
95.639 RSS-210 A6.1.4 RSS-210 A6.2.4	RF output power	PASS
95.635 RSS-210 A6.1.5 RSS-201 A6.2.5	Radiated spurious emissions	PASS
95.637 RSS-210 A6.1.2 RSS-210 A6.2.2	Modulation limiting	PASS
2.1047	Audio frequency response	PASS
95.637 RSS-210 A6.2.2	Low-pass filter response	PASS
2.1049, 95.633, 95.635 RSS-210 A6.1.3 RSS-210 A6.2.3 RSS-210 A6.1.5 RSS-210 A6.2.5	Occupied bandwidth and emission mask	PASS
2.1055, 95.621, 95.627 RSS-210 A6.1.6 RSS-201 A6.2.6	Frequency stability	PASS

Note:

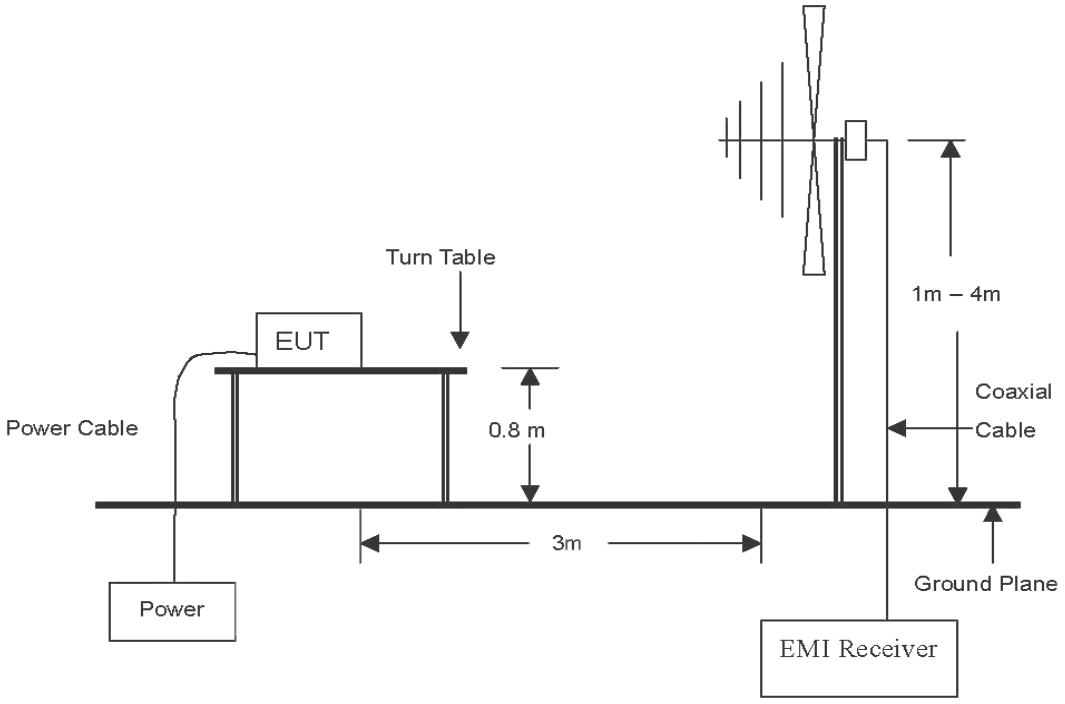
1. The measurement procedures described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 ㎑ to 40 ㎓ (ANSI C63.4-2009, ANSI/TIA 603C: 2004), RSS-210 (Issue 8) were used in the measurement of the DUT.
2. All modes of operation were investigated. The test results shown in the following sections represent the worst case emissions.

3. Test results

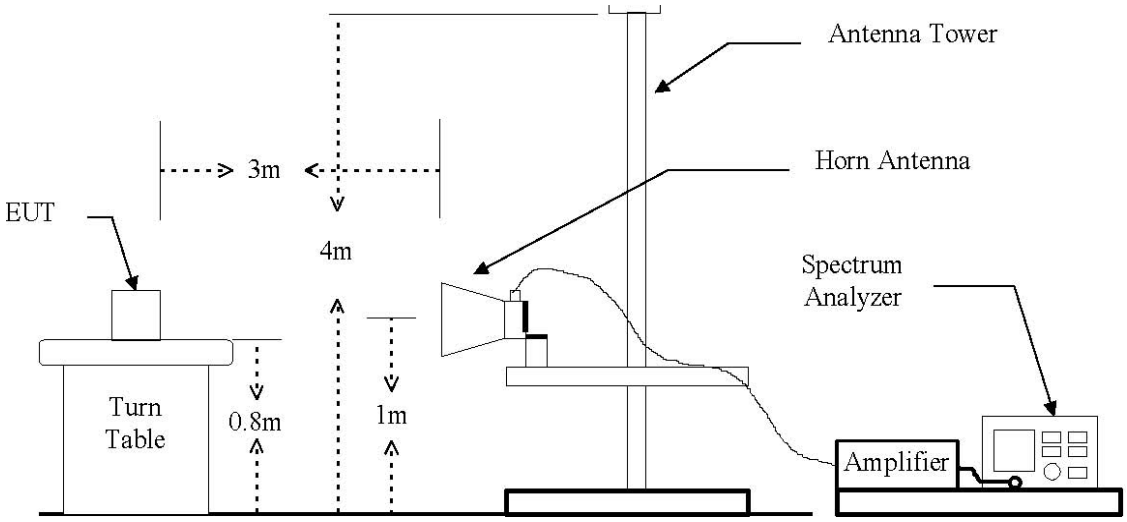
3.1. RF output power and radiated spurious emission

Test setup

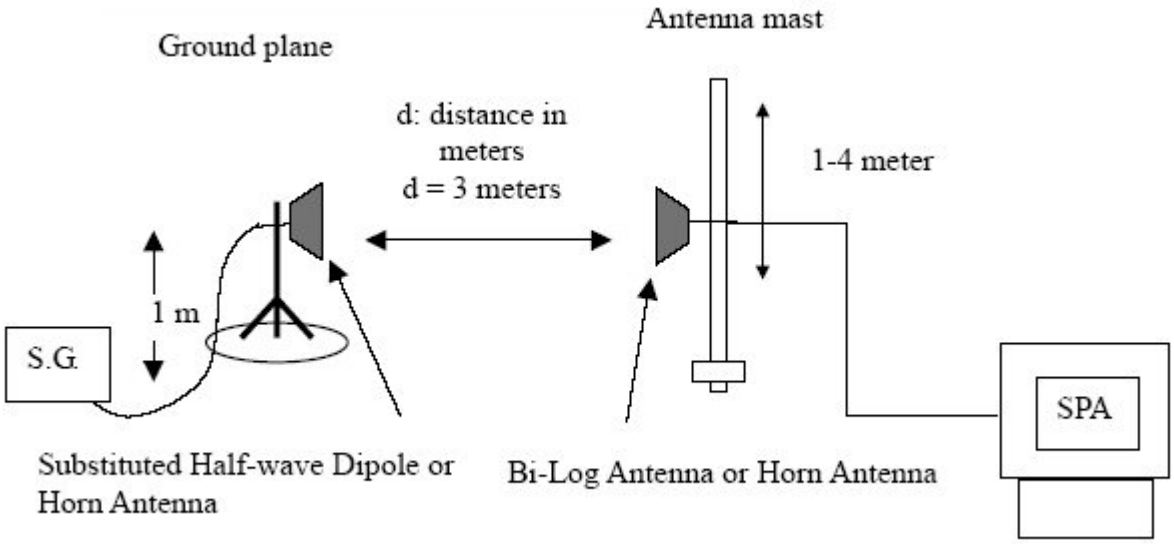
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to 18 ㎓ Emissions.



The diagram below shows the test setup for substituted method



Test procedure: Based on ANSI/TIA 603C: 2004

RF output power & radiated spurious emissions

1. On a test site, the EUT shall be placed at 80 ㎝ height on a turn table, and in the position closest to normal use as declared by the applicant.
2. The test antenna shall be oriented initially for vertical polarization located 3m from EUT to correspond to the fundamental frequency of the transmitter.
3. The output of the test antenna shall be connected to the measuring receiver and the peak detector is used for the measurement.
4. During the measurement of the EUT, the resolution bandwidth was to 1 ㎒ and the video bandwidth was set to 1 ㎒
5. The transmitter shall be switched on, the measuring receiver shall be tuned to the frequency of the transmitter under test.
6. The test antenna shall be raised and lowered through the specified range of height until a maximum signal level is detected by the measuring receiver.
7. The transmitter shall then the rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.
8. The test antenna shall be raised and lowered again through the specified range of height until a maximum signal level is detected by the measuring receiver.
9. The maximum signal level detected by the measuring receiver shall be noted.
10. The EUT was replaced by half-wave dipole(below 1000 ㎒) or horn antenna(above 1000 ㎒) connected to a signal generator.
11. In necessary, the input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver.
12. The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received.
13. The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring received, which is equal to the level noted while the transmitter radiated power was measured, corrected for the change of input attenuator setting of the measuring receiver.
14. 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.
15. The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

Limit

RF output power

§95.639
Power output shall not exceed 0.50 Watts effective radiated power for the FRS channels. There can be no provisions for increasing the power or varying the power.
No GMRS channel, under any condition of modulation, shall exceed:

1. 50W Carrier power (average TP during one modulated RF cycle) when transmitting emissions type A1D, F1D, G1D, A3E, F3E, or G3E.
2. 50W peak envelope TP when transmitting emission type H1D, J1D, R1D, H3E, J3E or R3E.

RSS-210 A6.1.4
The maximum permissible transmitter output power under any operating conditions is 0.5 W effective radiated power (e.r.p.). The radio shall be equipped with an integral antenna.

RSS-210 A6.2.4
A GMRS transmitter may transmit with a maximum power of 2 W e.r.p.

Radiated spurious emissions

§95.635 & RSS-201 A6.1.5, A6.2.5
(7) At least 43 + 10 $\log_{10}$(T) dB on any frequency removed from the center of the authorized bandwidth by more than 250%.

Test results

RF output power

Mode: GRMS
Distance of measurement: 3 meter
Operating frequency: 462.6750 ㎒
Channel: 20

Frequency (㎒)	Ant. Pol. (H/V)	E.R.P.	
		(dBm)	(W)
462.6750	H	20.05	0.101
462.6750	V	18.76	0.075

Mode: FRS
Distance of measurement: 3 meter
Operating frequency: 467.5625 ㎒
Channel: 08

Frequency (㎒)	Ant. Pol. (H/V)	E.R.P.	
		(dBm)	(W)
467.5625	H	18.00	0.063
467.5625	V	16.42	0.044

Radiated spurious emissions

Mode:	GRMS
Distance of measurement:	3 meter
Operating frequency:	462.6750 ㎒
Channel:	20

Frequency (㎒)	Ant. Pol. (H/V)	Spurious attenuation (dBc)	Limit (dBc)	Margin (dB)
925.350	H	57.52	33.05	24.47
925.350	V	56.11	33.05	23.06
1388.025	H	45.38	33.05	12.33
1388.025	V	54.40	33.05	21.35
1850.700	H	47.80	33.05	14.75
1850.700	V	53.43	33.05	20.38
2313.375	H	49.97	33.05	16.92
2313.375	V	54.83	33.05	21.78
2776.050	H	50.48	33.05	17.43
2776.050	V	48.97	33.05	15.92
3238.725	H	50.12	33.05	17.07
3238.725	V	59.37	33.05	26.32
3701.400	H	48.61	33.05	15.56
3701.400	V	50.84	33.05	17.79
4164.075	H	61.03	33.05	27.98
4164.075	V	62.83	33.05	29.78
4626.750	H	63.17	33.05	30.12
4626.750	V	64.23	33.05	31.18

Remark;
1. Spurious attenuation = EUT max. output power(㏈m) - absolute level
2. Spurious attenuation limit in ㏈ = 43 + 10log(power in watts)

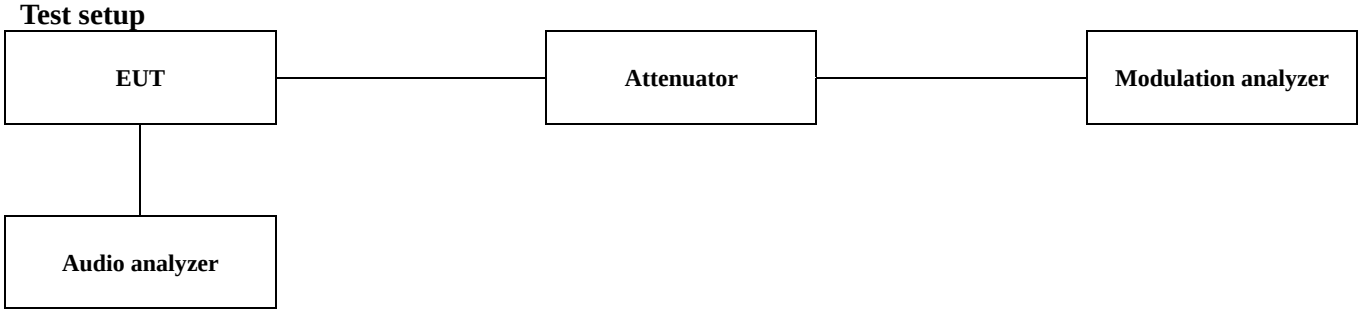
Mode:	FRS
Distance of measurement:	3 meter
Operating frequency:	467.5625 ㎒
Channel:	08

Frequency (㎒)	Ant. Pol. (H/V)	Spurious attenuation (dBc)	Limit (dBc)	Margin (dB)
935.1250	H	56.21	31.00	25.21
935.1250	V	52.85	31.00	21.85
1402.6875	H	44.23	31.00	13.23
1402.6875	V	49.89	31.00	18.89
1870.2500	H	49.68	31.00	18.68
1870.2500	V	49.10	31.00	18.10
2337.8125	H	52.61	31.00	21.61
2337.8125	V	58.31	31.00	27.31
2805.3750	H	48.48	31.00	17.48
2805.3750	V	45.18	31.00	14.18
3272.9375	H	52.58	31.00	21.58
3272.9375	V	57.95	31.00	26.95
3740.5000	H	46.68	31.00	15.68
3740.5000	V	46.79	31.00	15.79
4208.0625	H	60.69	31.00	29.69
4208.0625	V	60.00	31.00	29.00
4675.6250	H	67.50	31.00	36.50
4675.6250	V	63.81	31.00	32.81

Remark;
1. Spurious attenuation = EUT max. output power(㏈m) - absolute level
2. Spurious attenuation limit in ㏈ = 43 + 10log(power in watts)

3.2. Modulation limiting

Test setup



Test procedure
TIA/EIA-603-C

Limit
§95.639
(a) A GMRS transmitter that transmits emission types F1D, G1D, or G3E must not exceed a peak frequency deviation of plus or minus 5 ㎑. A GMRS transmitter that transmits emission type F3E must not exceed a peak frequency deviation of plus or minus 5 ㎑. A FRS unit that transmits emission type F3E must not exceed a peak frequency deviation of plus or minus 2.5 ㎑, and the audio frequency response must not exceed 3.125 ㎑.

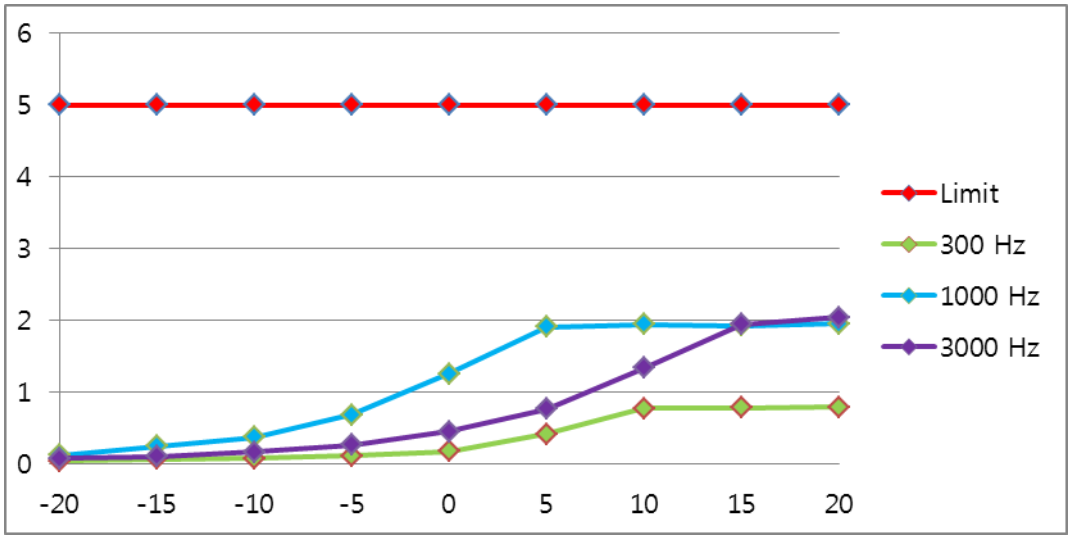
RSS-210 A6.1.2
(c) The peak frequency deviation shall not exceed ±2.5 ㎑. The limiter shall be followed by a low-pass filter to remove unwanted harmonics.

RSS-210 A6.2.2
(b) For emission types F1D, G1D, G3E, F3E or F2D, the peak frequency deviation shall not exceed ±5 ㎑. GMRS transmitters must include an audio frequency low-pass filter, unless they comply with the appropriate emission masks in Section A6.2.5 below. The filter must be between the modulation limiter and the modulated stage of the transmitter. The filter attenuation must be as follows: for 3 ㎑ ≤ f ≤ 20 ㎑, the attenuation is at least 60 $\log_{10}$(f, ㎑/3) ㏈ greater than the attenuation at 1 ㎑; and for f > 20 ㎑, the attenuation is at least 50 ㏈ greater than the attenuation at 1 ㎑.

Test results

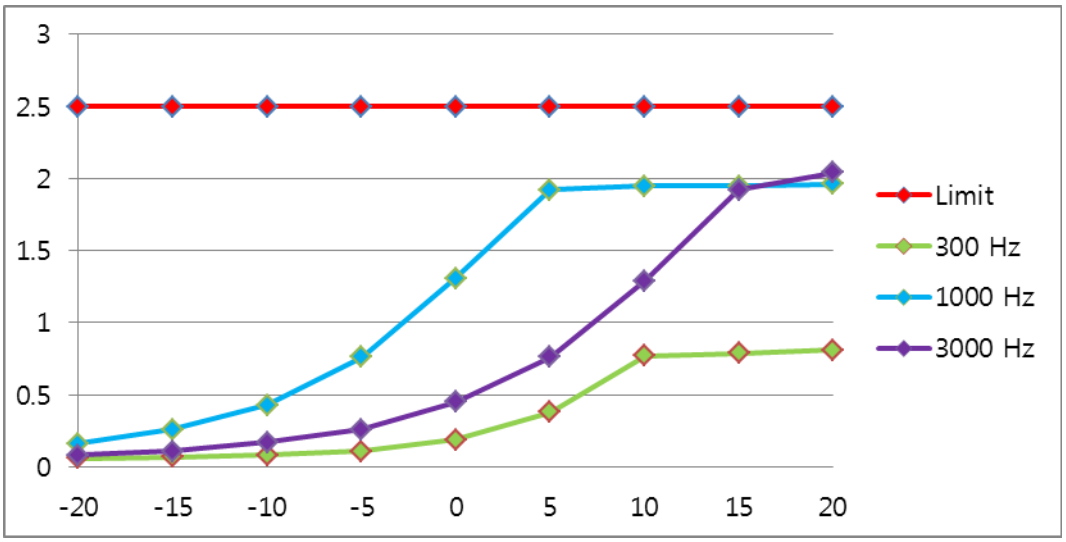
GMRS

Audio level (dB)	Deviation at 300 Hz	Deviation at 1 kHz	Deviation at 3 kHz	Limit (kHz)
-20	0.05	0.13	0.08	5
-15	0.07	0.25	0.11	5
-10	0.08	0.38	0.17	5
-5	0.12	0.69	0.27	5
0	0.18	1.26	0.46	5
5	0.42	1.91	0.77	5
10	0.78	1.95	1.34	5
15	0.79	1.93	1.95	5
20	0.80	1.96	2.05	5



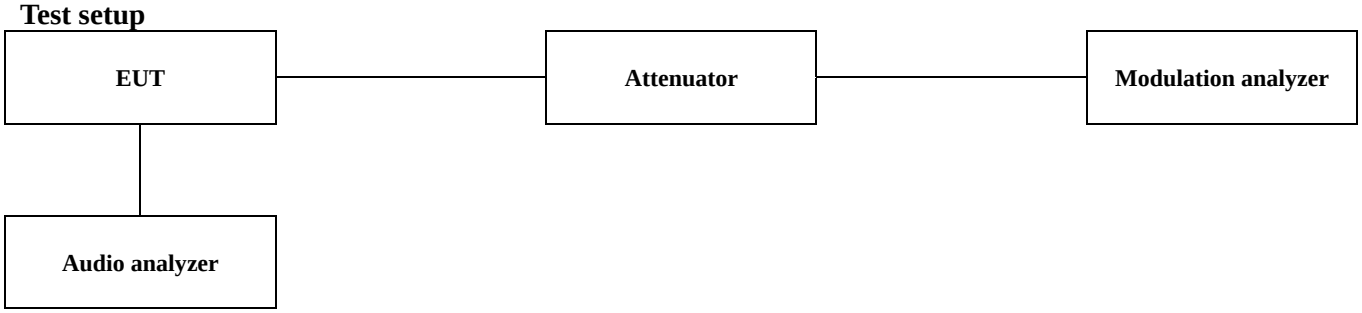
FRS

Audio level (dB)	Deviation at 300 Hz	Deviation at 1 kHz	Deviation at 3 kHz	Limit (kHz)
-20	0.06	0.16	0.08	2.5
-15	0.07	0.26	0.11	2.5
-10	0.08	0.43	0.17	2.5
-5	0.11	0.76	0.26	2.5
0	0.19	1.31	0.45	2.5
5	0.38	1.92	0.76	2.5
10	0.77	1.95	1.29	2.5
15	0.79	1.95	1.92	2.5
20	0.81	1.96	2.04	2.5



3.3. Audio frequency response

Test setup



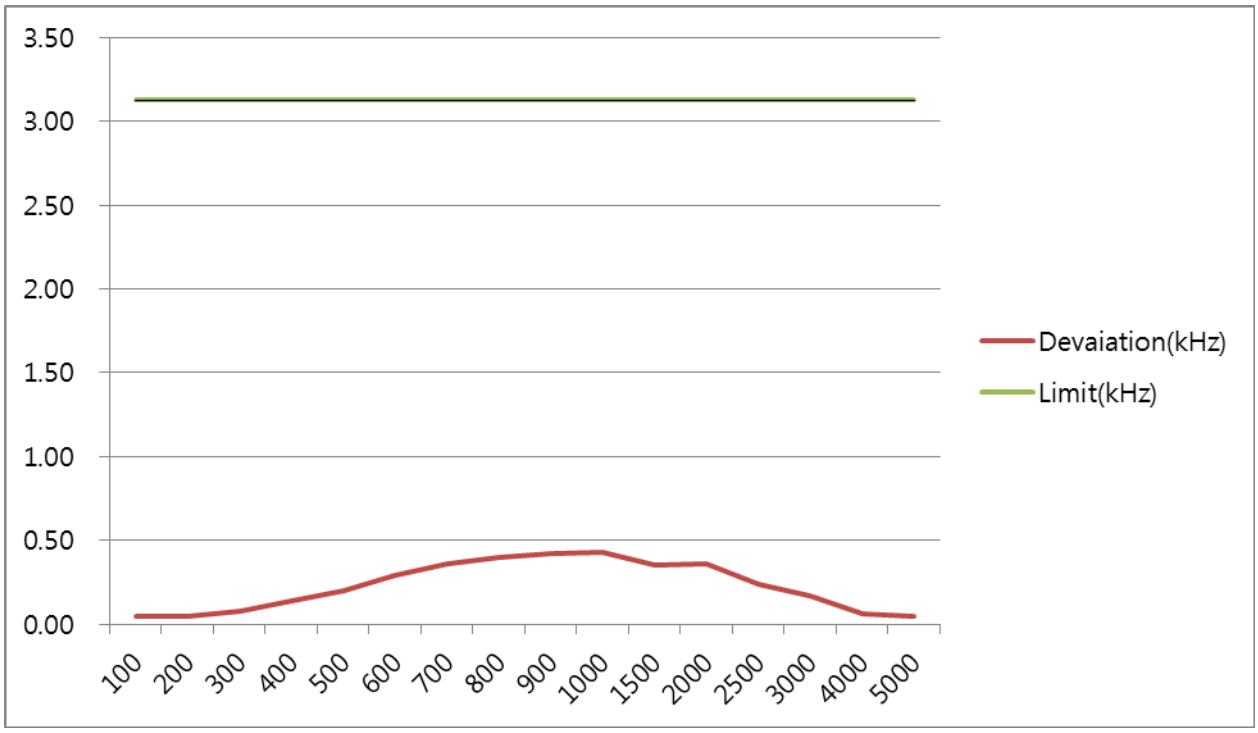
Test procedure
TIA/EIA-603-C

Limit
§2.1047
a) Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 ㎐ shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

Test results

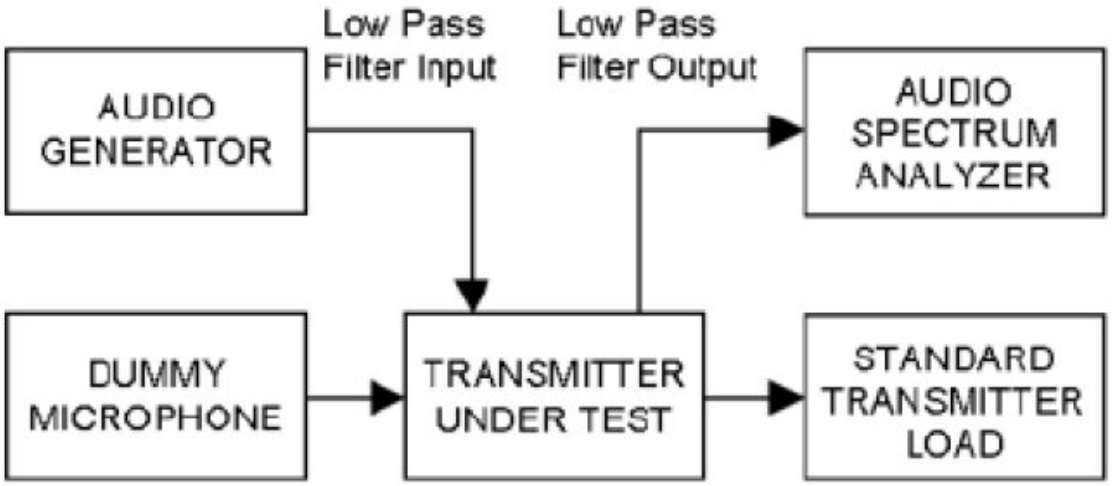
FRS

Audio frequency(㎐)	Deviation(㎑)	Limit(㎑)
100	0.05	3.125
200	0.05	3.125
300	0.08	3.125
400	0.14	3.125
500	0.20	3.125
600	0.29	3.125
700	0.36	3.125
800	0.40	3.125
900	0.42	3.125
1000	0.43	3.125
1500	0.35	3.125
2000	0.36	3.125
2500	0.24	3.125
3000	0.17	3.125
4000	0.06	3.125
5000	0.05	3.125



3.4. Low-pass filter response

Test setup

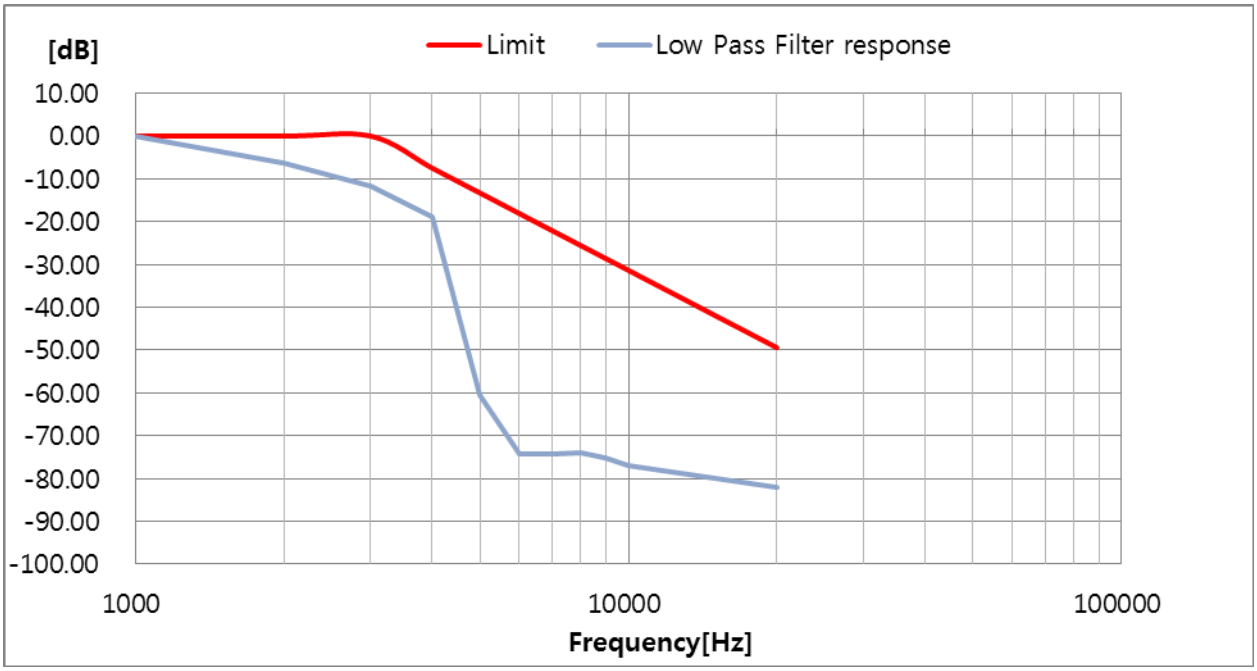


Test procedure
TIA/EIA-603-C

Limit
§95.637 & RSS-210 A6.2.2
(b) Each GMRS transmitter, except a mobile station transmitter with a power output of 2.5 W or less, must automatically prevent a greater than normal audio level from causing over modulation. The transmitter also must include audio frequency low pass filtering, unless it complies with the applicable paragraphs of §95.631 (without filtering.) The filter must be between the modulation limiter and the modulated stage of the transmitter. At any frequency (f in ㎑) between 3 and 20 ㎑, the filter must have an attenuation of at least 60 $\log_{10}$(f/3) ㏈ greater than the attenuation at 1 ㎑. Above 20 ㎑, it must have an attenuation of at least 50 ㏈ greater than the attenuation at 1 ㎑.

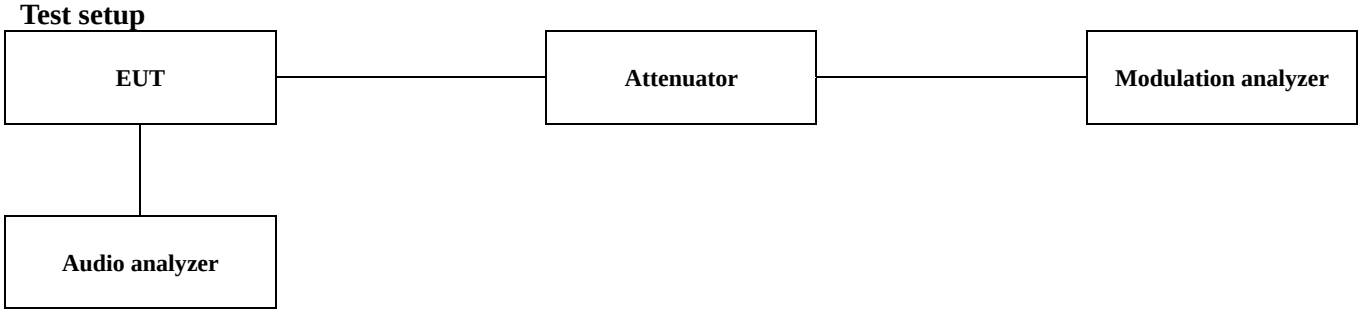
Test results

Audio frequency(Hz)	Response(dB)	Limit(dB)
1000	0.00	0.00
2000	-6.46	0.00
3000	-11.70	0.00
4000	-18.77	-7.50
5000	-60.48	-13.31
6000	-74.23	-18.06
7000	-74.35	-22.08
8000	-74.04	-25.56
9000	-75.13	-28.63
10000	-77.02	-31.37
20000	-82.21	-49.43



3.5. Occupied bandwidth and emission mask

Test setup



Test procedure

TIA/EIA-603-C section 2.2.11

(Modulate the transmitter with a 2 500 ㎐ sine wave at an input level 16 ㏈ greater than that necessary to produce 50 % of rated system deviation.)

Limit

§95.633 & RSS-210 A6.1.3, A6.2.3

The authorized bandwidth (maximum permissible bandwidth of a transmission) for emission type H1D, J1D, R1D, H3E, J3E or R3E is 4 ㎑. The authorized bandwidth for emission type A1D or A3E is 8 ㎑. The authorized bandwidth for emission type F1D, G1D, F3E or G3E is 20 ㎑.

The authorized bandwidth for emission type F3E or F2D transmitted by a FRS unit is 12.5 ㎑.

§95.635 & RSS-210 A6.1.5, A6.2.5

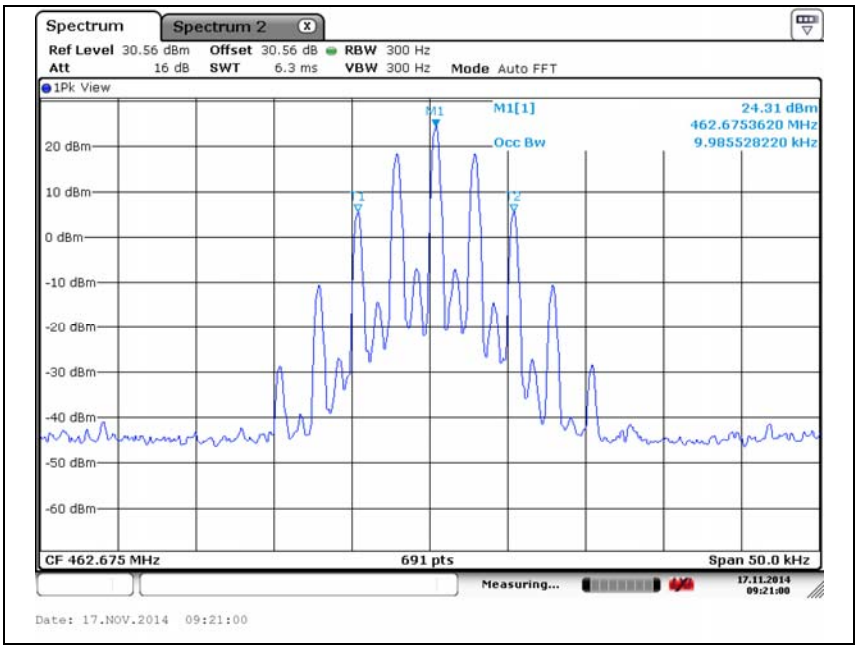
At least 25 ㏈ (decibels) on any frequency removed from the center of the authorized bandwidth by more than 50 % up to and including 100 % of the authorized bandwidth.

At least 35 ㏈ on any frequency removed from the center of the authorized bandwidth by more than 100 % up to and including 250 % of the authorized bandwidth.

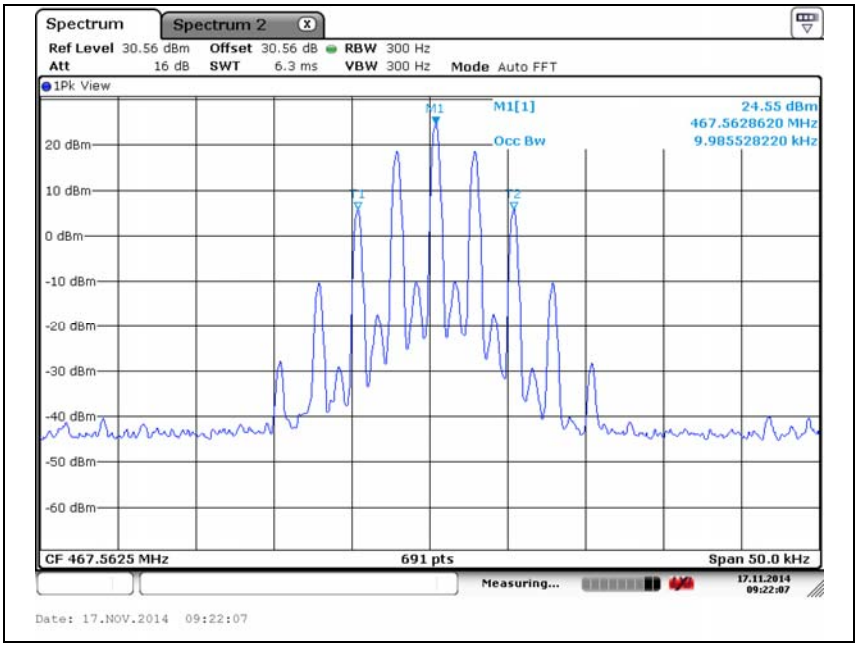
At least 43 + 10 $\log_{10}$(T) ㏈ on any frequency removed from the center of the authorized bandwidth by more than 250 %.

Test results

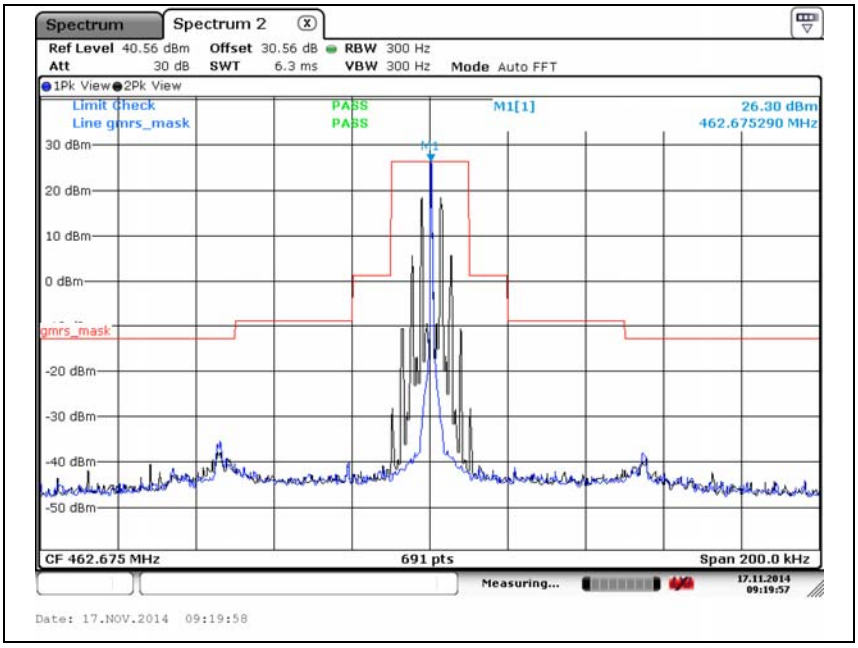
99 % bandwidth for GMRS



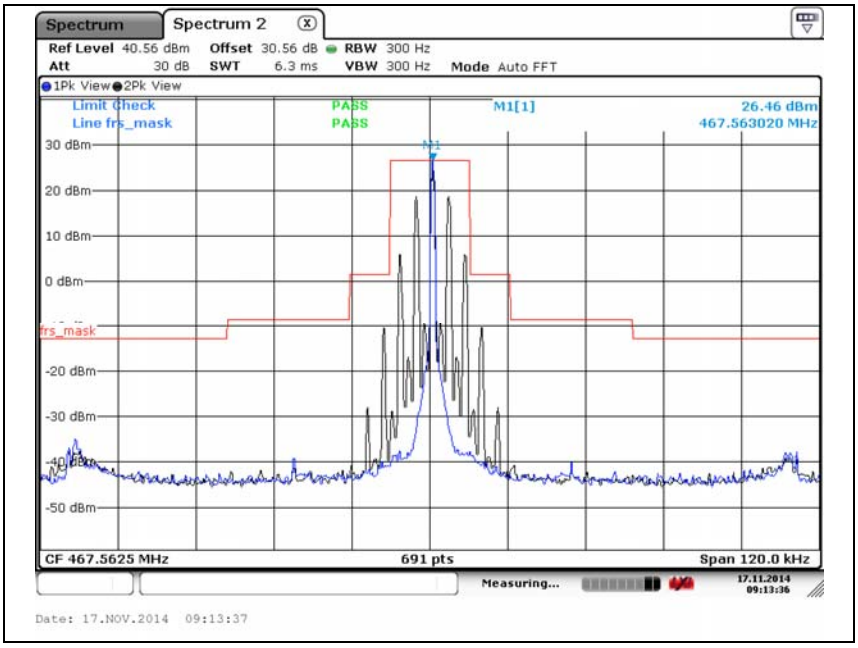
99 % bandwidth for FRS



Emission mask for GMRS

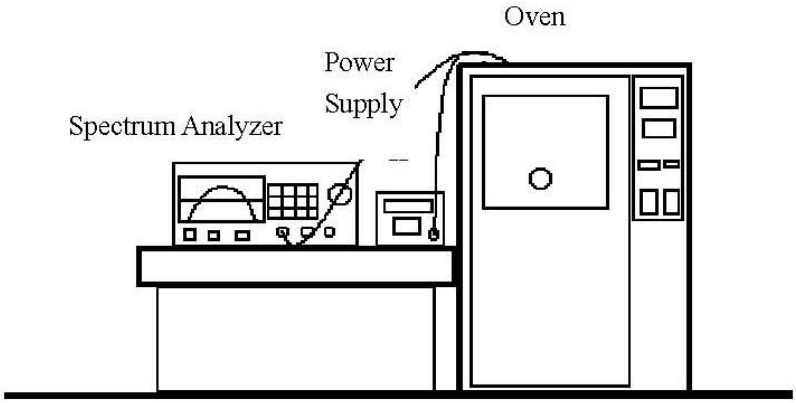


Emission mask for FRS



3.6. Frequency stability

Test setup



Test procedure

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. The transmission time was measured with the spectrum analyzer using RBW=1 ㎑, VBW=1 ㎑.
3. Set the temperature of chamber to -30℃. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize. While maintaining a constant temperature inside the chamber, turn the EUT on and measure the EUT operating frequency.
4. Repeat step 2 with a 10℃ decreased per stage until the highest temperature 50℃ is measured, record all measured frequencies on each temperature step.

Frequency stability vs voltage;

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 end point which shall be specified by the manufacturer.

The output frequency was recorded for each voltage.

Limit

§95.621

(b) Each GMRS transmitter for mobile station, small base station and control station operation must be maintained within a frequency tolerance of 0.000 5%. Each GMRS transmitter for base station (except small base), mobile relay station or fixed station operation must be maintained within a frequency tolerance of 0.000 25%.

§95.627

(b) Each FRS unit must be maintained within a frequency tolerance of 0.000 25%.

RSS-210 A6.1.6

FRS Devices: Carrier frequency tolerance shall be better that ±5 ppm

RSS-210 A6.2.6

GMRS Devices: Carrier frequency tolerance shall be better that ±5 ppm

Test results

Assigned frequency (㎒): 462.675 0

Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Frequency deviation (ppm)	Frequency deviation (%)
-30	462.676213	1213	2.622	0.000262
-20	462.675912	912	1.971	0.000197
-10	462.675890	890	1.924	0.000192
0	462.675754	754	1.630	0.000163
10	462.675511	511	1.104	0.000110
20	462.675404	404	0.873	0.000087
30	462.675324	324	0.700	0.000070
40	462.675567	567	1.225	0.000123
50	462.674885	-115	-0.249	-0.000025

Temperature (℃)	Voltage (V)	Measure frequency (㎒)	Frequency deviation (ppm)	Frequency deviation (%)
25	3.06	462.675333	0.720	0.000072
25	4.14	462.675342	0.739	0.000074

Assigned frequency (㎒): 467.562 5

Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Frequency deviation (ppm)	Frequency deviation (%)
-30	467.563147	647	1.384	0.000138
-20	467.563102	602	1.288	0.000129
-10	467.562976	476	1.018	0.000102
0	467.562935	435	0.930	0.000093
10	467.562914	414	0.885	0.000089
20	467.562885	385	0.823	0.000082
30	467.562872	372	0.796	0.000080
40	467.562604	104	0.222	0.000022
50	467.562335	-165	-0.353	-0.000035

Temperature (℃)	Voltage (V)	Measure frequency (㎒)	Frequency deviation (ppm)	Frequency deviation (%)
25	3.06	467.562861	0.772	0.000077
25	4.14	467.562855	0.759	0.000076

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum analyzer	R&S	FSV30	101389	1 year	2015.04.30
Wideband Power Sensor	R&S	NRP-Z81	1137.9009.02-101886-ds	1 year	2015.01.07
Vector signal generator	R&S	SMBV2100A	1407.6004K02	1 year	2015.01.06
Trilog-broadband antenna	Schwarzbeck	VULB 9168	9168-385	2 years	2015.05.09
Dipole antenna	R&S	VHAP	574	2 years	2015.05.09
Dipole antenna	R&S	VHAP	575	2 years	2015.05.09
Dipole antenna	R&S	UHAP	545	2 years	2015.05.09
Dipole antenna	R&S	UHAP	546	2 years	2015.05.09
Horn antenna	A.H.	SAS-571	414	2 years	2015.02.28
Horn antenna	A.H.	SAS-571	781	2 years	2015.05.13
Preamplifier	HP	8447F	2805A02570	1 year	2015.04.30
Preamplifier	Schwarzbeck	BBV 9721	9721-003	2 years	2015.09.04
Brodband coaxial preamplifier	Schwarzbeck Mess-Elektronik	BB9718	9718-245	1 year	2015.08.13
Attenuator	HP	8494B	2630A12857	1 year	2015.04.30
Attenuator	BRID	8325	4676	1 year	2015.04.30
EMI Test Receiver	LIG NEX1	ISA-80	L0912K014	1 year	2015.11.14
High pass filter	Mini-circuits	NHP-800+	15542	1 year	2015.07.23
High pass filter	Weinschel	WHKX1.2/15G-6TT	1	1 year	2015.07.23
Modulation analyzer	HP	8901B	3438A05094	1 year	2015.04.30
Audio analyzer	HP	8903B	3413A14728	1 year	2015.07.23
DC power supply	HP	6674A	US36370369	1 year	2015.07.23
Temperature chamber	TABAI	MC711P	112000492	1 year	2015.04.30

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
N/A			

Appendix B. Test setup photo

Radiated field emissions