

TEST REPORT

Part 95(A/B)

Equipment under test GMRS / FRS 2-way Radio

Model name T35A

FCC ID MMAT35A

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

Tel.: +1-816-241-8500 / Fax.: +1-816-241-571

Issued by

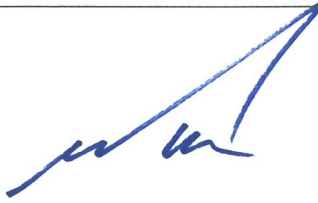
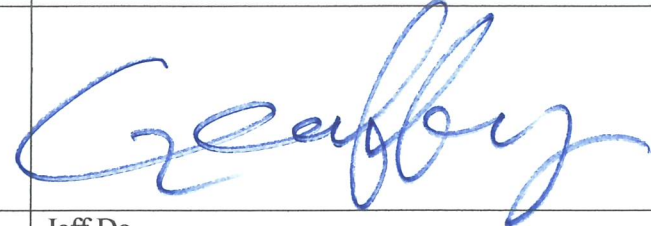
KES Co., Ltd.

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

Tel: +82-31-425-6200 / Fax: +82-31-424-0450

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-15T0055	Initial



TABLE OF CONTENTS

1.	General information.....	4
1.1.	EUT description	4
1.2.	Test configuration.....	4
1.3.	Frequency/channel operations	5
1.4.	Information about derivative model	5
1.5.	Conclusion of worst-case for each mode of representative channel respectively.....	6
2.	Summary of tests	7
3.	Test results	8
3.1.	RF output power and radiated spurious emission.....	8
3.2.	Modulation limiting.....	15
3.3.	Audio frequency response	18
3.4.	Low-pass filter response.....	20
3.5.	Occupied bandwidth and emission mask.....	22
3.6.	Frequency stability	25
Appendix A.	Measurement equipment	27
Appendix B.	Test setup photo.....	28

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, Yeosu-si, Gyeonggi-do, 126-58, Korea
FCC rule part(s): FCC Part 95
Model: T35A
FCC ID: MMAT35A
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 MHz ~ 462.712 5 MHz (GMRS Channels 1 ~7)
467.562 5 MHz ~ 467.712 5 MHz (FRS Channels 8 ~ 14)
462.550 0 MHz ~ 462.725 0 MHz (GMRS Channels 15 ~ 22)
Type of Emission 11K0F3E
E.R.P. GMRS: 0.221 W// FRS: 0.199 W
Number of channels 22
Power source DC 3.6 V

1.2. Test configuration

The GMRS / FRS 2-way Radio FCC ID: MMAT35A 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 (MHz)
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(MHz)	Conducted output power	
			dBm	W
GMRS	1	462.562 5	25.12	0.325
	2	462.587 5	25.17	0.329
	3	462.612 5	25.18	0.330
	4	462.637 5	25.19	0.330
	5	462.662 5	25.20	0.331
	6	462.687 5	25.20	0.331
	7	462.712 5	25.22	0.333
FRS	8	467.562 5	25.23	0.333
	9	467.587 5	25.24	0.334
	10	467.612 5	25.24	0.334
	11	467.637 5	25.24	0.334
	12	467.662 5	25.25	0.335
	13	467.687 5	25.24	0.334
	14	467.712 5	25.26	0.336
GMRS	15	462.550 0	25.24	0.334
	16	462.575 0	25.22	0.333
	17	462.600 0	25.22	0.333
	18	462.625 0	25.23	0.333
	19	462.650 0	25.21	0.332
	20	462.675 0	25.22	0.333
	21	462.700 0	25.22	0.333
	22	462.725 0	25.22	0.333

Therefore all applicable requirements were tested to the two channels, the 15th for GMRS and the 14th 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	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:

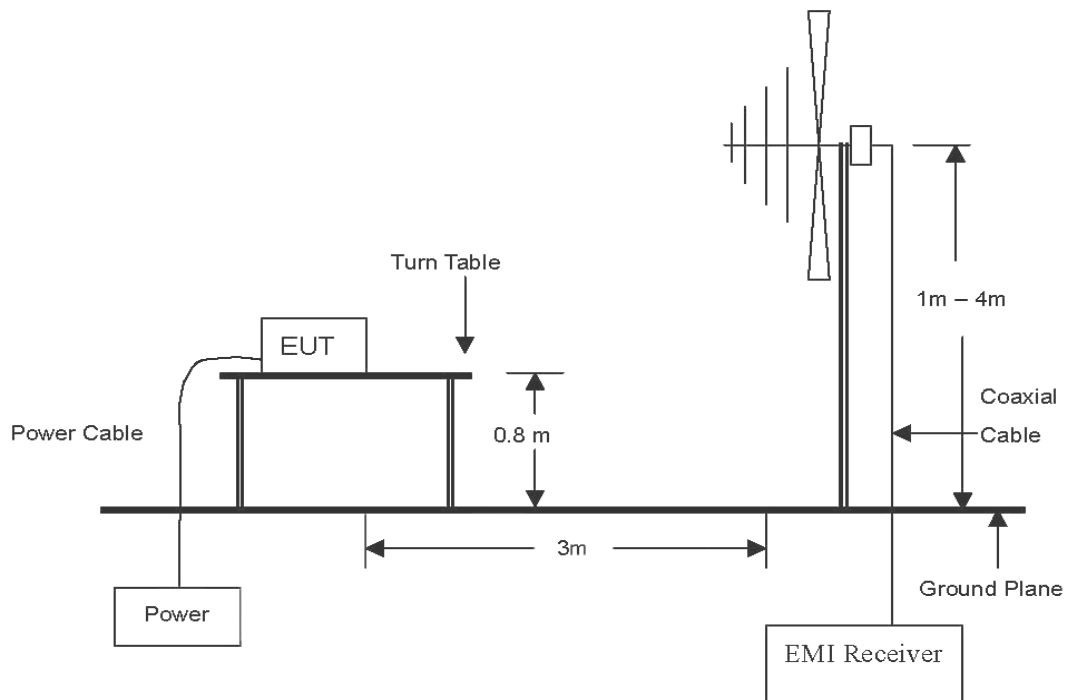
- The measurement procedures described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2009, ANSI/TIA 603D: 2010) were used in the measurement of the DUT.
- All modes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

3. Test results

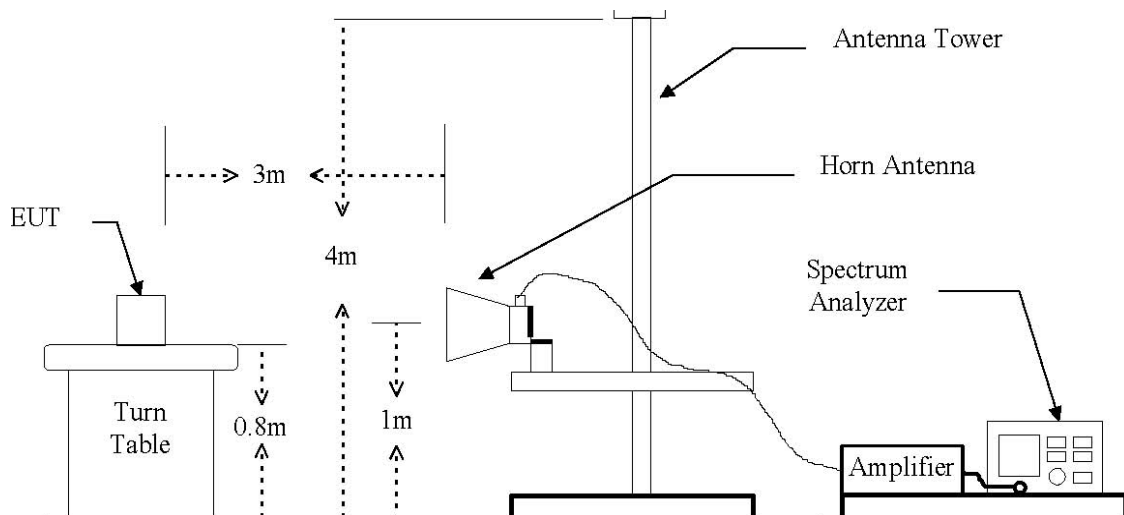
3.1. RF output power and radiated spurious emission

Test setup

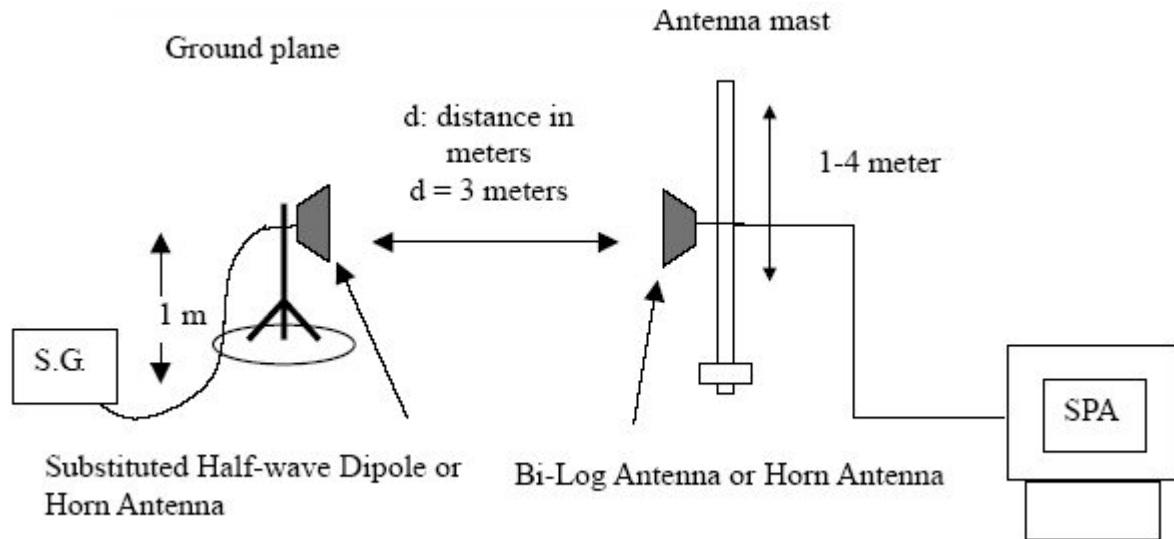
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to 18 GHz 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 cm 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 MHz and the video bandwidth was set to 1 MHz
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 be 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 MHz) or horn antenna(above 1000 MHz) 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 receiver, 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 dBm, 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 $43 + 10 \log_{10}(T)$ 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: 462.550 0 MHz
Channel: 15

Frequency (MHz)	Ant. Pol. (H/V)	E.R.P.	
		(dBm)	(W)
462.550 0	H	23.44	0.221
462.550 0	V	22.70	0.186

Mode: FRS
Distance of measurement: 3 meter
Operating frequency: 467.7125 MHz
Channel: 14

Frequency (MHz)	Ant. Pol. (H/V)	E.R.P.	
		(dBm)	(W)
467.712 5	H	14.16	0.026
467.712 5	V	22.98	0.199

Radiated spurious emissions

Mode: GRMS
Distance of measurement: 3 meter
Operating frequency: 462.550 0 MHz
Channel: 15

Frequency (MHz)	Ant. Pol. (H/V)	Spurious attenuation (dBc)	Limit (dBc)	Margin (dB)
925.100	H	51.26	36.44	14.82
925.100	V	48.64	36.44	12.20
1 387.650	H	57.46	36.44	21.02
1 387.650	V	62.89	36.44	26.45
1 850.200	H	56.50	36.44	20.06
1 850.200	V	48.52	36.44	12.08
2 312.750	H	59.13	36.44	22.69
2 312.750	V	51.77	36.44	15.33
2 775.300	H	51.74	36.44	15.30
2 775.300	V	52.97	36.44	16.53
3 237.850	H	51.21	36.44	14.77
3 237.850	V	55.97	36.44	19.53
3 700.400	H	44.26	36.44	7.82
3 700.400	V	45.12	36.44	8.68
4 162.950	H	61.15	36.44	24.71
4 162.950	V	63.29	36.44	26.85
4 625.500	H	67.30	36.44	30.86
4 625.500	V	73.12	36.44	36.68

Remark;

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

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

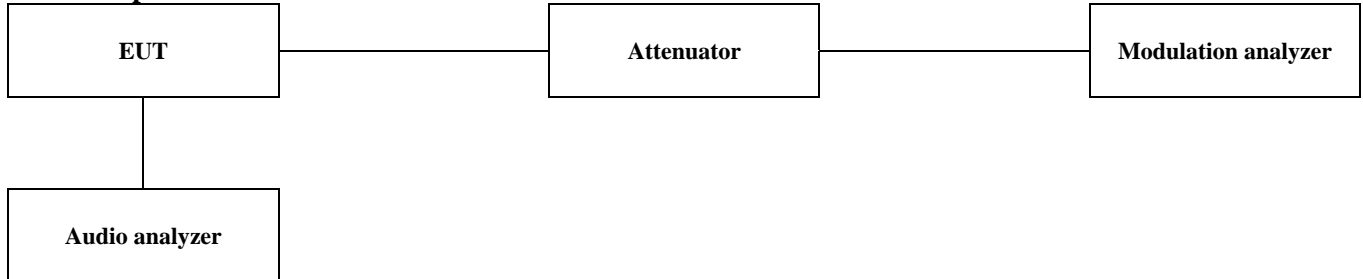
Frequency (MHz)	Ant. Pol. (H/V)	Spurious attenuation (dBc)	Limit (dBc)	Margin (dB)
935.425	H	65.14	35.98	29.16
935.425	V	52.28	35.98	16.30
1 403.138	H	54.99	35.98	19.01
1 403.138	V	59.46	35.98	23.48
1 870.850	H	50.78	35.98	14.80
1 870.850	V	41.98	35.98	6.00
2 338.563	H	54.66	35.98	18.68
2 338.563	V	49.67	35.98	13.69
2 806.275	H	48.40	35.98	12.42
2 806.275	V	49.80	35.98	13.82
3 273.988	H	54.13	35.98	18.15
3 273.988	V	61.14	35.98	25.16
3 741.700	H	47.30	35.98	11.32
3 741.700	V	48.96	35.98	12.98
4 209.413	H	57.42	35.98	21.44
4 209.413	V	58.83	35.98	22.85
4 677.125	H	68.62	35.98	32.64
4 677.125	V	68.15	35.98	32.17

Remark;

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

3.2. Modulation limiting

Test setup



Test procedure

TIA/EIA-603-D

Limit

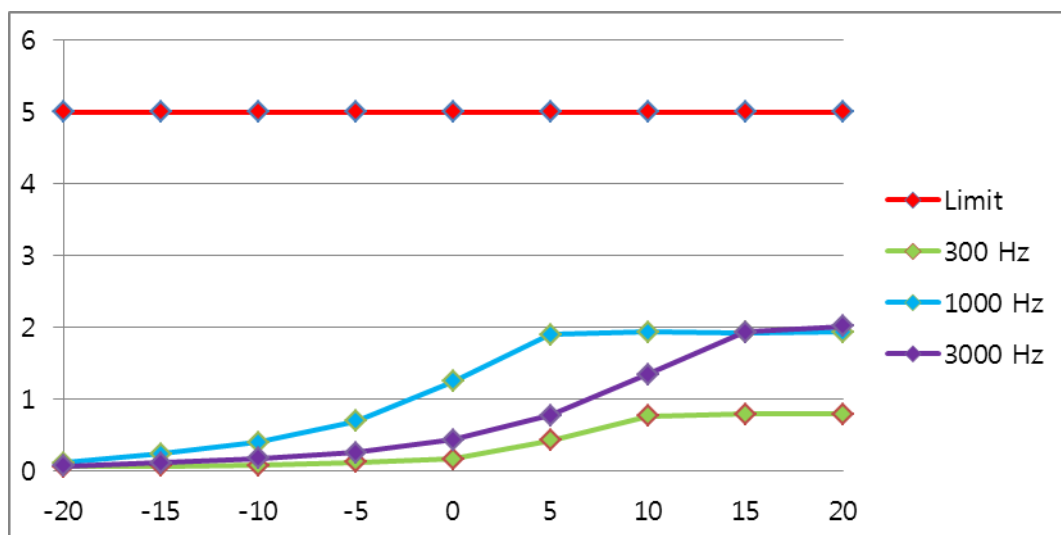
§95.637

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

Test results

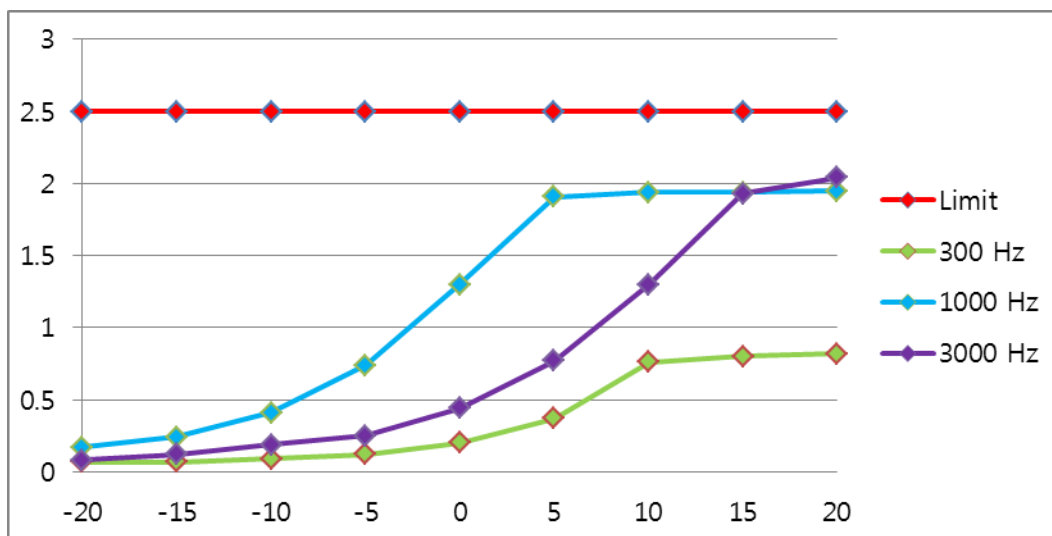
GMRS

Audio level (dB)	Deviation at 300 Hz	Deviation at 1 kHz	Deviation at 3 kHz	Limit (kHz)
-20	0.06	0.12	0.07	5
-15	0.07	0.24	0.12	5
-10	0.08	0.40	0.18	5
-5	0.13	0.70	0.26	5
0	0.17	1.25	0.44	5
5	0.43	1.90	0.78	5
10	0.77	1.94	1.35	5
15	0.80	1.93	1.94	5
20	0.80	1.94	2.02	5



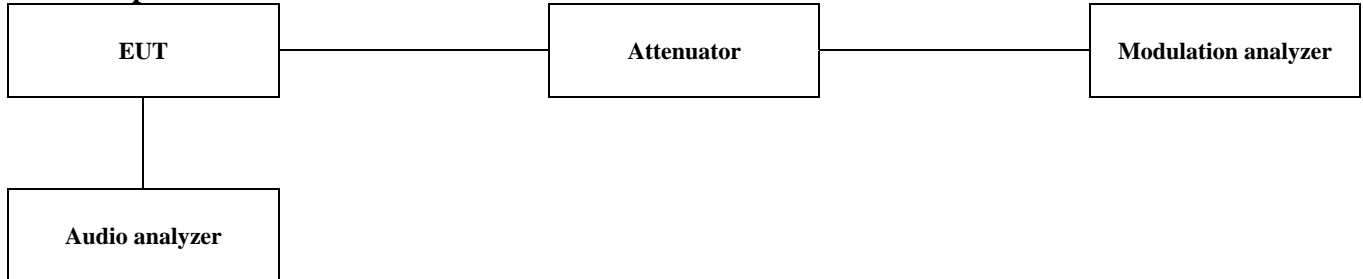
FRS

Audio level (dB)	Deviation at 300 Hz	Deviation at 1 kHz	Deviation at 3 kHz	Limit (kHz)
-20	0.07	0.17	0.08	2.5
-15	0.07	0.24	0.12	2.5
-10	0.09	0.41	0.19	2.5
-5	0.12	0.74	0.25	2.5
0	0.20	1.30	0.44	2.5
5	0.37	1.91	0.77	2.5
10	0.76	1.94	1.30	2.5
15	0.80	1.94	1.93	2.5
20	0.82	1.95	2.04	2.5



3.3. Audio frequency response

Test setup



Test procedure

TIA/EIA-603-D

Limit

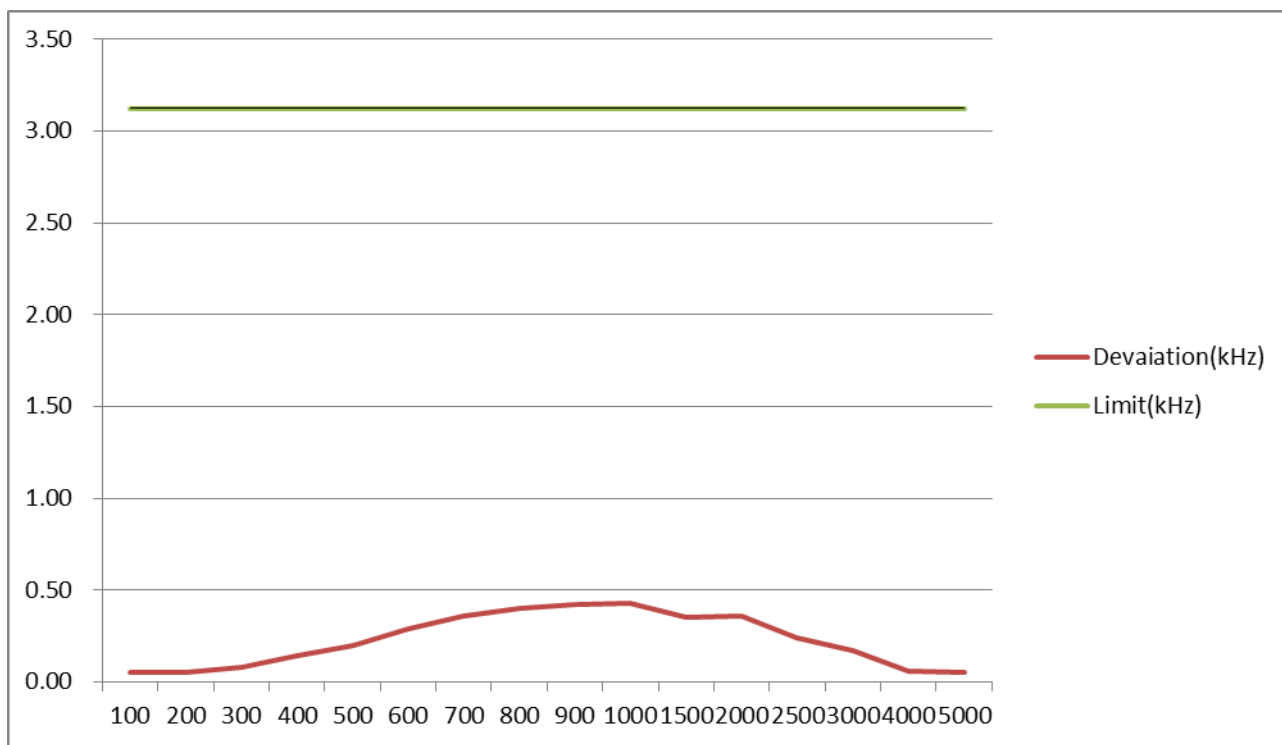
§2.1047

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 Hz 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

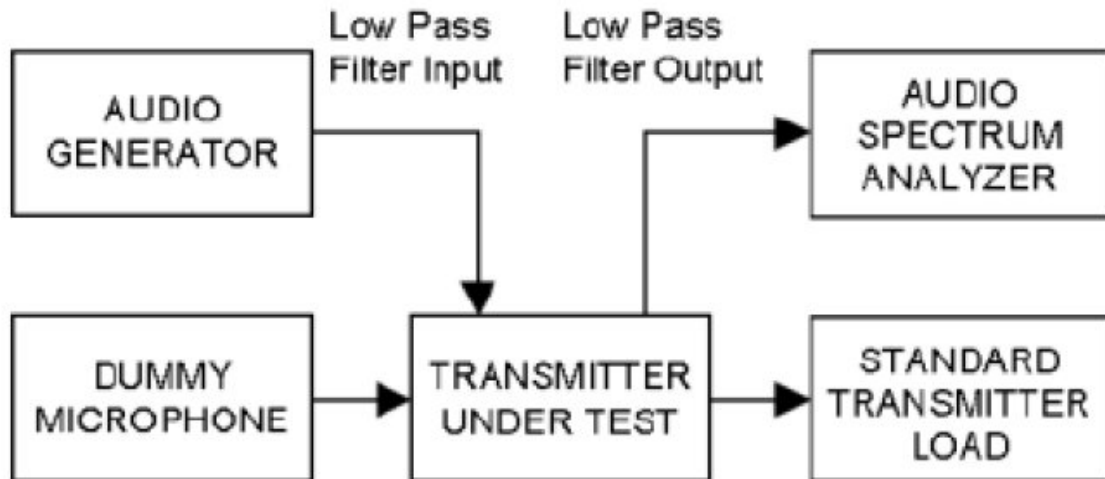
Audio frequency(Hz)	Deviation(kHz)	Limit(kHz)
100	0.02	3.125
200	0.02	3.125
300	0.02	3.125
400	0.05	3.125
500	0.16	3.125
600	0.22	3.125
700	0.25	3.125
800	0.24	3.125
900	0.30	3.125
1000	0.34	3.125
1500	0.44	3.125
2000	0.56	3.125
2500	0.64	3.125
3000	0.63	3.125
4000	0.40	3.125
5000	0.20	3.125



This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.

3.4. Low-pass filter response

Test setup



Test procedure

TIA/EIA-603-D

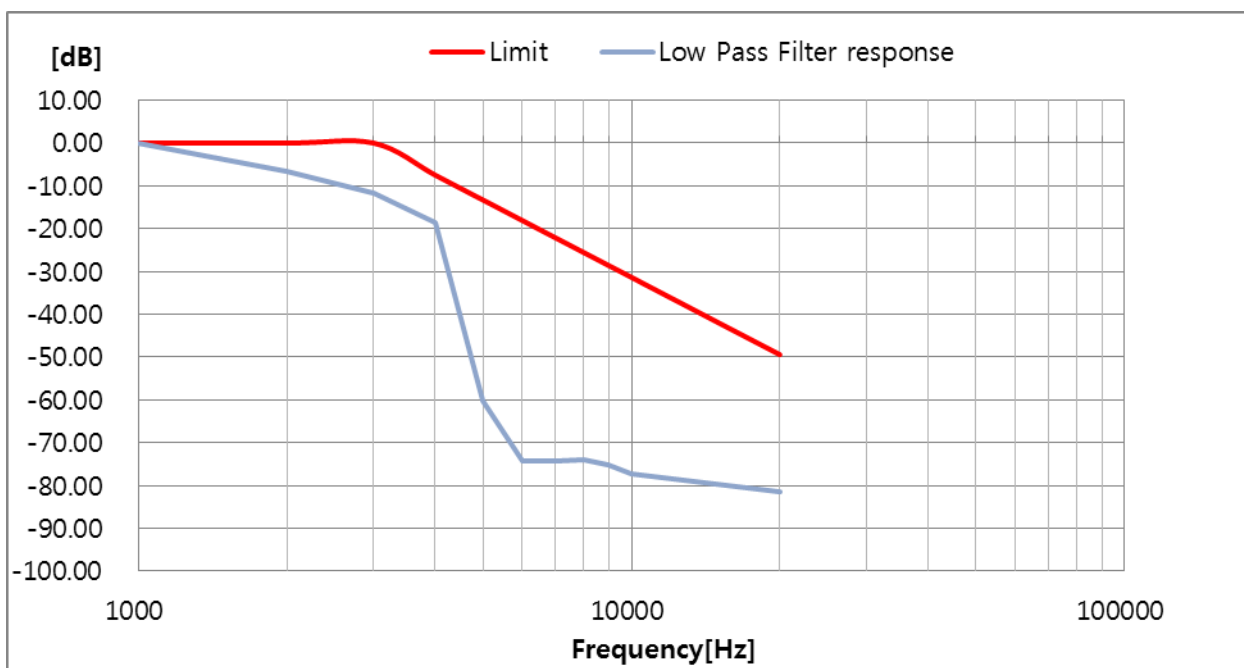
Limit

§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 kHz) between 3 and 20 kHz, the filter must have an attenuation of at least $60 \log_{10}(f/3)$ dB greater than the attenuation at 1 kHz. Above 20 kHz, it must have an attenuation of at least 50 dB greater than the attenuation at 1 kHz.

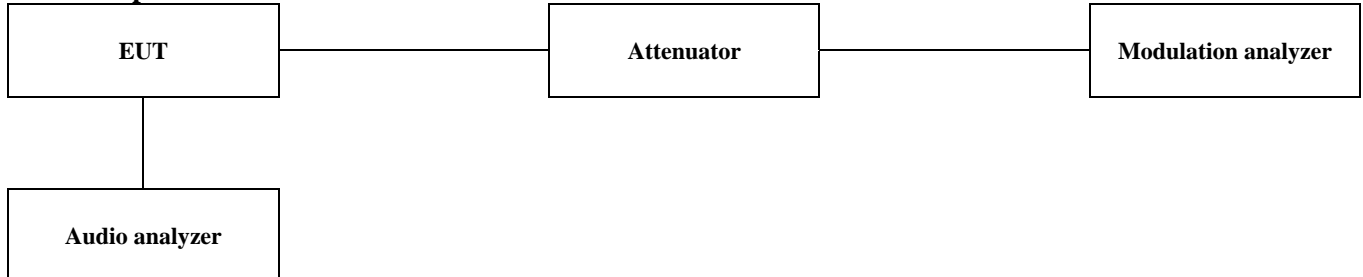
Test results

Audio frequency(Hz)	Response(dB)	Limit(dB)
1000	0.00	0.00
2000	-6.48	0.00
3000	-11.72	0.00
4000	-18.49	-7.50
5000	-60.31	-13.31
6000	-74.39	-18.06
7000	-74.33	-22.08
8000	-73.89	-25.56
9000	-75.22	-28.63
10000	-77.16	-31.37
20000	-81.49	-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 Hz sine wave at an input level 16 dB 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 kHz. The authorized bandwidth for emission type A1D or A3E is 8 kHz. The authorized bandwidth for emission type F1D, G1D, F3E or G3E is 20 kHz.

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

§95.635

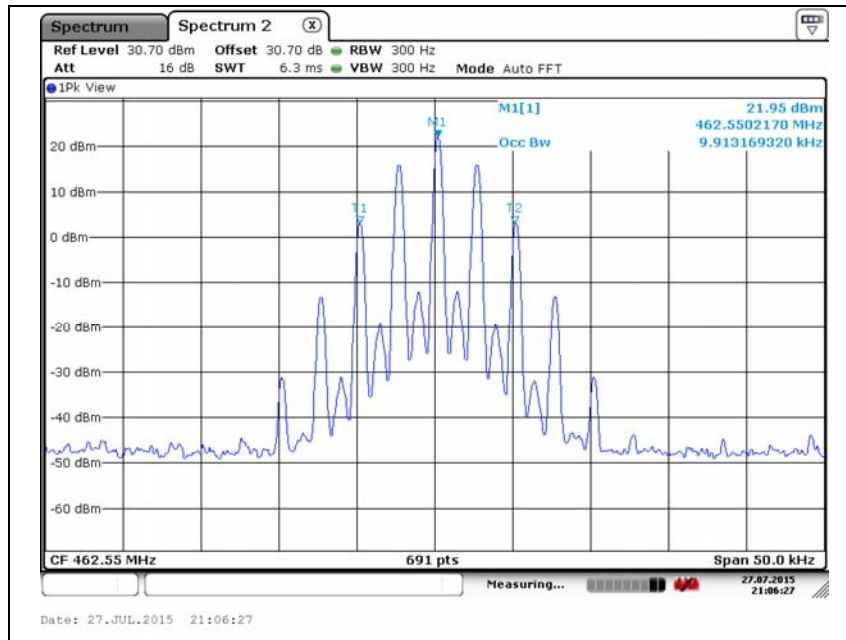
At least 25 dB (decibels) on any frequency removed from the center of the authorized bandwidth by more than 50 % up to and including 100 % of the authorized bandwidth.

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

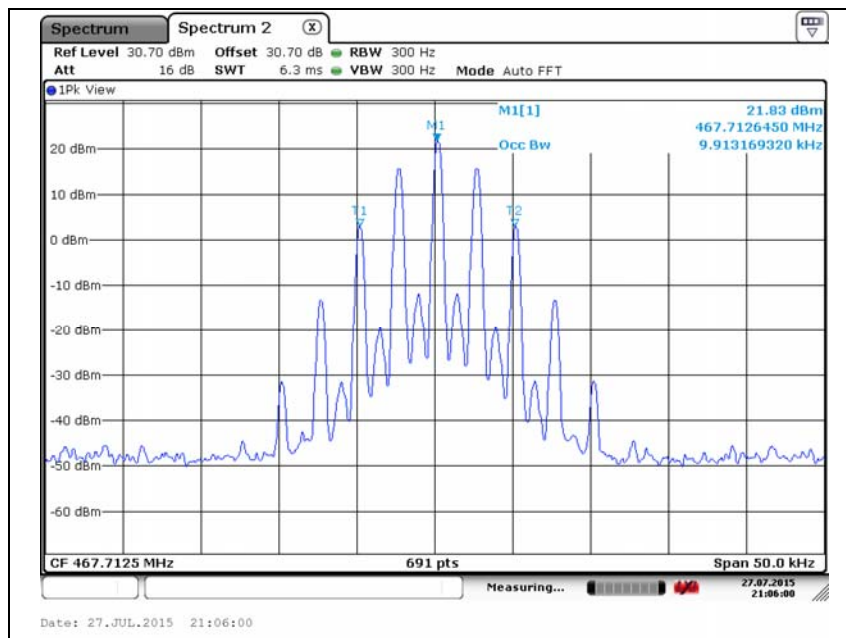
At least $43 + 10 \log_{10}(T)$ dB on any frequency removed from the center of the authorized bandwidth by more than 250 %.

Test results

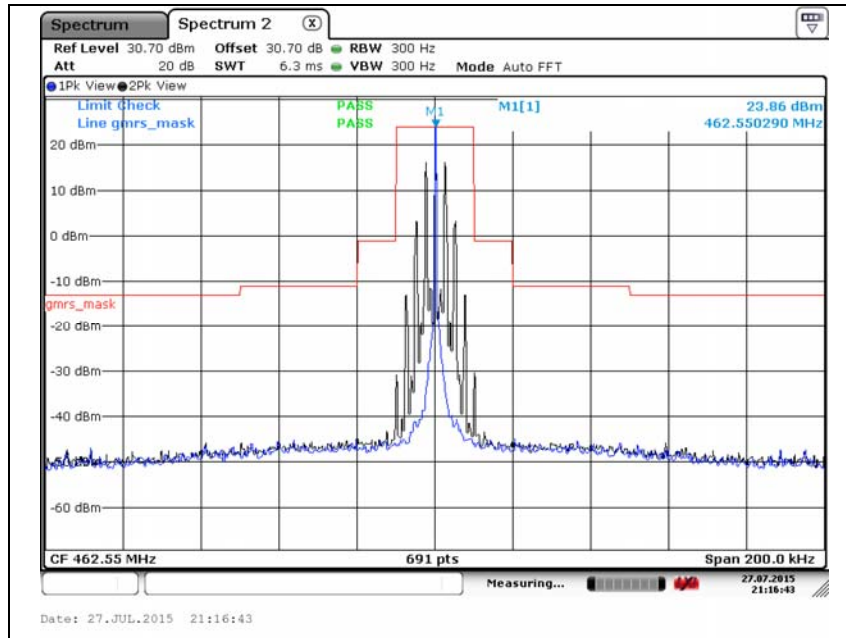
99 % bandwidth for GMRS



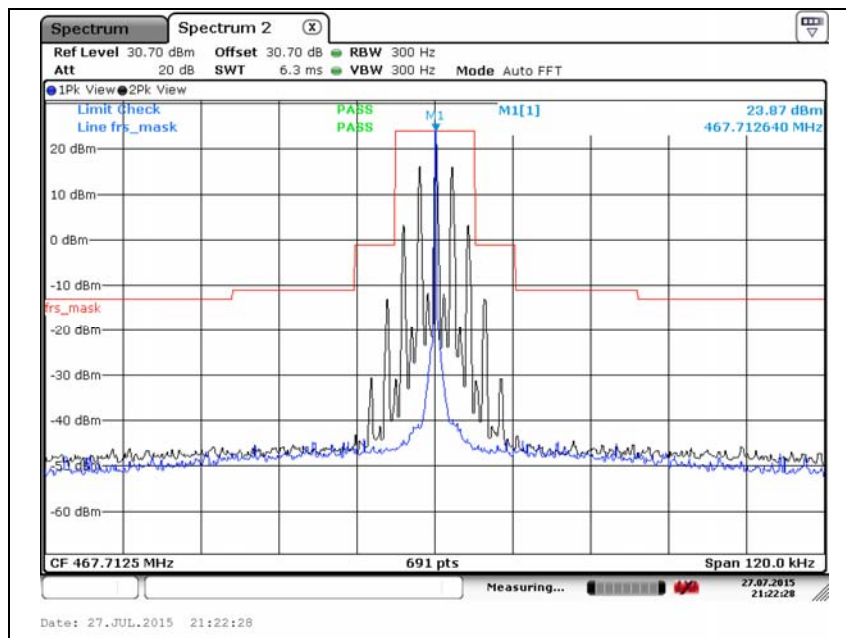
99 % bandwidth for FRS



Emission mask for GMRS



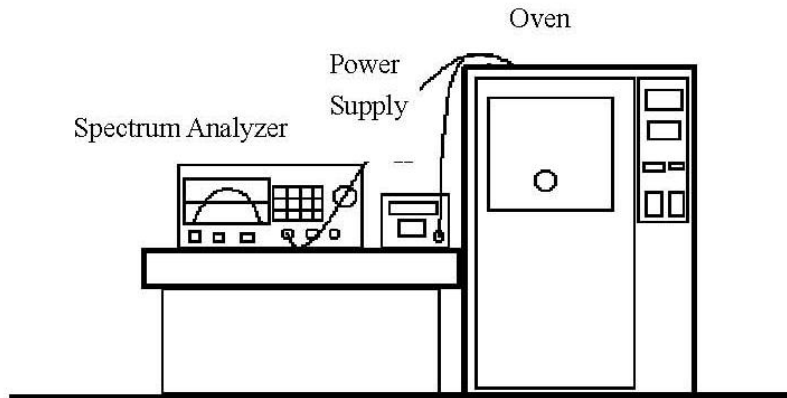
Emission mask for FRS



This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.

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 kHz, VBW=1 kHz.
3. Set the temperature of chamber to -30°C. 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°C decreased per stage until the highest temperature 50°C 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 (MHz): 462.550 0

Temperature (°C)	Measure frequency (MHz)	Frequency deviation (Hz)	Frequency deviation (ppm)	Frequency deviation (%)
-30	462.550528	528	1.141	0.000114
-20	462.550410	410	0.886	0.000089
-10	462.550254	254	0.549	0.000055
0	462.550185	185	0.400	0.000040
10	462.550094	94	0.203	0.000020
20	462.550050	50	0.108	0.000011
30	462.550031	31	0.067	0.000007
40	462.549943	-57	-0.123	-0.000012
50	462.549906	-94	-0.203	-0.000020

Temperature (°C)	Voltage (V)	Measure frequency (MHz)	Frequency deviation (ppm)	Frequency deviation (%)
25	3.06	462.550056	0.121	0.000012
25	4.14	462.550047	0.102	0.000010

Assigned frequency (MHz): 467.712 5

Temperature (°C)	Measure frequency (MHz)	Frequency deviation (Hz)	Frequency deviation (ppm)	Frequency deviation (%)
-30	467.713084	584	1.249	0.000125
-20	467.712946	446	0.954	0.000095
-10	467.712899	399	0.853	0.000085
0	467.712723	223	0.477	0.000048
10	467.712625	125	0.267	0.000027
20	467.712560	60	0.128	0.000013
30	467.712520	20	0.043	0.000004
40	467.712429	-71	-0.152	-0.000015
50	467.712406	-94	-0.201	-0.000020

Temperature (°C)	Voltage (V)	Measure frequency (MHz)	Frequency deviation (ppm)	Frequency deviation (%)
25	3.06	467.712555	0.118	0.000012
25	4.14	467.712558	0.124	0.000012

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
Broadband 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			