TEST REPORT

OF

FCC Part 90, Part 2

FCC ID: UYKRFCT-10

Equipment Under Test	:	Transmitter for wireless clock system
Model Name	:	RFCT-10
Serial No.	:	N/A
Applicant	:	Hanyang Navicom Co., Ltd.
Manufacturer	:	Hanyang Navicom Co., Ltd.
Date of Test(s)	:	2007-02-22~ 2007-03-15
Date of Issue	:	2007-03-15

In the configuration tested, the EUT complied with the standards specified above.

Tested By:  **Date** **2007-03-15**

Denny Ham

Approved By  **Date** **2007-03-15**

James Kwon

INDEX

TABLE OF CONTENTS

1. General Information

1.1. Testing Laboratory

SGS Testing Korea Co., Ltd.
Wireless Div. 2FL, 18-34, Sanbon-dong, Gunpo-Si, Gyeonggi-do, Korea 435-040
www.electrolab.kr.sgs.com
Telephone : +82 +31 428 5700
FAX : +82 +31 427 2371

1.2. Details of Applicant

Applicant : Hanyang Navicom Co., Ltd.
Address : 100 Sinseong-dong, Yuseong-gu, Daejeon Korea 305-804
Contact Person : Seungil Lee
Phone No. : +82 +42 868 4551
Fax No. : +82 +42 868 4501

1.3. Description of EUT

Kind of Product	Transmitter for wireless clock system
Model Name	RFCT-10
Serial Number	N/A
Power Supply	DC 9 V(AC 100 ~240 V adaptor)
Frequency Range	72.1 MHz ~ 72.4 MHz
Modulation Technique	F1D(FSK)
Number of Channels	16 ch
Operating Conditions	-30 ℃ ~ 50 ℃
Antenna Type	Whip antenna
Antenna Gain	-4.72 dBi

1.4. Details of modification

-N/A

1.5. Test Equipment List

EQUIPMENT	MANUFACTURER	MODEL	CAL DUE.
Signal Generator	Agilent	E4438C	May 2007
Spectrum Analyzer	H.P	8593E	Sep. 2007
Spectrum Analyzer	R & S	FSP40	Jan. 2008
Power Meter	Agilent	E4416A	May 2007
Power Sensor	Agilent	E9327A	May 2007
DC Power Supply	Agilent	6674A	May 2007
Attenuator	Agilent	8494B	May 2007
Two-Line V-Network	NNB 41	Schaffner	Sep. 2007
Test Receiver	Rohde & Schwarz	ESVS10	May 2007
Ultra-Broadband Antenna	Rohde & Schwarz	HL562	Sep. 2007
Dipole Antenna	Schwarzbeck	VHAP/UHAP	Jun. 2007
Anechoic Chamber	SY Corporation	L x W x H 9.6 x 6.4 x 6.4	Aug. 2007

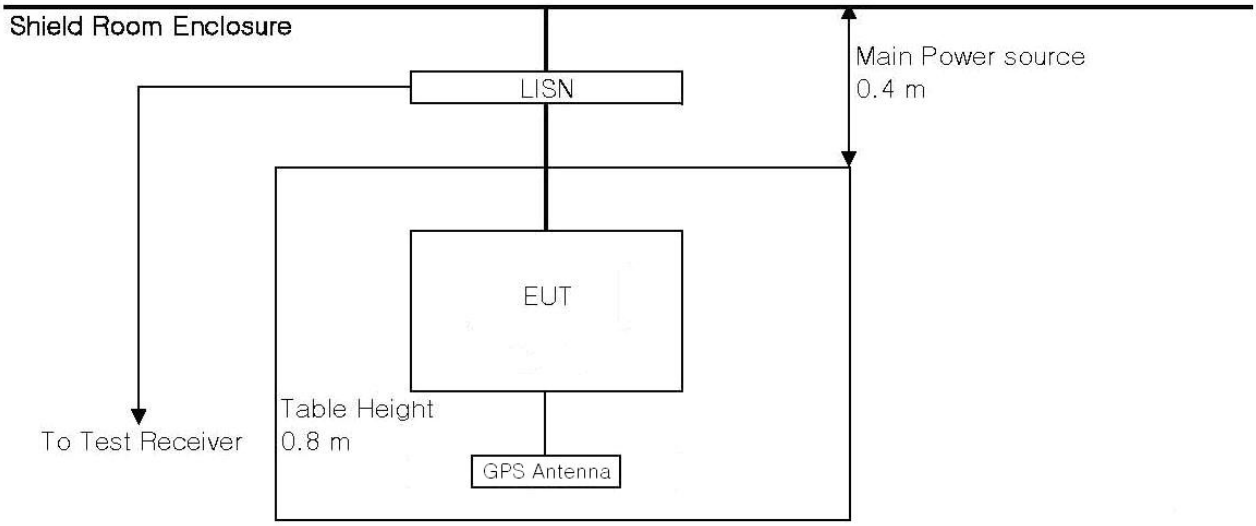
1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD:FCC Part 90, Part 2, Part 15		
Standard Section	**Test Item**	**Result**
15.107(b)	AC Power Line Conducted Emission	-
90.210(c)	Spurious Radiated Emission	Complied
90.213(a)	Frequency Stability	Complied
90.257(b)(2)	Conducted Output Power	Complied
2.1047	Modulation Characteristics	Complied
2.1049	Occupied Bandwidth	Complied

2. AC Power Line Conducted Emission

2.1. Test Setup



2.2. Test Procedures

The test procedure is performed in a 6.5m × 3.6m× 3.6m (L×W×H) shielded room. The EUT along with its peripherals were placed on a 1.0m(W)× 1.5m(L) and 0.8m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

2.3. Limit : §15.107(b)

According to §15.107(b) for a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm LISN(line impedance stabilization network).Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15 – 0.50	79	66
0.50 – 30	73	60

2.4. Test Results

The following table shows the highest levels of conducted emissions on both phase of Hot and Neutral line.

Ambient temperature : 22 ℃ Relative humidity : 43 %

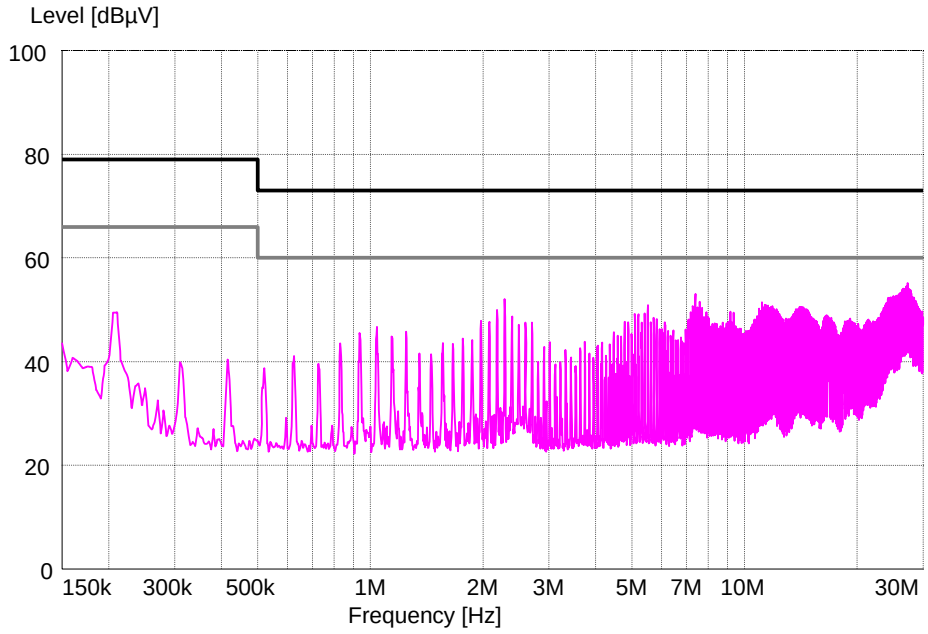
Frequency range : 0.15 MHz – 30 MHz
Measured Bandwidth : 9 kHz

FREQ.	LEVEL(dBuV)		LINE	LIMIT(dBuV)		MARGIN(dB)	
(MHz)	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.207	48.4	41.2	H	79	66	30.6	24.8
5.517	46.0	39.9	H	73	60	27.0	20.1
2.289	51.0	42.0	H	73	60	22.0	18.0
7.393	49.3	42.6	H	73	60	23.7	17.4
11.139	47.4	41.2	H	73	60	25.6	18.8
27.317	49.5	35.7	H	73	60	23.5	24.3
0.207	45.2	38.3	N	79	66	33.8	27.7
2.291	50.6	42.1	N	73	60	22.4	17.9
7.400	48.8	42.5	N	73	60	24.2	17.5
11.668	48.2	42.3	N	73	60	24.8	17.7
14.277	49.6	41.7	N	73	60	23.4	18.3
26.979	51.4	43.4	N	73	60	21.6	16.6

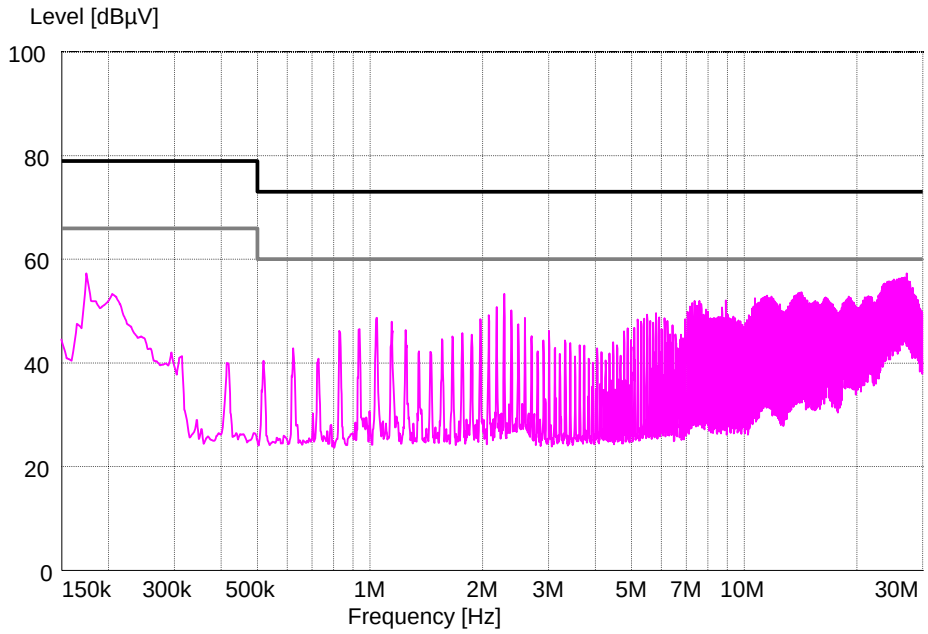
Note ;
Line (H) : Hot
Line (N) : Neutral

Plot of Conducted Power line

Test mode : Hot



Test mode : Neutral

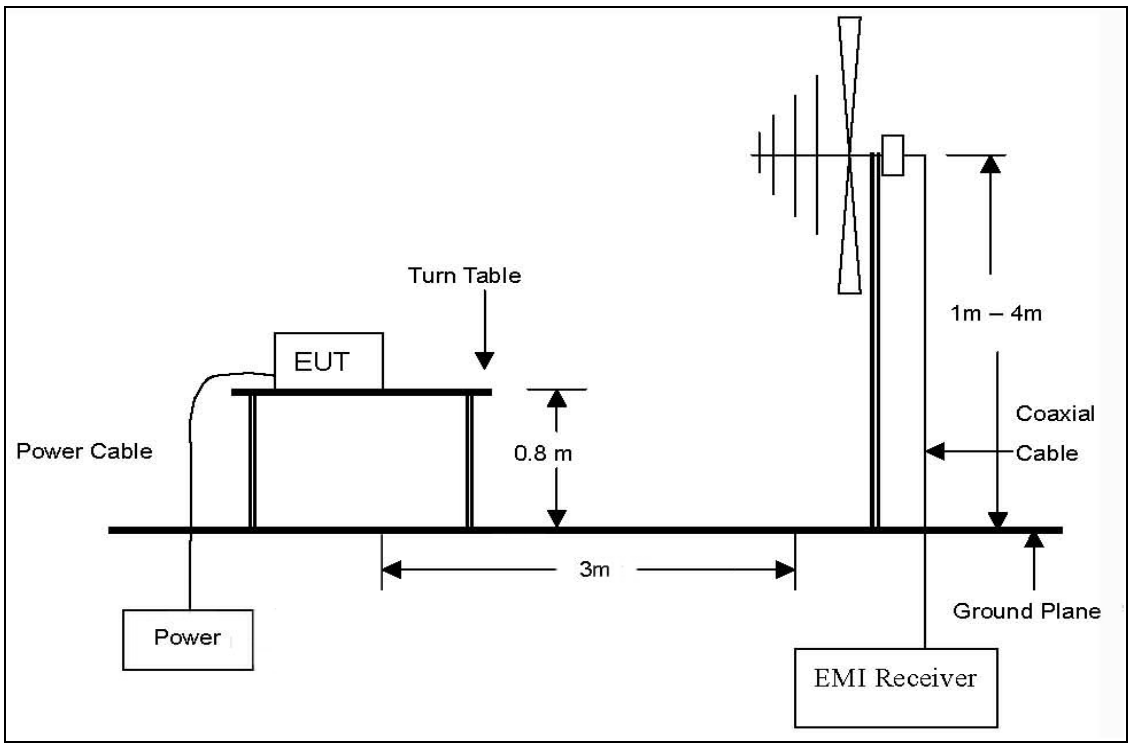


3. Spurious Radiated Emission

3.1. Test Setup

3.1.1. Spurious Radiated Emissions

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



3.1.2. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI/TIA-603-C:2004

1. On a test site, the EUT shall be placed at 0.8cm 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 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. The transmitter shall be switched on, the measuring receiver shall be tuned to the frequency of the transmitter under test.
5. 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.
6. The transmitter shall then the rotated through 360° in the horizontal plane, until the maximum signal level is detected by the measuring receiver.
7. 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.
8. The maximum signal level detected by the measuring receiver shall be noted.
9. The transmitter shall be replaced by a horn (substitution antenna).
10. The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of the transmitter.
11. The substitution antenna shall be connected to a calibrated signal generator.
12. In necessary, the input attenuator setting of the measuring receiver shall be adjusted in order to increase he sensitivity of the measuring receiver.
13. The test antenna shall be raised and lowered through the specified range of height to ensure that the maximum signal is received.
14. 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.
15. 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.
16. The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.
17. The measure of the effective radiated power is the large of the two levels recorded, at the input to the substitution antenna, corrected for gain of the substitution antenna if necessary

3.1.3. Spurious RF Conducted Emissions

3.1.4. Test Procedures for Spurious RF Conducted Emissions

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

3.2. Limit : § 90.210(C)

According §90.210(C) Emmission Mask C. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (F_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (F_d /5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (F_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (F_d^2/11) dB or 50 dB, whichever is the lesser attenuation;

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB. P is output power in Watts.

§ 90.210 (C)	Absolute Frequency Offset Range (F_d)	Attenuation relative to Carrier Power P.	
(1)	0 to 5 kHz	0 dB	0 dB
(1)	5 kHz to 10 kHz	83 log (F_d) dB	0 to 24.9 dB
(2)	10 kHz to 70 kHz	29 log (F_d^2/11) dB or 50 dB, whichever is the lesser attenuation;	27.8 to 50 dB
(3)	More than 70 kHz	43 + 10 log (P) dB	43 dB (-13 dBm)

3.3. Test Results

3.3.1. Spurious Radiated Emissions

Ambient temperature : 21℃ Relative humidity : 43 %

Low : 72. 100 MHz

Frequency (MHz)	Ant.Pol. (H/V)	S.G. Reading (dBm)	CL (dB)	Ant Gain (dBd)	ERP (dBm)	Limit (dBm)	Margin (dB)
39.700	V	-31.18	0.14	-7.67	-38.99	-13	25.99
107.600	V	-26.92	0.24	-7.88	-35.04	-13	22.04
181.967	V	-41.42	0.36	-7.51	-49.29	-13	36.29
288.667	V	-45.74	0.48	-7.62	-53.84	-13	40.84
450.333	V	-43.54	0.50	-7.53	-51.57	-13	38.57
<1 GHz	Not detected						

Middle : 72. 240 MHz

Frequency (MHz)	Ant.Pol. (H/V)	S.G. Reading (dBm)	CL (dB)	Ant Gain (dBd)	ERP (dBm)	Limit (dBm)	Margin (dB)
38.083	V	-31.20	0.14	-7.70	-39.04	-13	26.04
107.600	V	-27.22	0.24	-7.88	-35.34	-13	22.34
183.583	V	-41.40	0.36	-7.54	-49.30	-13	36.30
450.333	V	-43.54	0.50	-7.53	-51.57	-13	38.57
<1 GHz	Not detected						

High : 72.400 MHz

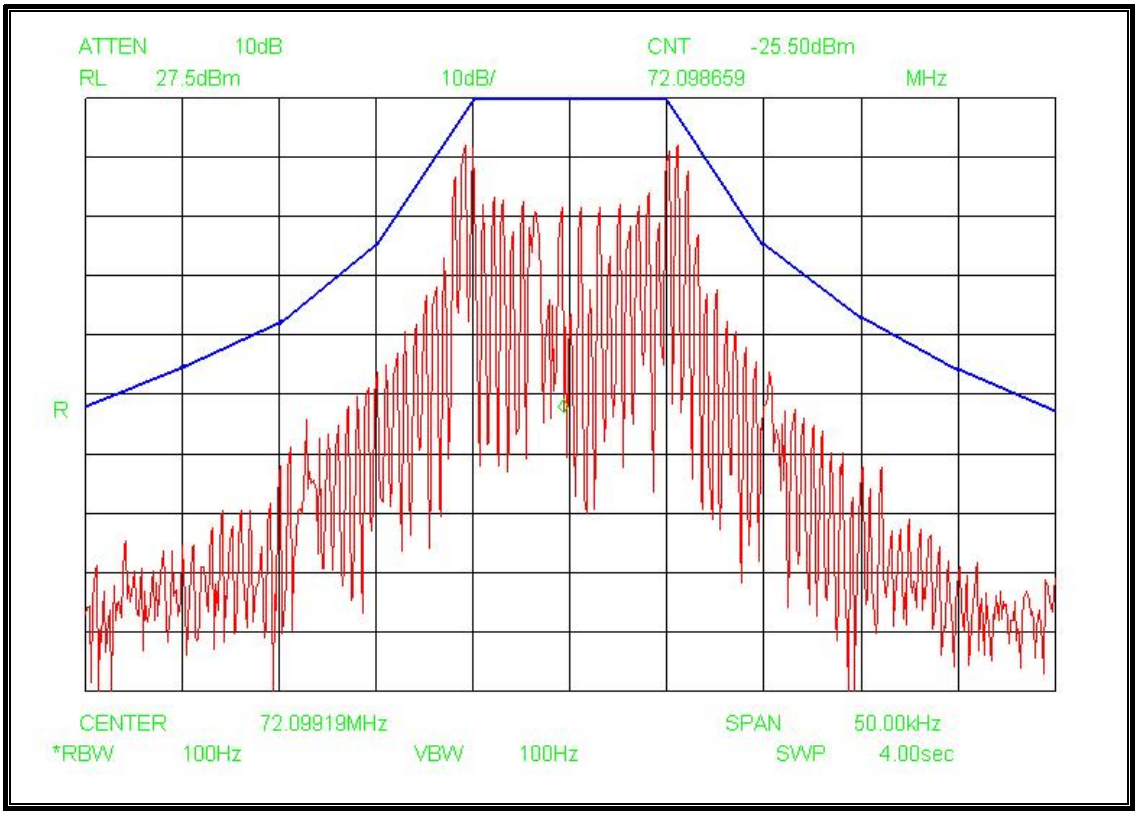
Frequency (MHz)	Ant Pol. (H/V)	SG. Reading (dBm)	CL (dB)	Ant Gain (dBd)	ERP (dBm)	Limit (dBm)	Margin (dB)
38.083	V	-32.62	0.14	-7.70	-40.46	-13	27.46
107.600	V	-27.22	0.24	-7.88	-35.34	-13	22.34
183.583	V	-41.42	0.36	-7.54	-49.32	-13	36.32
280.583	V	-44.02	0.48	-7.65	-52.15	-13	39.15
450.333	V	-43.50	0.50	-7.53	-51.53	-13	38.53
<1 GHz	Not detected						

Note :

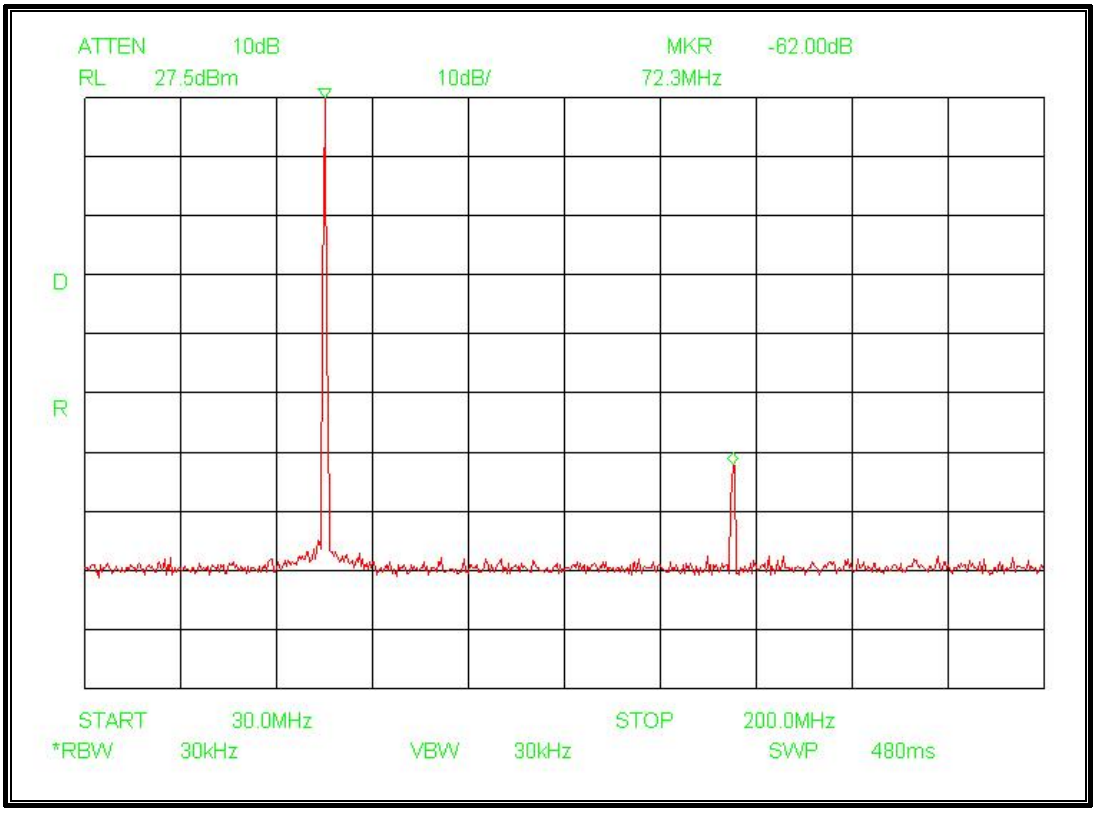
1. All spurious emission at channels are almost the same below 1 GHz, so that the channel was chosen at representative in final test.
2. ERP = SG Reading – CL .+ Ant Gain

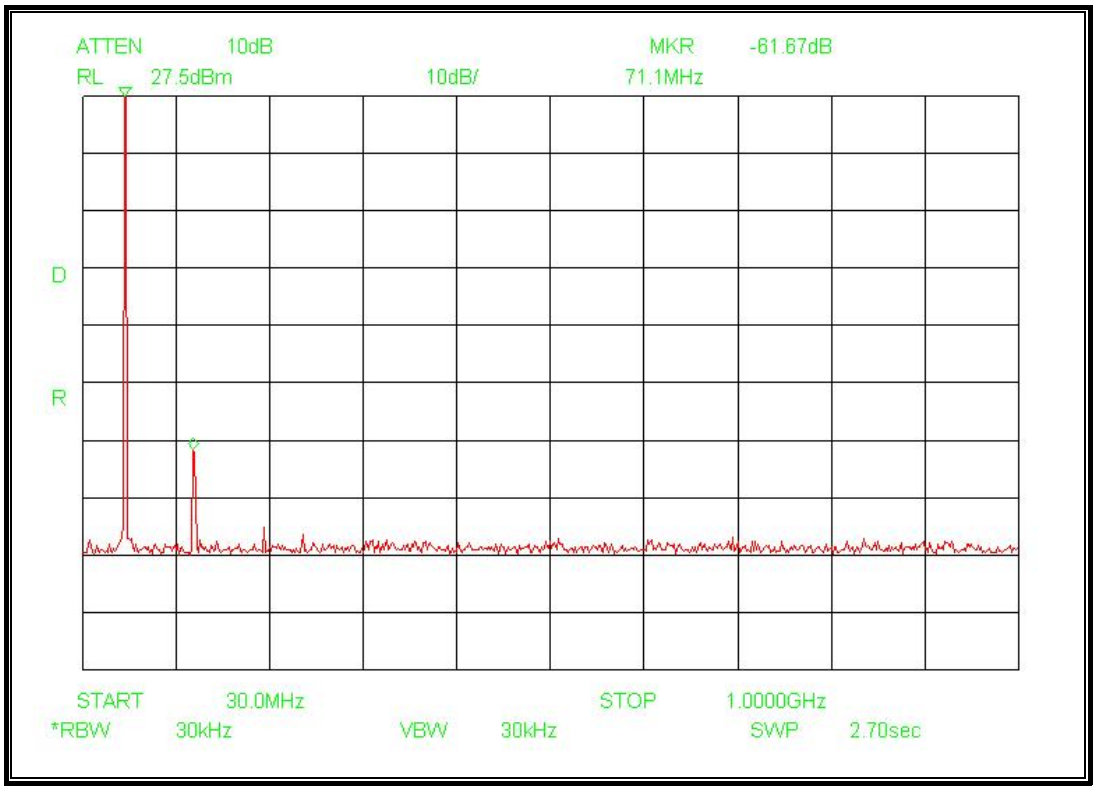
3.3.2. Spurious RF Conducted Emissions : Plot of RF Conducted Emission

Low : 72.100 MHz

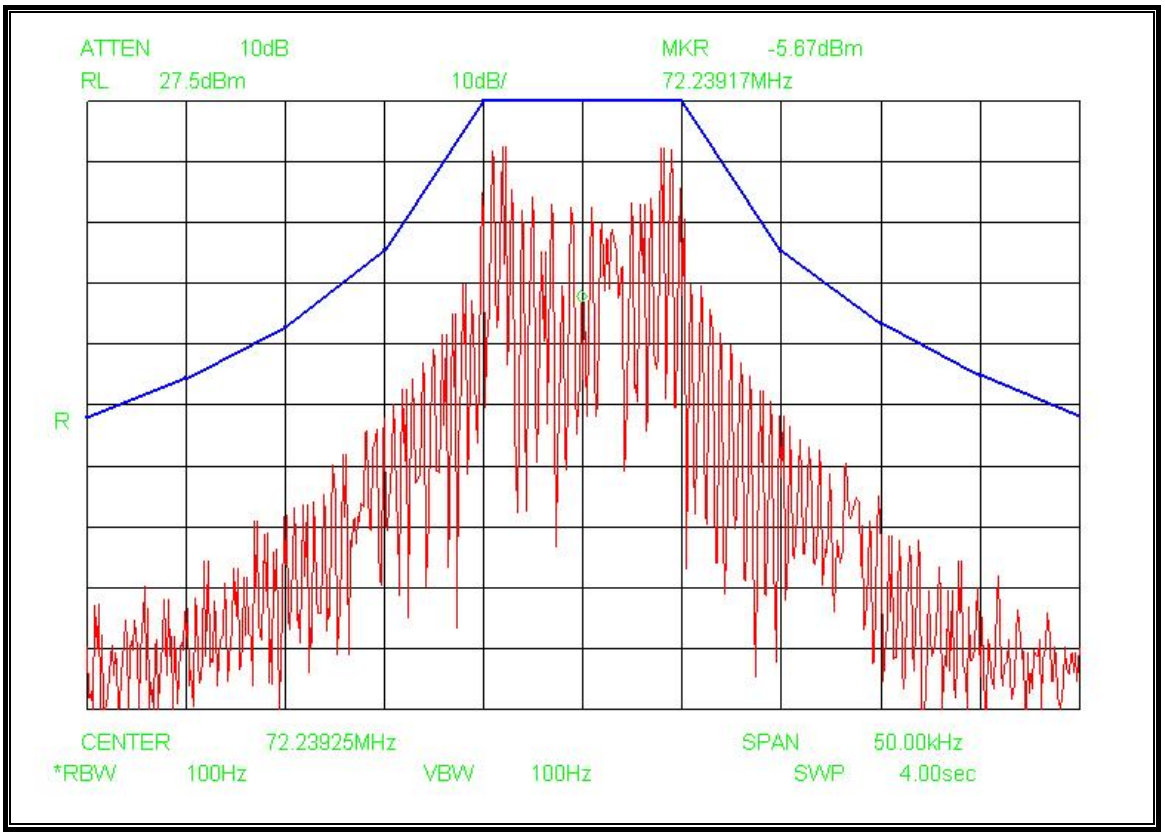


Low : 72.100 MHz

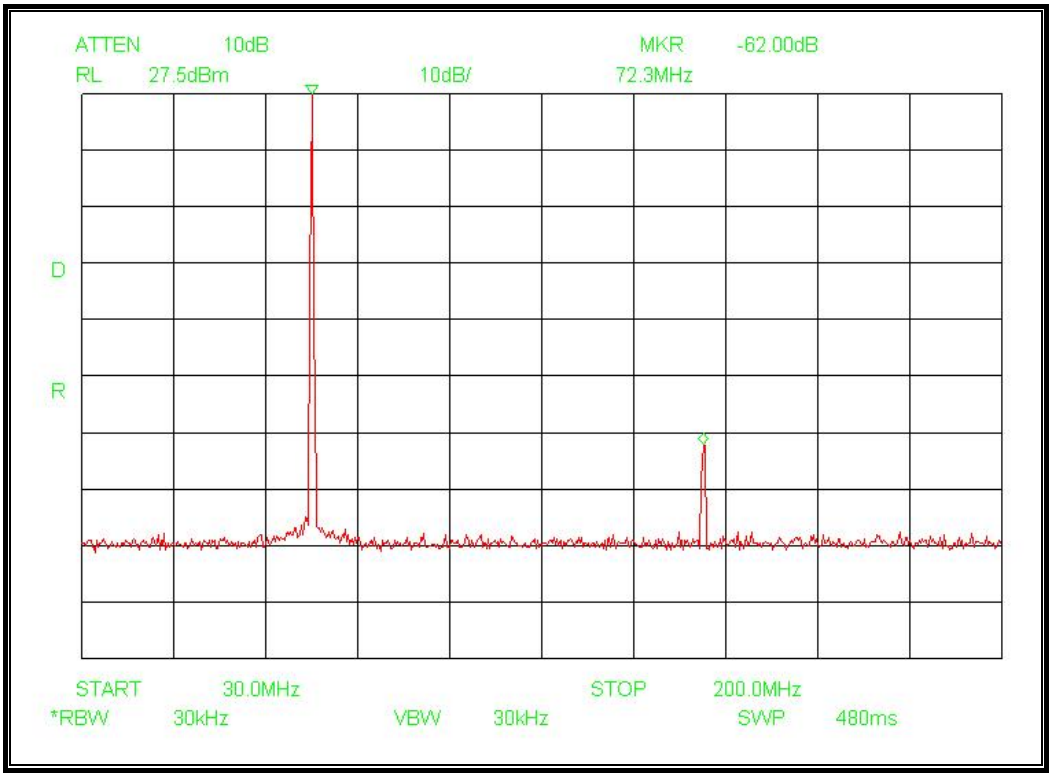


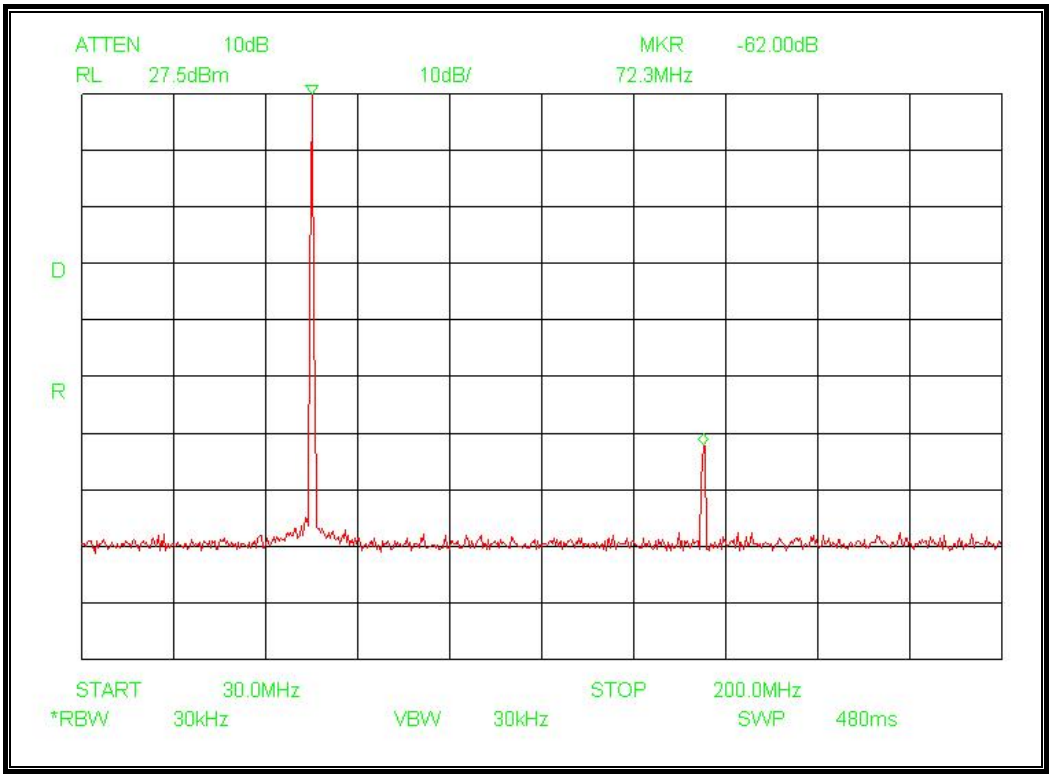


Middle : 72.2400 MHz

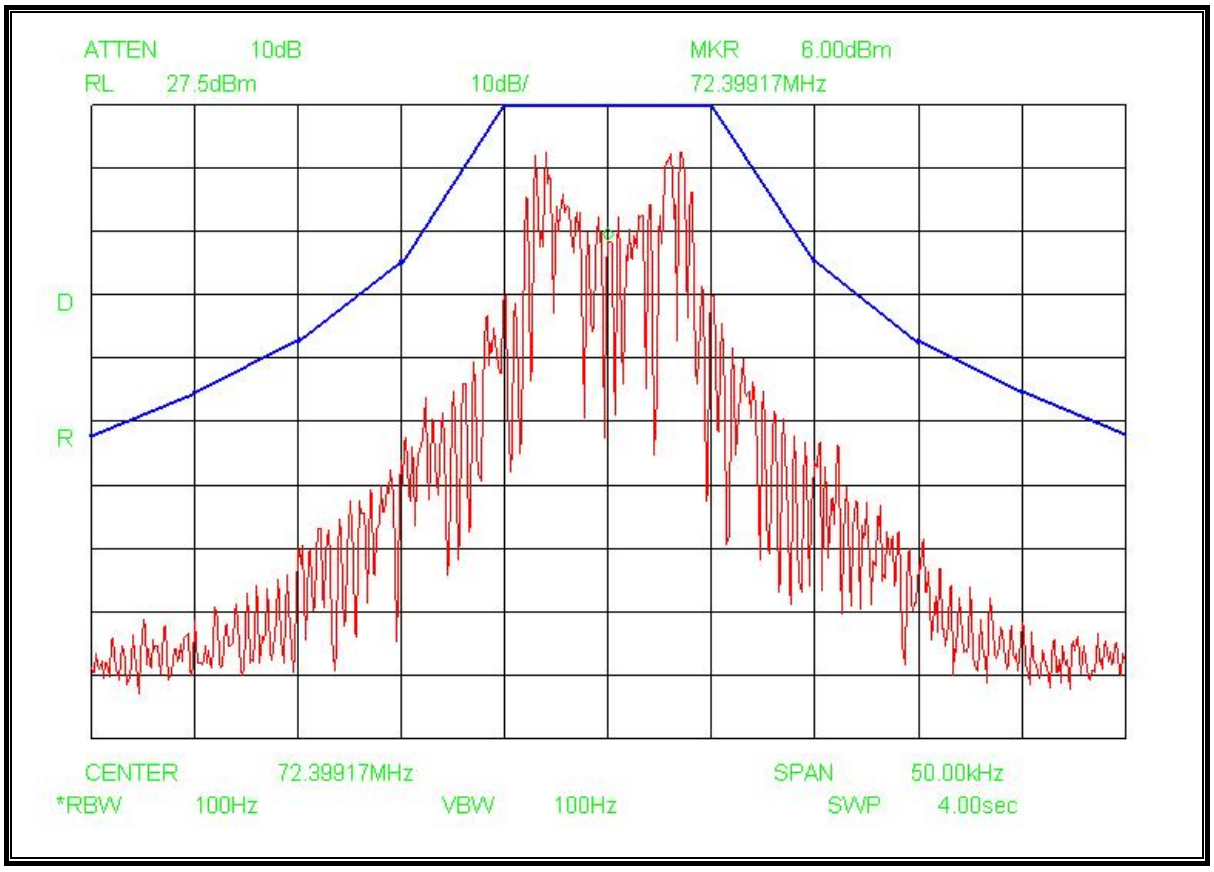


Middle : 72.2400 MHz

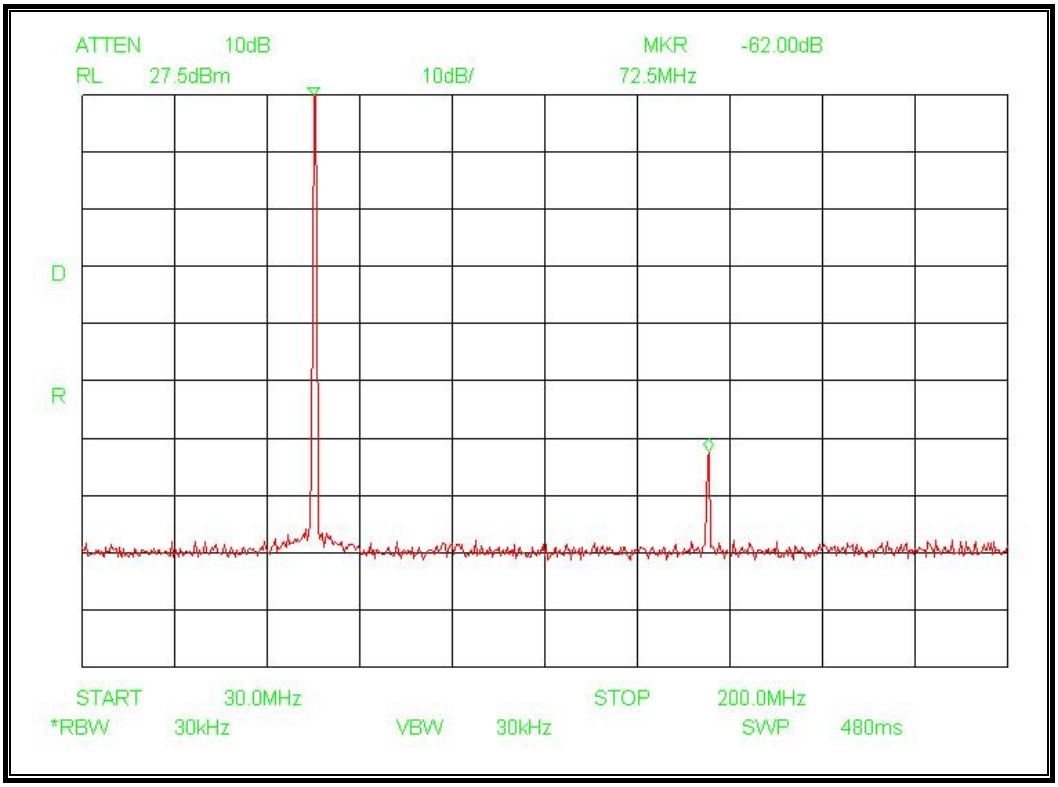


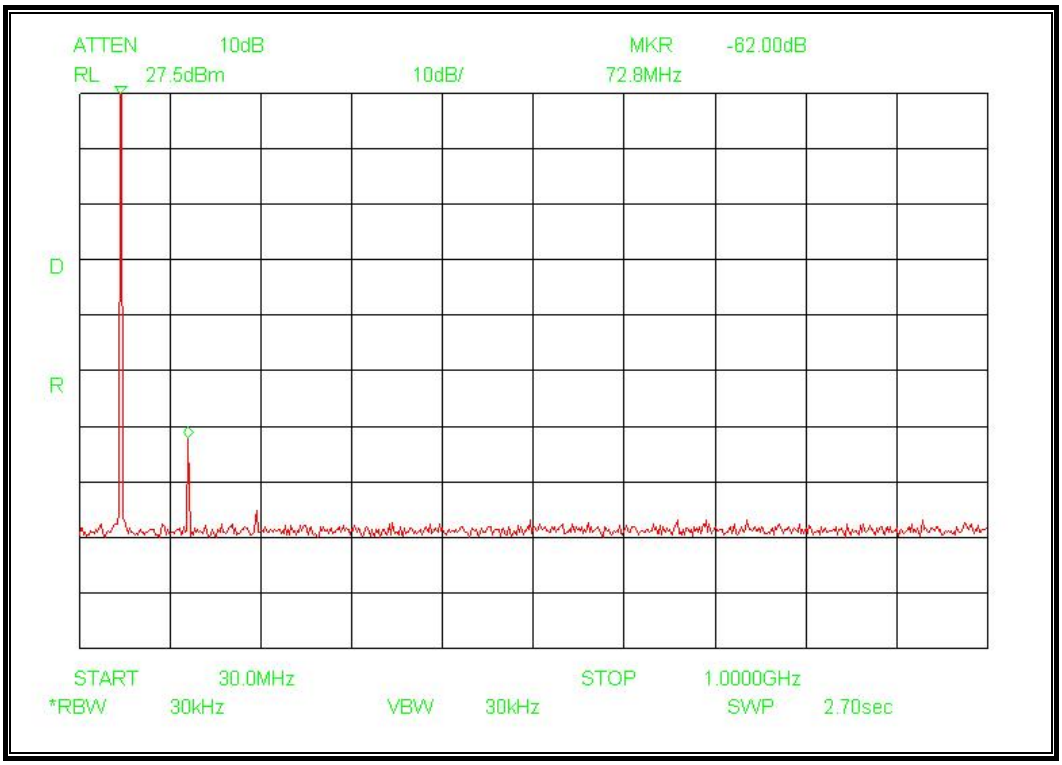


High : 72.400 MHz



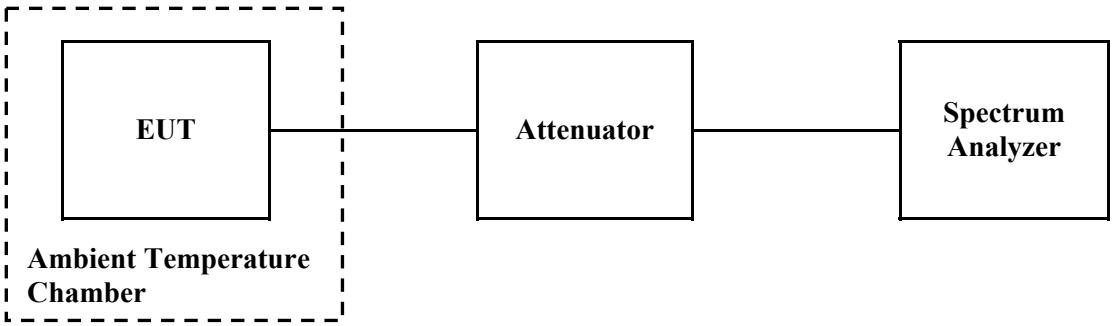
High : 72.400 MHz





4. Frequency Stability

4.1. Test Setup



4.2. Test Procedure

According to § 2.1055 (a)(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

4.3. Limit : § 90.213(a)

According to §90.213(a) Mobile stations in 72 to 76 MHz frequency range bellow 2W output power must have a minimum frequency stability 50 ppm as specified in the following table.

Frequency Range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 Watts output power	2 Watts or Less output power
72-76 MHz	5	-	50 ppm

4.4. Test Results

Test Frequency : 72.100 MHz

Temperature (℃)	Frequency (MHz)	PPM Frequency Error (ppm)	Limit (ppm)
-30	72.09902	-13.59	50
-20	72.09911	-12.34	
-10	72.09939	-8.46	
0	72.09949	-7.07	
10	72.09918	-11.37	
20	72.09939	-8.46	
30	72.09925	-10.40	
40	72.09918	-11.37	
50	72.09905	-13.18	

Note :

Calculate the ppm frequency error by the following:

PPM Frequency Error = [(MCF/ACF)-1] * 10^6

where

MCF is the Measured Carrier Frequency in MHz
ACF is the Assigned Carrier Frequency in MHz

5. Frequency Stability for primary supply voltage

5.1. Test Setup

5.2. Test Procedure

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.

5.3. Limit : § 90.213(a)

5.4. Test Results

Test Frequency : 72.100 MHz

Voltage [V]		Frequency (MHz)	Frequency Delta (ppm)	Limit (ppm)
Vmin	102	72.09935	-9.02	50
Vnom	120	72.09933	-9.29	
Vmax	138	72.09940	-8.32	

6. Conducted Output Power

6.1. Test Setup

6.2. Test Procedure

According to § 2.1046 (c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load

6.3. Limit : § 90.257(b)(2)

According to §90.257(b)(2) The maximum transmitter output power that will be authorized is 1 watt; and each station authorized will be classified and licensed as a mobile station. Any units of such a station, however, may be used to provide the operational functions of a base or fixed station.

6.4. Test Results

Ambient temperature : 21 ℃ Relative humidity : 42 %

Channel	Channel Frequency (MHz)	Peak Power Output (dBm)	Peak Power Limit (dBm)	Margin (dB)
Low	72.100	27.17	30	2.83
Middle	72.240	27.33	30	2.67
High	72.400	27.33	30	2.67

The supply voltage to the transmitter was set to 9V DC. The RF output power was measured with the indicated current applied into the final RF amplifying device.

RF Output 1 W, Frequency 72.100 MHz

Measured DC Current : 1.09 A

7. Modulation Characteristics & Occupied Bandwidth

7.1. Modulation Characteristics: § 2.1047

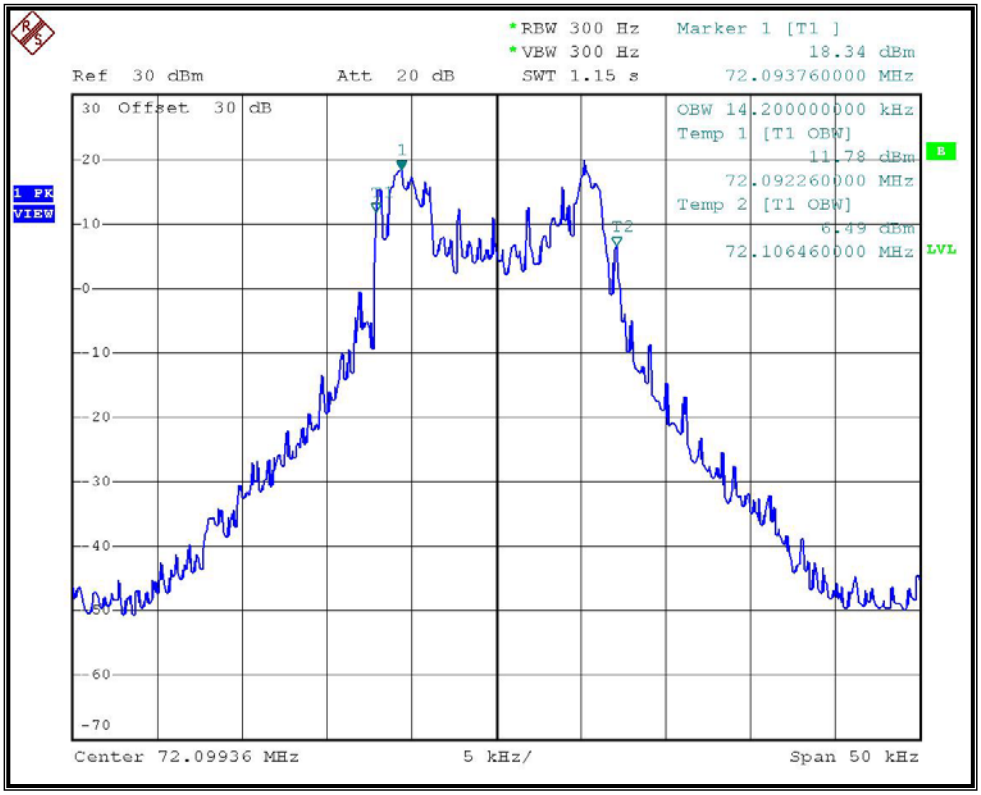
Classified as an F1D emitter (Frequency Modulation, Digital Modulation, Data)

Power level : 1W

7.2.Occupied Bandwidth : §2.1049

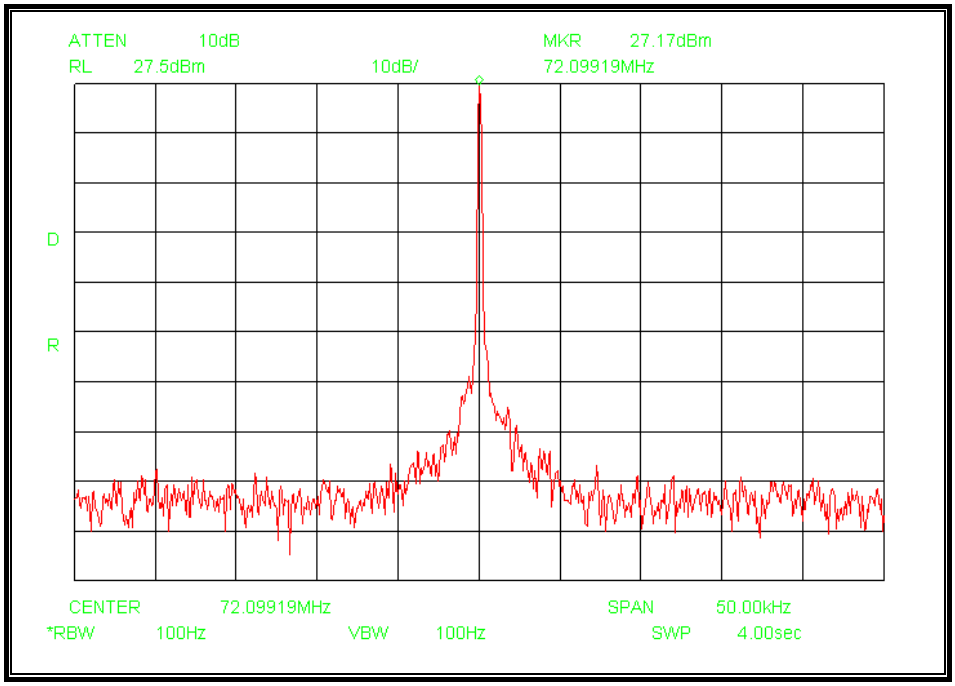
Device Classification, Test Condition

Nominal Channel Bandwidth : 20 kHz

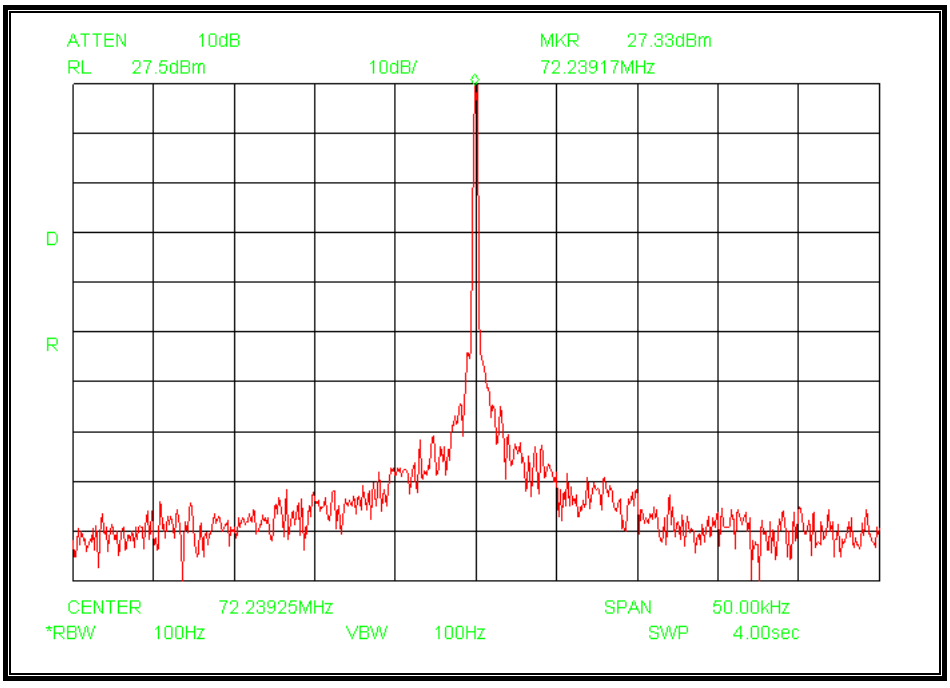


Conducted Output Power Test Plot

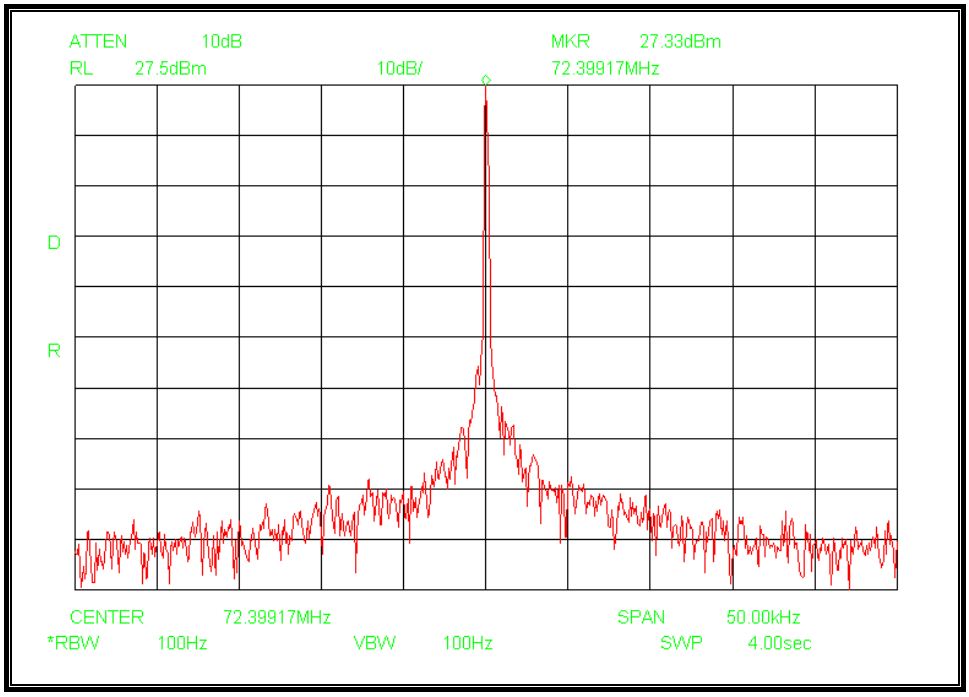
Low : 72.100 MHz



Middle : 72.240 MHz



High : 72.400 MHz



8. Maximum Permissible Exposure (MPE)

8.1. Radiofrequency radiation exposure limits. : § 1.1310

§ 1.1310 The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in § 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of § 2.1093 of this chapter.

Table 1--Limits for Maximum Permissible Exposure (MPE)

Frequency Range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*($900/f^2$)	6
30-300	61.4	0.613	1.0	6
300-1500	-	-	f/300	6
1500-100,000	-	-	5	6
(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric field strength (V/m)**	**Magnetic field strength (A/m)**	**Power density (mW/cm^2)**	**Averaging time (minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	-	-	f/300	30
1500-100,000	-	-	1.0	30

f = frequency in MHz
***** = Plane-wave equivalent power density

Note 1 To Table 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2 To Table 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

8. 2 MPE Calculations

$$S = P * G/(4 * \pi * R^2) \quad [mW/ cm^2]$$

where S = power density
P = power input to the antenna
G = antenna gain of an isotropic radiator
R = distance to the center of radiation of the antenna

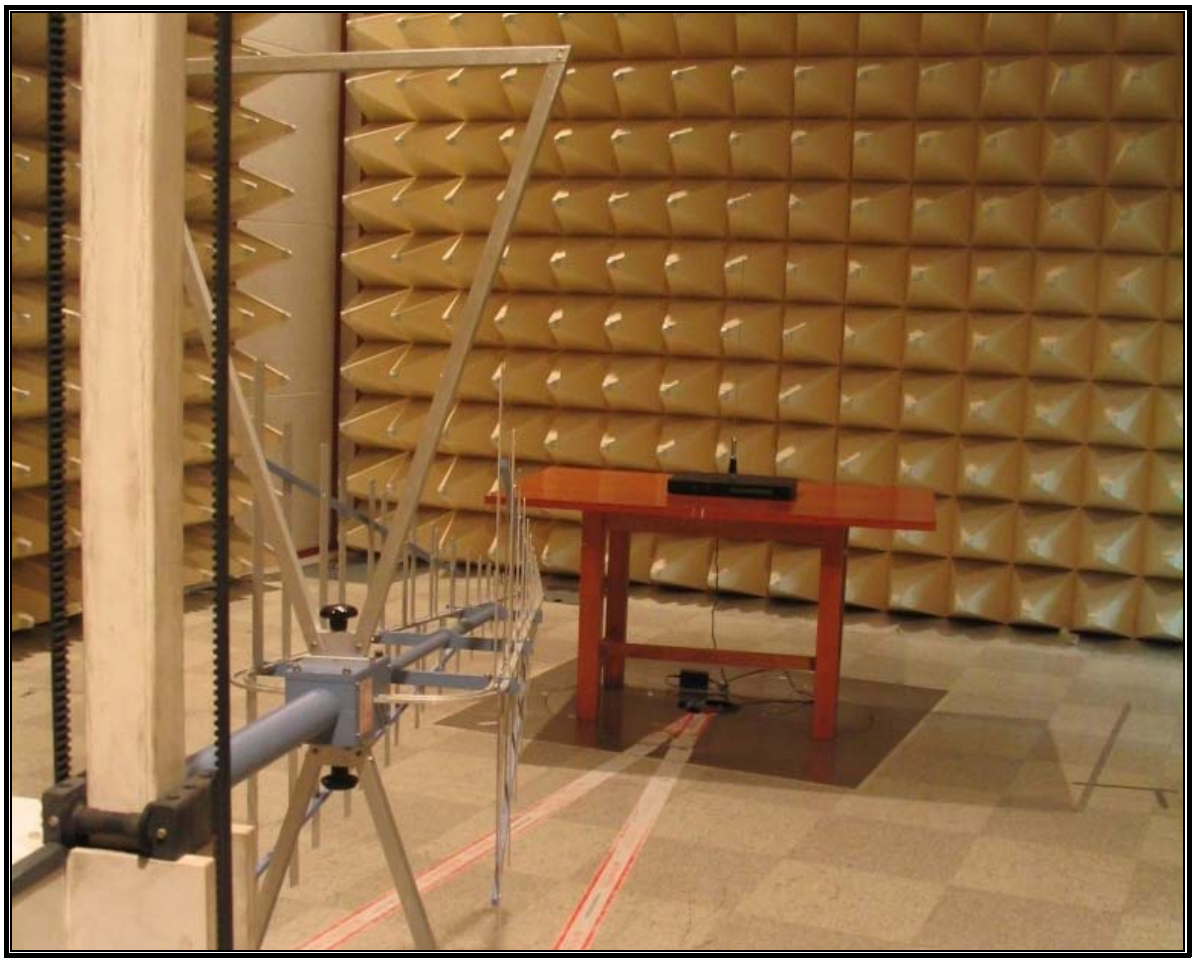
P_t= P + G =27.33 [dBm] + (-4.72).[dBi] = 22.61 [dBm] = 0.182 [W] $[10^{(27.33/10)} * 10^{-3}]$

S = P_t / (4 * π * 0.2^2) = 0.182 / 0.502 [W/m^2] = **0.036 [mW/cm^2]**

8.3 Results

MPE Distance (cm)	Output Power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
20	27.33	-4.72	0.036	0.2

Appendix A. Photo of Radiated Emission Test



Appendix B. Photos of Conducted Power Line Test