TEST REPORT

Part 95(A/B)

Equipment under test	GMRS / FRS 2-way Radio
Model name	T55A
FCC ID	MMAT55A
Applicant	Midland Radio Corporation
Manufacturer	Global Link Corporation Ltd.
Date of test(s)	2015.08.04~2015.08.25
Date of issue	2015.08.25

Issued to

Midland Radio Corporation

5900 Parretta Drive, Kansas City, Missouri United States 64120

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Issued by

KES Co., Ltd.

C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si,

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473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, 126-58, Korea

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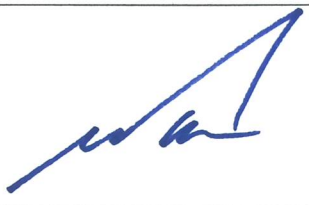
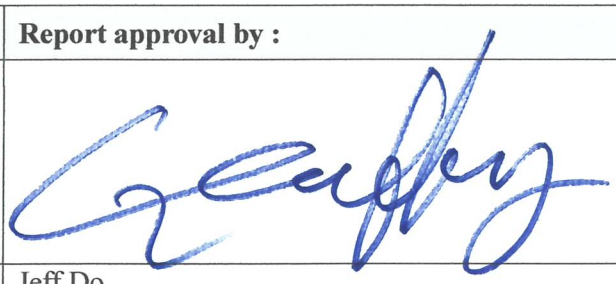
Test and report completed by :	**Report approval by :**
	
Kwang-Yeol Choo Test engineer	Jeff Do Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2015.08.25	KES-RF-15T0056	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,14057, Korea 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, 126-58, Korea
FCC rule part(s):	FCC Part 95
Model:	T55A
FCC ID:	MMAT55A
Test device serial No.:	☐ Production ☒ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	FRS / GMRS
Serial number	N/A
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: 0.247 W// FRS: 0.305 W
Number of channels	22
Power source	Rechargeable Ni-MH battery pack(DC 3.6 V)

1.2. Test configuration

The GMRS / FRS 2-way Radio FCC ID: MMAT55A was tested per the guidance of ANSI C63.10-2009, ANSI/TIA 603D: 2010 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	25.10	0.324
	2	462.587 5	25.15	0.327
	3	462.612 5	25.18	0.330
	4	462.637 5	25.20	0.331
	5	462.662 5	25.19	0.330
	6	462.687 5	25.20	0.331
	7	462.712 5	25.22	0.333
FRS	8	467.562 5	25.69	0.371
	9	467.587 5	25.70	0.372
	10	467.612 5	25.68	0.370
	11	467.637 5	25.72	0.373
	12	467.662 5	25.73	0.374
	13	467.687 5	25.73	0.374
	14	**467.712 5**	**25.74**	**0.375**
GMRS	15	462.550 0	25.25	0.335
	16	462.575 0	25.26	0.336
	17	462.600 0	25.26	0.336
	18	462.625 0	25.27	0.337
	19	462.650 0	25.29	0.338
	20	462.675 0	25.32	0.340
	21	462.700 0	25.33	0.341
	22	**462.725 0**	**25.33**	**0.341**

Therefore all applicable requirements were tested to the two channels, the 22th for GMRS and the 14th for FRS.

DC input into the final amplifier

Mode	Voltage(V)	Current(A)	Power(W)
GMRS	3.6	0.35	1.26
FRS	3.6	0.36	1.30

2. Summary of tests

Reference	Test description	Test results
95.639	RF output power	PASS
95.635	Radiated spurious emissions	PASS
95.637	Modulation limiting	PASS
2.1047	Audio frequency response	PASS
95.637	Low-pass filter response	PASS
2.1049, 95.633, 95.635	Occupied bandwidth and emission mask	PASS
2.1055, 95.621, 95.627	Frequency stability	PASS

Note:

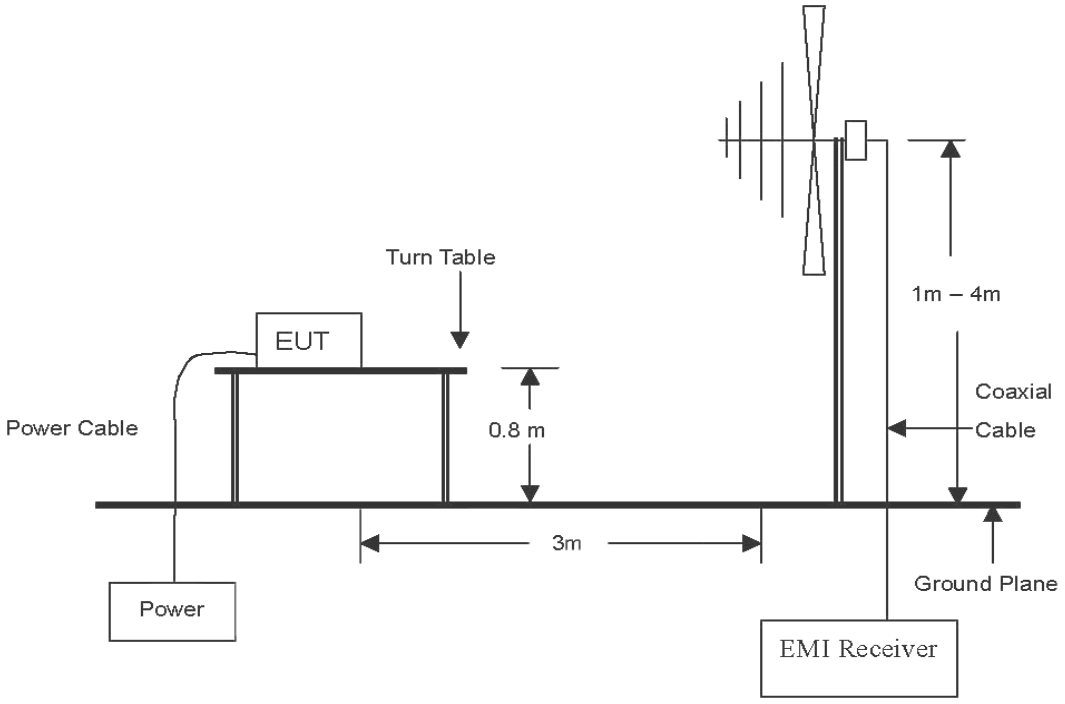
1. The measurement procedures described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 ㎑ to 40 ㎓ (ANSI C63.4-2009, ANSI/TIA 603D: 2010) were used in the measurement of the DUT.
2. All modes of operation were investigated. The test results shown in the following sections represent the worst case emissions.

3. Test results

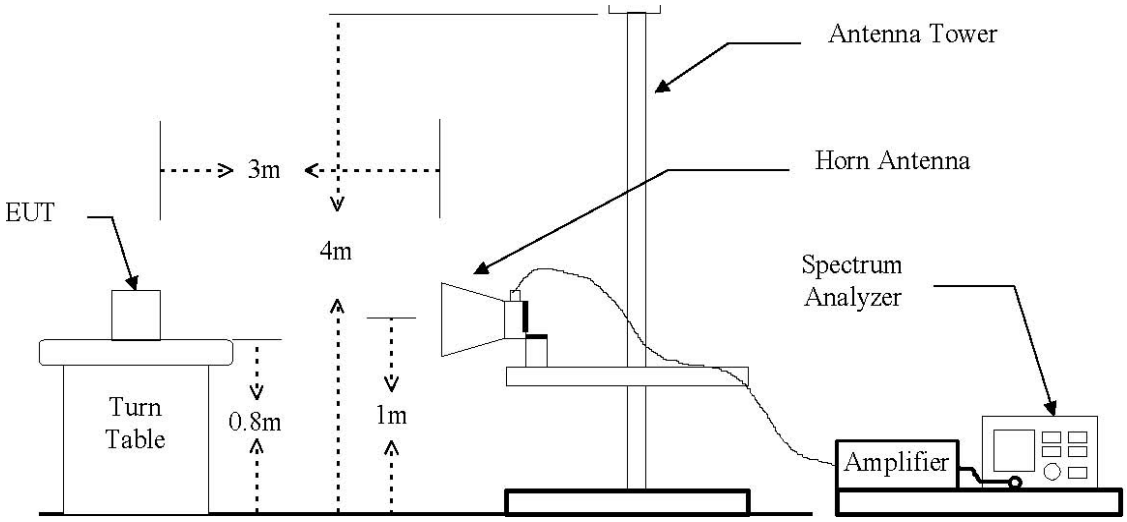
3.1. RF output power and radiated spurious emission

Test setup

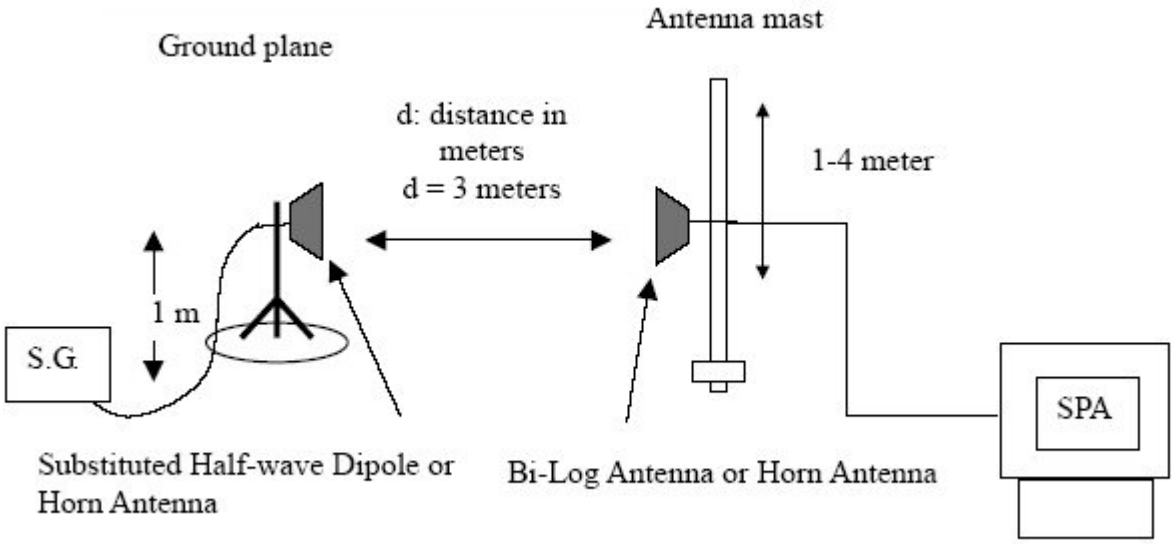
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ Emissions.



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 603D: 2010

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.

Radiated spurious emissions

§95.635
(7) At least 43 + 10 $\log_{10}$(T) ㏈ 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: 462.725 0 ㎒
Channel: 22

Frequency (㎒)	Ant. Pol. (H/V)	E.R.P.	
		(dBm)	(W)
462.725 0	H	7.97	0.006
462.725 0	V	23.93	0.247

Mode: FRS
Distance of measurement: 3 meter
Operating frequency: 467.712 5 ㎒
Channel: 14

Frequency (㎒)	Ant. Pol. (H/V)	E.R.P.	
		(dBm)	(W)
467.712 5	H	9.57	0.009
467.712 5	V	24.85	0.305

Radiated spurious emissions

Mode:	GRMS
Distance of measurement:	3 meter
Operating frequency:	462.725 0 ㎒
Channel:	22

Frequency (㎒)	Ant. Pol. (H/V)	Spurious attenuation (dBc)	Limit (dBc)	Margin (dB)
925.450	H	59.86	36.93	22.93
925.450	V	55.05	36.93	18.12
1 388.175	H	69.43	36.93	32.50
1 388.175	V	69.48	36.93	32.55
1 850.900	H	61.19	36.93	24.26
1 850.900	V	49.39	36.93	12.46
2 313.625	H	56.89	36.93	19.96
2 313.625	V	54.35	36.93	17.42
2 776.350	H	62.30	36.93	25.37
2 776.350	V	62.35	36.93	25.42
3 239.075	H	64.30	36.93	27.37
3 239.075	V	64.55	36.93	27.62
3 701.800	H	65.04	36.93	28.11
3 701.800	V	61.65	36.93	24.72
4 164.525	H	65.44	36.93	28.51
4 164.525	V	63.38	36.93	26.45
4 627.250	H	73.42	36.93	36.49
4 627.250	V	75.93	36.93	39.00

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: 467.712 5 ㎒

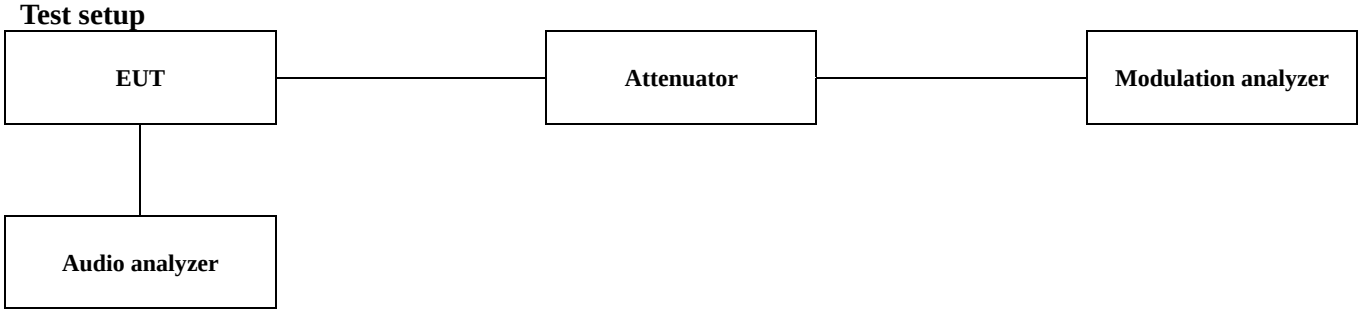
Channel: 14

Frequency (㎒)	Ant. Pol. (H/V)	Spurious attenuation (dBc)	Limit (dBc)	Margin (dB)
935.425	H	70.29	37.85	32.44
935.425	V	69.89	37.85	32.04
1 403.138	H	69.50	37.85	31.65
1 403.138	V	67.90	37.85	30.05
1 870.850	H	57.36	37.85	19.51
1 870.850	V	48.18	37.85	10.33
2 338.563	H	56.20	37.85	18.35
2 338.563	V	53.09	37.85	15.24
2 806.275	H	63.69	37.85	25.84
2 806.275	V	59.02	37.85	21.17
3 273.988	H	58.92	37.85	21.07
3 273.988	V	62.52	37.85	24.67
3 741.700	H	60.53	37.85	22.68
3 741.700	V	59.59	37.85	21.74
4 209.413	H	67.15	37.85	29.30
4 209.413	V	65.86	37.85	28.01
4 677.125	H	72.94	37.85	35.09
4 677.125	V	72.16	37.85	34.31

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



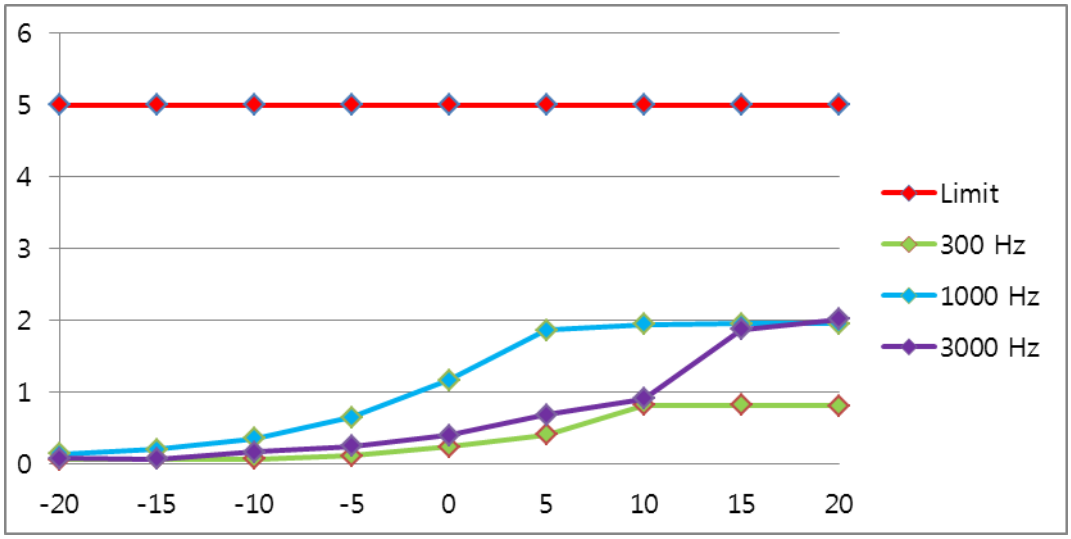
Test procedure
TIA/EIA-603-D

Limit
§95.637
(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 ㎑.

Test results

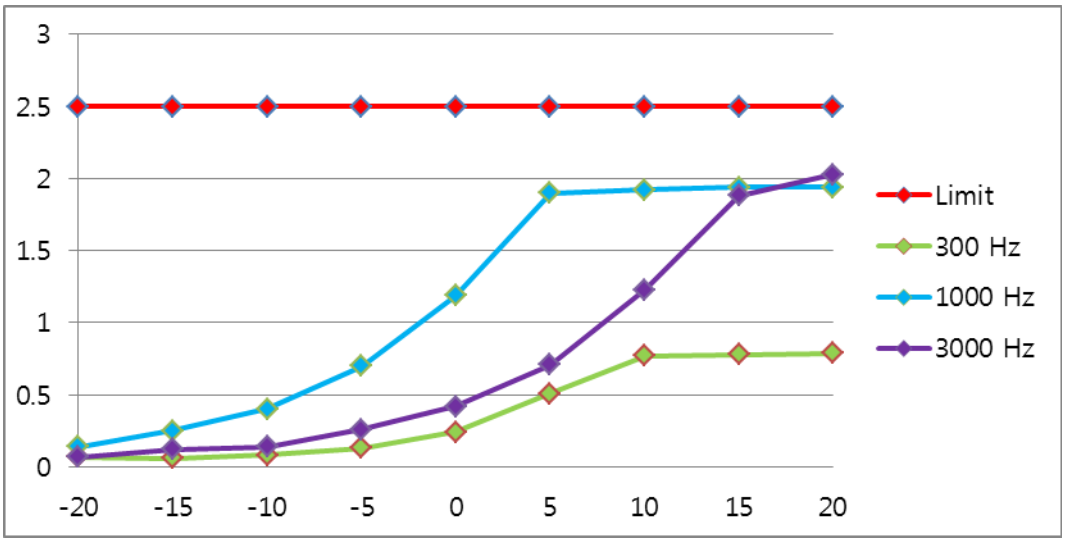
GMRS

Audio level (dB)	Deviation at 300 ㎐	Deviation at 1 ㎑	Deviation at 3 ㎑	Limit (㎑)
-20	0.06	0.14	0.08	5
-15	0.07	0.21	0.07	5
-10	0.07	0.36	0.17	5
-5	0.12	0.65	0.25	5
0	0.24	1.17	0.40	5
5	0.41	1.87	0.69	5
10	0.82	1.95	0.91	5
15	0.82	1.96	1.88	5
20	0.81	1.96	2.02	5



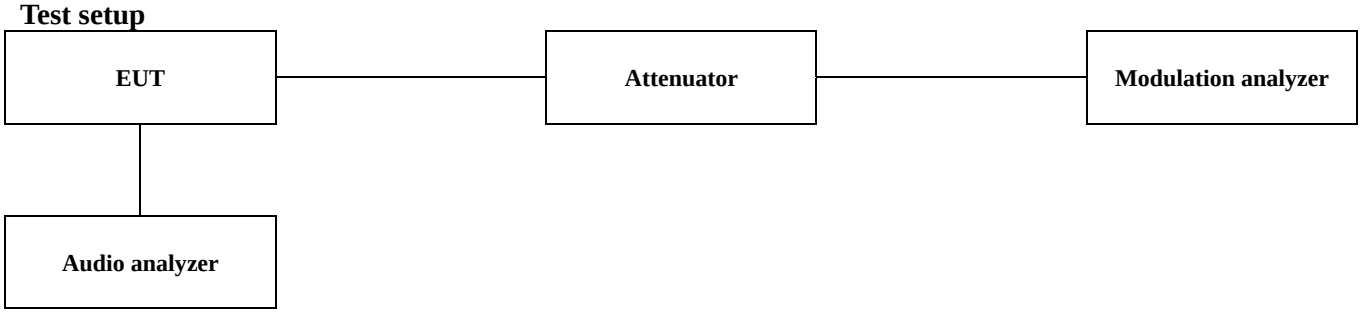
FRS

Audio level (dB)	Deviation at 300 Hz	Deviation at 1 kHz	Deviation at 3 kHz	Limit (kHz)
-20	0.07	0.14	0.07	2.5
-15	0.06	0.25	0.12	2.5
-10	0.08	0.40	0.14	2.5
-5	0.13	0.70	0.26	2.5
0	0.24	1.19	0.42	2.5
5	0.51	1.90	0.71	2.5
10	0.77	1.92	1.23	2.5
15	0.78	1.94	1.88	2.5
20	0.79	1.94	2.03	2.5



3.3. Audio frequency response

Test setup



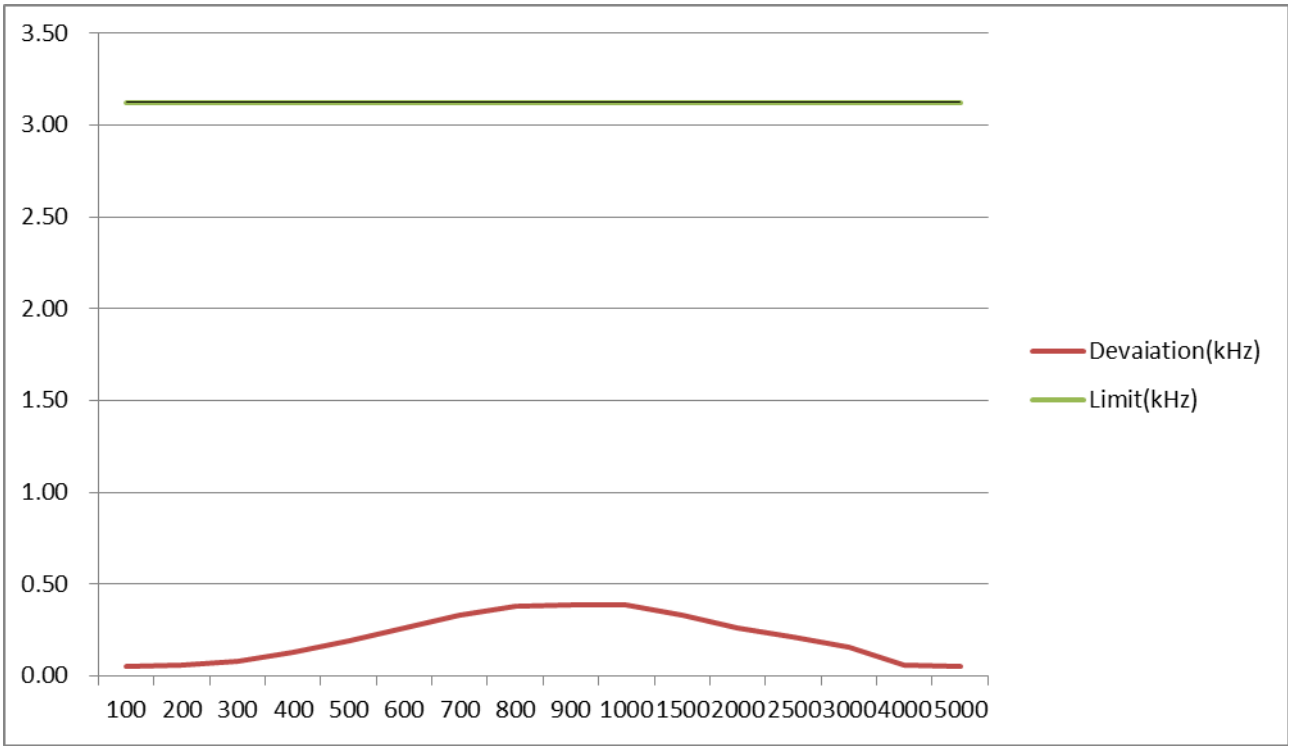
Test procedure
TIA/EIA-603-D

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

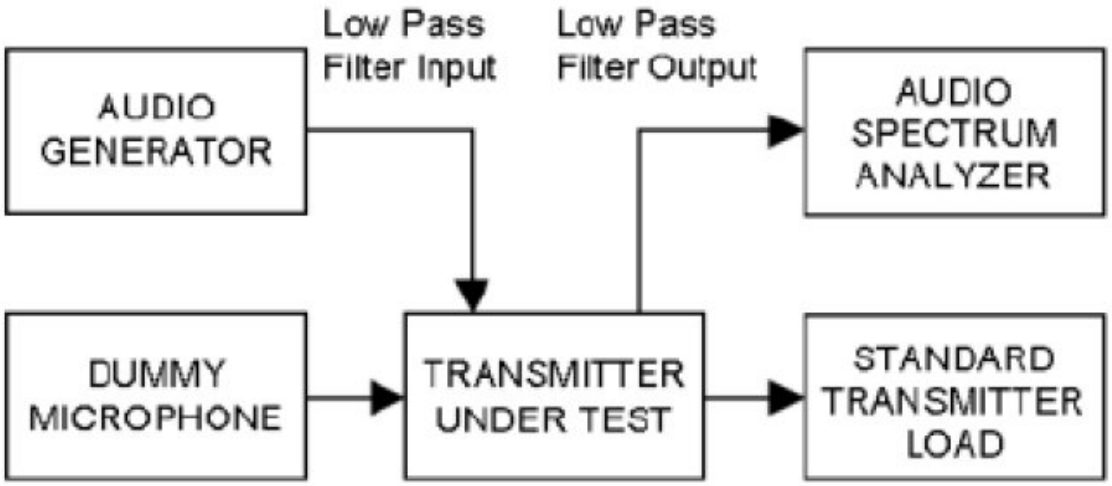
FRS

Audio frequency(㎐)	Deviation(㎑)	Limit(㎑)
100	0.02	3.125
200	0.02	3.125
300	0.02	3.125
400	0.05	3.125
500	0.15	3.125
600	0.21	3.125
700	0.23	3.125
800	0.24	3.125
900	0.28	3.125
1000	0.33	3.125
1500	0.47	3.125
2000	0.56	3.125
2500	0.62	3.125
3000	0.63	3.125
4000	0.39	3.125
5000	0.21	3.125



3.4. Low-pass filter response

Test setup

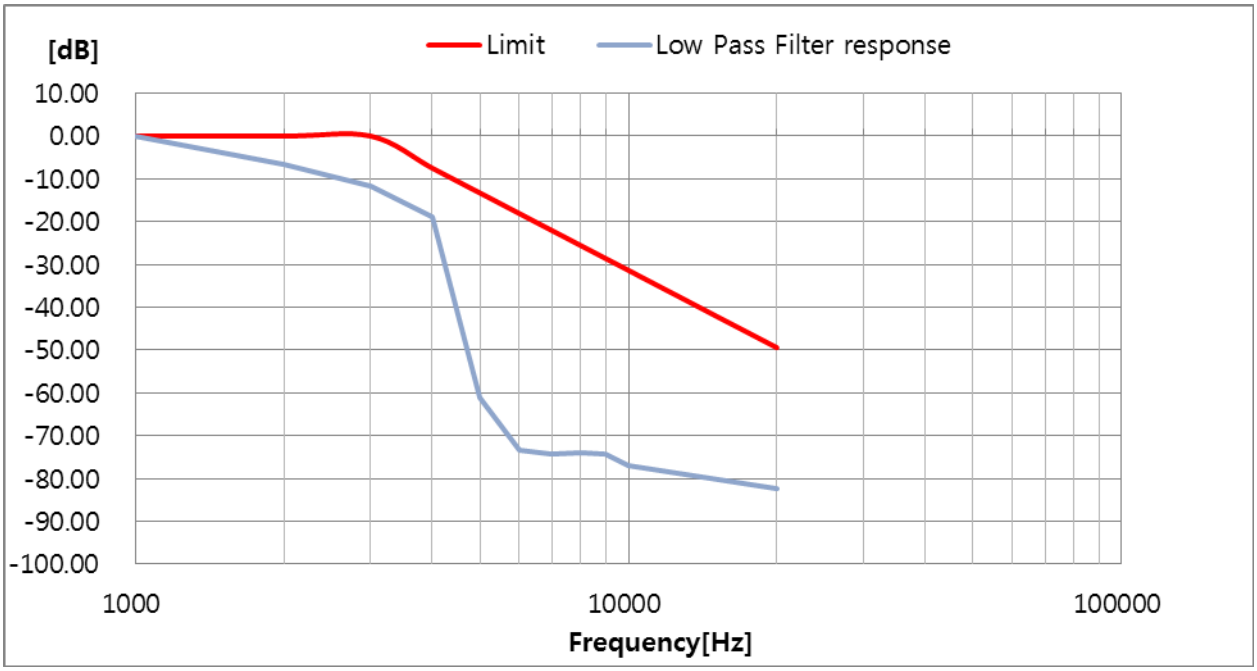


Test procedure
TIA/EIA-603-D

Limit
§95.637
(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 ㎑.

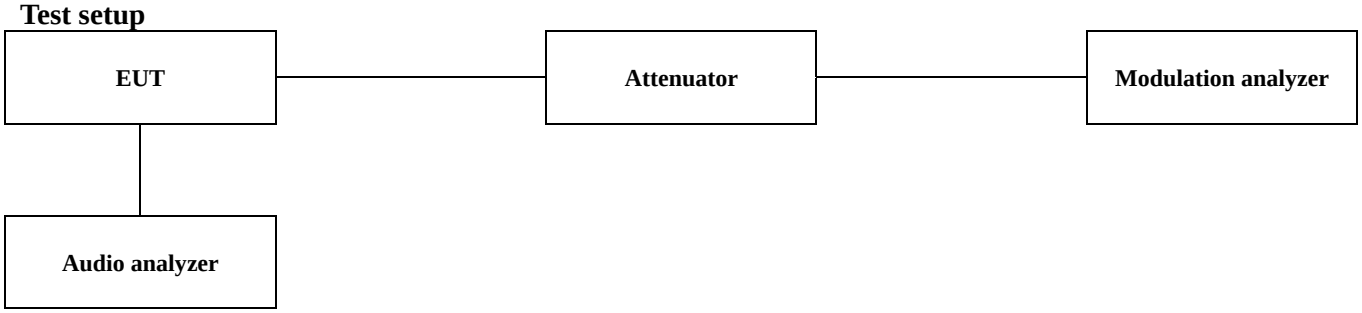
Test results

Audio frequency(㎐)	Response(㏈)	Limit(㏈)
1000	0.00	0.00
2000	-6.48	0.00
3000	-11.78	0.00
4000	-18.81	-7.50
5000	-61.25	-13.31
6000	-73.29	-18.06
7000	-74.39	-22.08
8000	-73.92	-25.56
9000	-74.36	-28.63
10000	-76.88	-31.37
20000	-82.35	-49.43



3.5. Occupied bandwidth and emission mask

Test setup



Test procedure

TIA/EIA-603-D 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

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

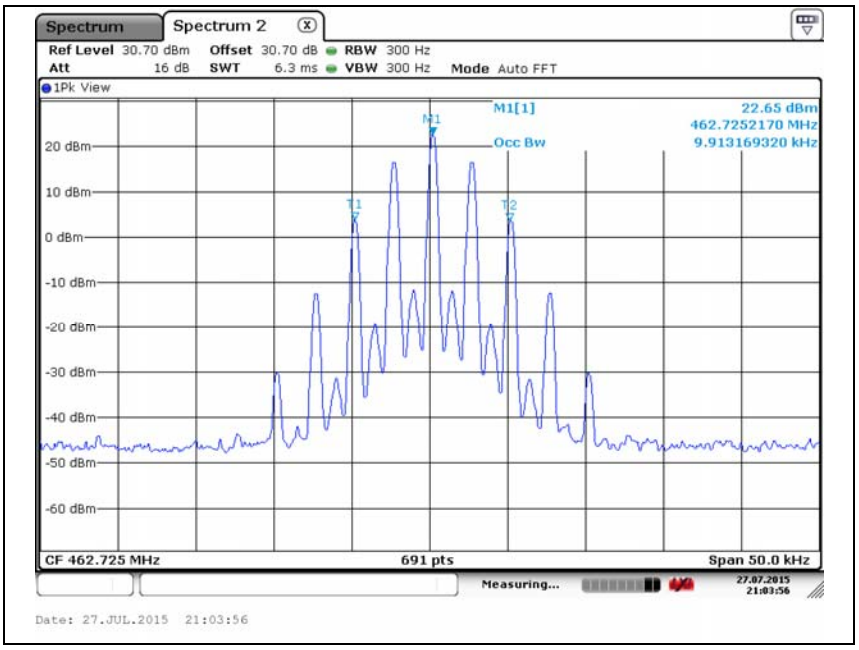
At least 25 ㏈ (decibels) on any frequency removed from the center of the authorized bandwidth by more than 50 % up to and including 100 % of the authorized bandwidth.

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.

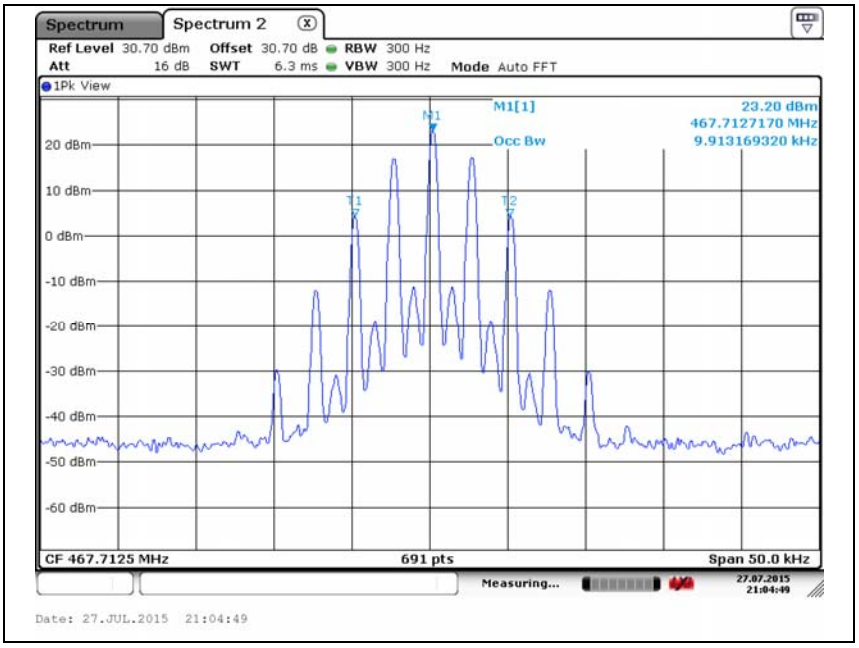
At least 43 + 10 $\log_{10}$(T) ㏈ on any frequency removed from the center of the authorized bandwidth by more than 250 %.

Test results

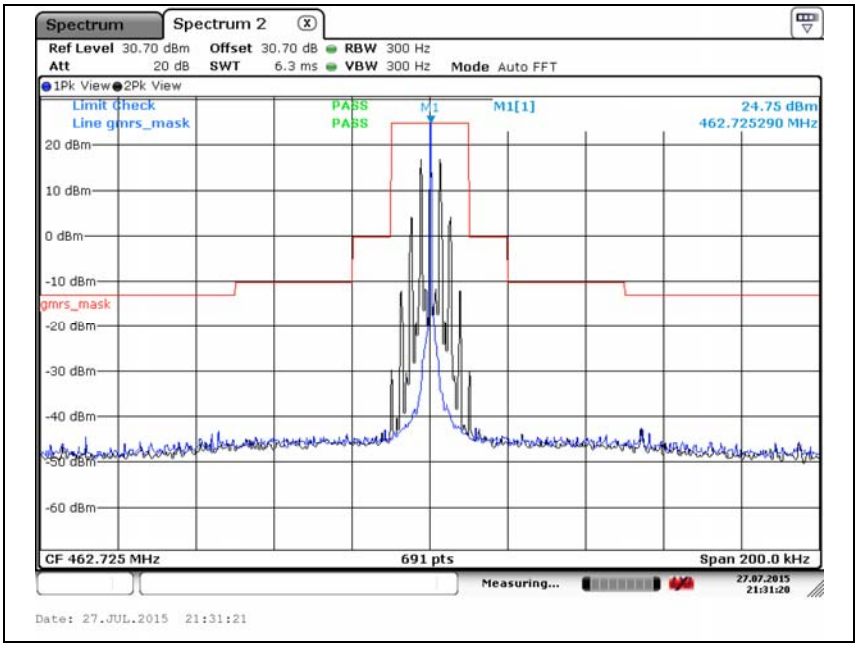
99 % bandwidth for GMRS



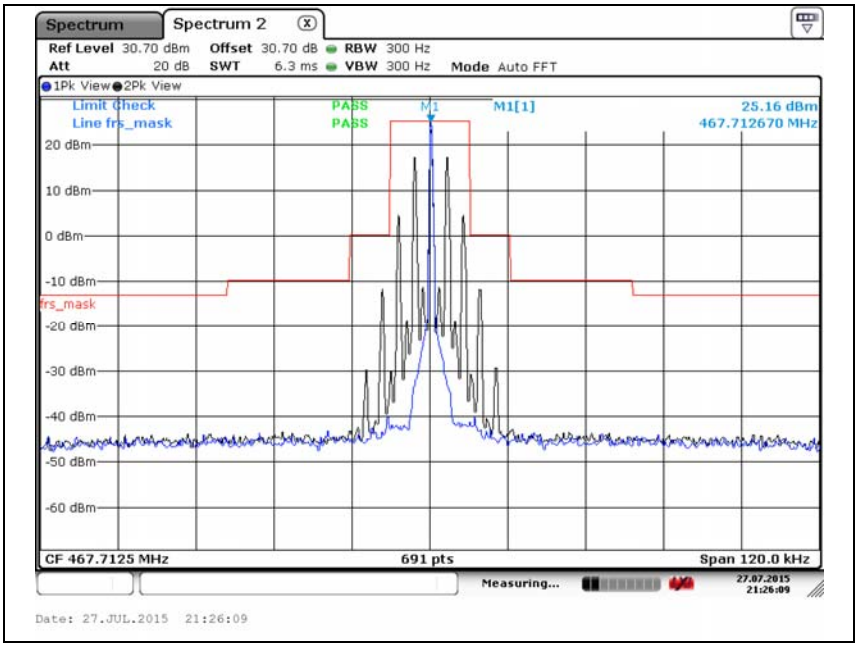
99 % bandwidth for FRS



Emission mask for GMRS

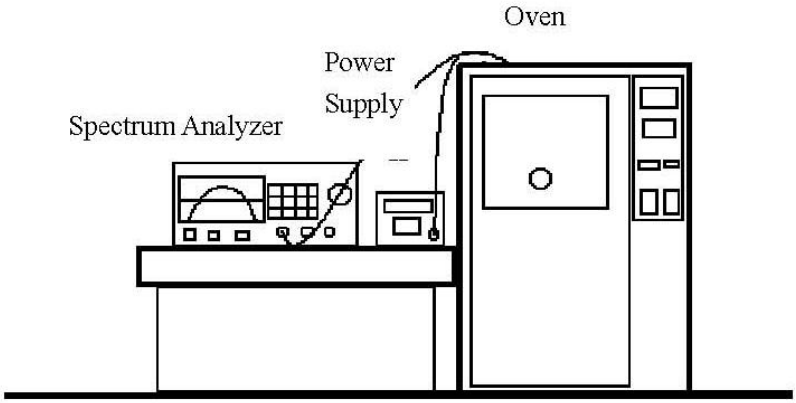


Emission mask for FRS



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%.

Test results

Assigned frequency (㎒): 462.725 0

Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Frequency deviation (ppm)	Frequency deviation (%)
-30	462.725442	442	0.955	0.000096
-20	462.725406	406	0.877	0.000088
-10	462.725285	285	0.616	0.000062
0	462.725125	125	0.270	0.000027
10	462.725089	89	0.192	0.000019
20	462.725062	62	0.134	0.000013
30	462.725008	8	0.017	0.000002
40	462.724962	-38	-0.082	-0.000008
50	462.724802	-198	-0.428	-0.000043

Temperature (℃)	Voltage (V)	Measure frequency (㎒)	Frequency deviation (ppm)	Frequency deviation (%)
25	3.06	462.725075	0.162	0.000016
25	4.14	462.725070	0.151	0.000015

Assigned frequency (㎒): 467.712 5

Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Frequency deviation (ppm)	Frequency deviation (%)
-30	467.712993	493	1.054	0.000105
-20	467.712889	389	0.832	0.000083
-10	467.712813	313	0.669	0.000067
0	467.712702	202	0.432	0.000043
10	467.712618	118	0.252	0.000025
20	467.712575	75	0.160	0.000016
30	467.712535	35	0.075	0.000008
40	467.712470	-30	-0.064	-0.000006
50	467.712332	-168	-0.359	-0.000036

Temperature (℃)	Voltage (V)	Measure frequency (㎒)	Frequency deviation (ppm)	Frequency deviation (%)
25	3.06	467.712568	0.145	0.000015
25	4.14	467.712560	0.128	0.000013

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum analyzer	R&S	FSV30	100736	1 year	2016.07.25
Wideband Power Sensor	R&S	NRP-Z81	101886	1 year	2016.04.10
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2016.01.23
Trilog-broadband antenna	Schwarzbeck	VULB 9168	9168-461	2 years	2017.04.03
Dipole antenna	R&S	VHAP	574	2 years	2017.05.15
Dipole antenna	R&S	VHA 9103	91032557	2 years	2016.07.10
Dipole antenna	R&S	UHA 9105	91052417	2 years	2016.07.10
Dipole antenna	R&S	UHAP	546	2 years	2017.05.15
Horn antenna	A.H.	SAS-571	414	2 years	2017.02.09
Horn antenna	A.H.	SAS-571	781	2 years	2017.05.07
Preamplifier	HP	8447F	2805A02570	1 year	2016.01.23
Brodband preamplifier	Schwarzbeck	BBV9718	9718-246	1 years	2015.10.23
Attenuator	HP	8494B	2630A12857	1 year	2016.01.22
Attenuator	HP	30dB ATTENUATOR ASSEMBLY	3318A05137	1 year	2016.01.22
EMI Test Receiver	LIG NEX1	ISA-80	L0912K014	1 year	2015.11.14
High pass filter	Mini-circuits	NHP-800+	15542	1 year	2016.07.24
High pass filter	Weinschel	WHKX1.2/15G-6TT	1	1 year	2016.07.24
Modulation analyzer	HP	8901B	3538A05593	1 year	2016.07.24
Audio analyzer	HP	8903B	3011A11219	1 year	2016.07.23
DC power supply	HP	6632B	US36351824	1 year	2016.01.22
Temperature chamber	TABAI	MC711P	112000492	1 year	2016.01.23

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
N/A			