LTA
Laboratory for Test & Approval Co.,Ltd.

243 Jubug-Ri,Yangji-Myeon, Yongin-Si, Gyeonggi-Do, Korea 17159
Tel: +82-31-444-7270 Fax: +82-31-444-7271
http://www.ltalab.com

YEONHWA

Dates of Tests: Mar 13 ~ Mar 22, 2019
Test Report S/N: LR500111903E
Test Site : LTA CO., LTD.

RF TEST REPORT

FCC ID **VSOMD-100D**
IC **184A-MD100D**
APPLICANT **YEONHWA M TECH CO.,LTD**

Device Category	:	**Private Land Mobile Radio Service**
Manufacturing Description	:	**VHF Transceiver**
Manufacturer	:	**YEONHWA M TECH CO.,LTD**
Trade name	:	**X Radio**
Model name	:	**MD-100D**
Variant Model	:	**MD-110D, MD-120D, MD-130D, MD-140D, MD-150D, SD-671D**
Serial number	:	**Identical prototype**
FCC Rule Part(s)	:	**§2, §90**
IC Rule Part(s)		**RSS-Gen Issue 3, RSS-119 Issue 11**
Frequency Range	:	**FCC : 150.8 ~ 173.4 MHz** **IC : 150.8 ~ 173.4 MHz**
RF Output Power	:	**10W**
Channel Separation	:	**12.5kHz**
Emission Designators:	:	**7K60F1D**
Data of issue	:	**Mar 20, 2019**

This test report is issued under the authority of:

JaBeom.Koo

Ja-Beom Koo, Manager

The test was supervised by:

Eun-Hwan Jung, Test Engineer

This test result only responds to the tested sample. It is not allowed to copy this report even partly without the allowance of the test laboratory. This report must not be used by the applicant to claim product endorsement by NVLAP or any agency of the U.S. Government.

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1. General information

1-1 Test Performed

Company name : LTA Co., Ltd.
Address : 243, Jubug-ri,Yangji-Myeon,Youngin-Si, Kyunggi-Do, Korea. 17159
Web site : http://www.ltalab.com
E-mail : chahn@ltalab.com
Telephone : +82-31-323-6008
Facsimile +82-31-323-6010

Quality control in the testing laboratory is implemented as per ISO/IEC 17025 which is the “General requirements for the competent of calibration and testing laboratory”.

1-2 Accredited agencies

LTA Co., Ltd. is approved to perform EMC testing by the following agencies:

Agency	Country	Accreditation No.	Validity	Reference
NVLAP	U.S.A	200723-0	2019-09-30	ECT accredited Lab.
RRA	KOREA	KR0049	-	EMC accredited Lab.
FCC	U.S.A	649054	2019-04-13	FCC CAB
VCCI	JAPAN	C-4948,	2020-09-10	VCCI registration
VCCI	JAPAN	T-2416,	2020-09-10	VCCI registration
VCCI	JAPAN	R-4483(10 m),	2020-10-15	VCCI registration
VCCI	JAPAN	G-847	2018-12-13	VCCI registration
IC	CANADA	5799A-1	2019-11-07	IC filing
KOLAS	KOREA	NO.551	2021-08-20	KOLAS accredited Lab.

2. Information about test item

2-1 Client & Manufacturer

Company name	:	YEONHWA M TECH CO.,LTD
Address	:	36, Jeonpa-ro 44beon-gil Manan-gu, Anyang-si, Gyeonggi-do, Korea
TEL / FAX	:	+82-31-444-7270 / +82-31-444-7271

2-2 Equipment Under Test (EUT)

Trade name	:	X Radio
Model name	:	DM-100D
Variant Model	:	MD-110D, MD-120D, MD-130D, MD-140D, MD-150D, SD-671D
Date of receipt	:	Mar 20, 2019
EUT condition	:	Identical prototype
Frequency Range	:	150.8 ~ 173.4 MHz
RF output power	:	10W
Channel Separation	:	12.5 kHz
Power Source	:	DC 10 V
Firmware version	:	V1.0

2-3 Operating frequency

	Range
Frequency (MHz)	150.8 – 156.2475
	157.1875 – 161.575
	161.775 – 161.9625
	162.0375 - 173.4

2-4 Tested frequency

	LOW	MID	HIGH
Frequency (MHz)	155.01	161.50	173.40

The time division multiple access (TDMA) mode of operation provides two voice paths in a 12.5 kHz channel bandwidth and a data rate of 9600 bits per second bits per second in a channel bandwidth of 12.5 kHz. The MD-100D conforms to the spectrum efficiency requirements of FCC rule § 90.203 (j) (5).

3. Test Report

3.1 Summary of tests

FCC Rules	Description of Test	Results
§1.1307(b); §2.1093	RF Exposure	C
§2.1046; §90.205	RF Output Power	C
§2.1047; §90.207	Modulation Characteristic	NA[3]
§2.1049; §90.209; §90.210	Occupied Bandwidth & Emission Mask	C
§2.1051; §90.210	Spurious Emission at Antenna Terminal	C
§2.1053; §90.210	Spurious Radiated Emissions	C
§2.1055; §90.213	Frequency Stability	C
§90.214	Transient Frequency Behavior	C

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

Note 2: The data in this test report are traceable to the national or international standards.

Note3: This device is not Analog.

The sample was tested according to the following specification :

- FCC Part2, Part 90
- ANCI C 63.4-2014
- TIA-603-E-2016
- ANSI C63.26_2015

3.2 TEST RESULTS

3.2.1 RF EXPOSURE

Applicable Standard :

According to FCC §1.1307(b) and §2.1093, protable device operates Part 90 should be subjected to rountine environmental evaluation for RF exposure prior or equipment authorization or use.

Result : Compliance.

3.2.2 RF OUTPUT POWER

Applicable Standard : FCC §2.1046 and §2.1033 and §90.205

Test Procedure

Conducted RF Output Power:

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The spectrum analyzer is setting:

Center frequency = the highest, middle and the lowest channels

RBW = 100 kHz

Sweep = auto

VBW = 300 kHz

Detector function = peak

Trace = max hold

Test Result : Compliance.

Measurement Data: Transmitting

Modulation	Channel Separation (kHz)	Frequency (MHz)	Power Level	Output Power (dBm)	Output Power (w)	Result
Digital	12.5	155.01	10 W	38.35	6.84	Pass
	12.5	161.50	10 W	38.29	6.75	Pass
	12.5	173.40	10 W	37.96	6.25	Pass

DC Inpit in to Final Amplifier

Input power : 10V * 1.2A = 12 Watts

Test Result : Compliance.

3.2.3 OCCUPIED BANDWIDTH EMISSION MASK

Applicable Standard : FCC §2.1049, §90.209 and §90.210

Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

1) For any frequency removed from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0, 0dB.
2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.626 kHz but no more than 12.5 kHz, at least 7.27 (f_d –2.88 kHz) dB.
3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

Digital :

The 99% energy rule (title 47CFR 2.989) was used for digital mode and is more accurate than Carson's rule. It basically states that 99% of the modulation energy falls within X kHz, in this case, 7.9 kHz Measurements were performed in accordance with TIA/EIA. The emission mask was obtained from47CFR90.210(d)

Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set at 100 Hz and the spectrum was recorded in the frequency band ±50 kHz from the carrier frequency.

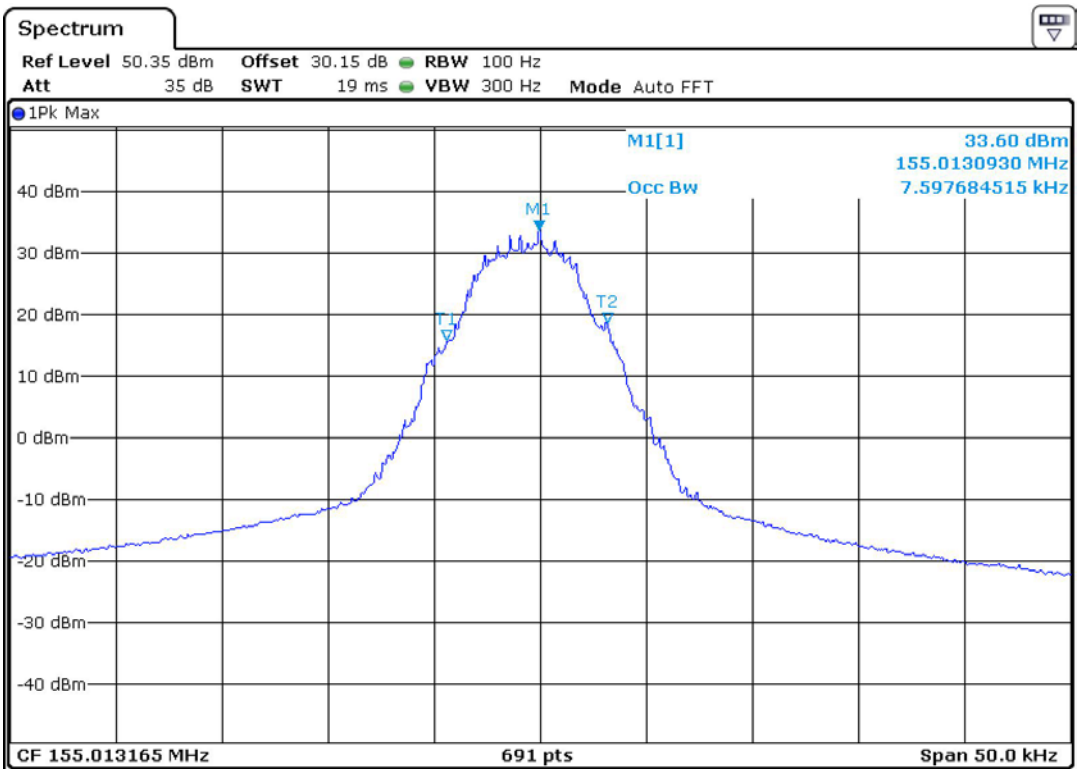
Test Result : Compliance.

Measurement Data: Transmitting

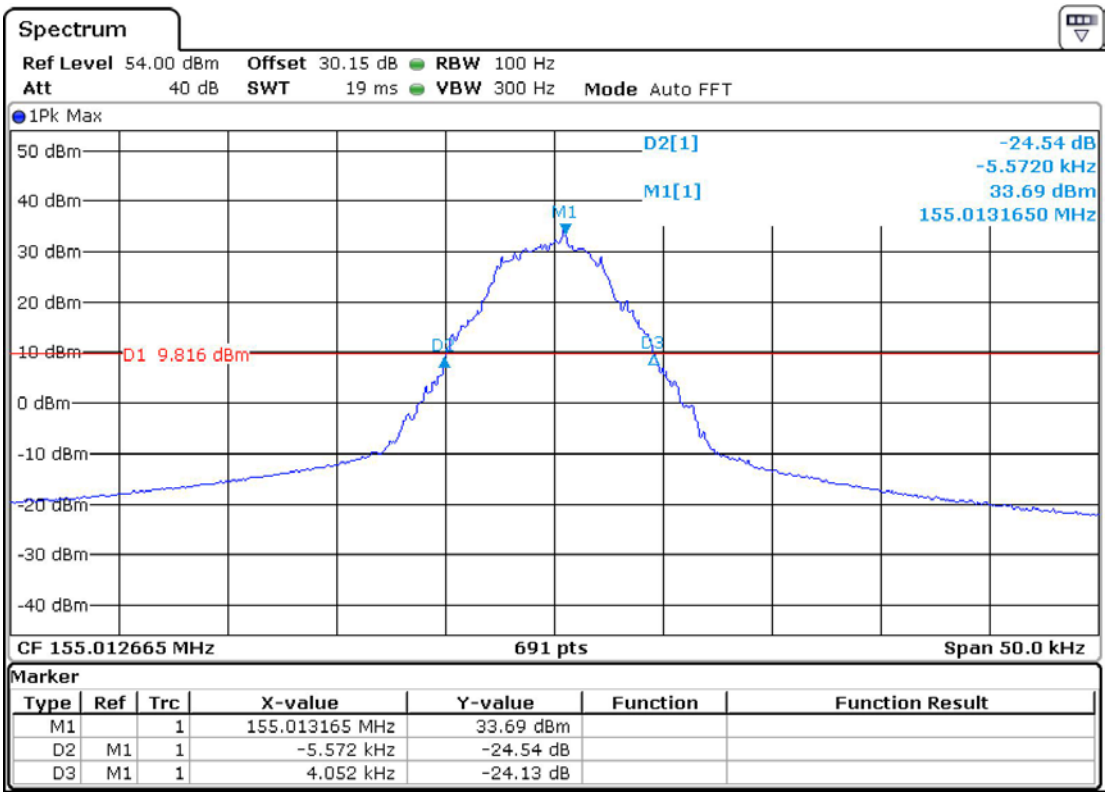
Modulation	Frequency (MHz)	Channel Space (kHz)	Power Level	99%Occupied Bandwidth (kHz)	26dB Emissions Bandwidth (kHz)	FCC Limit (kHz)
Digital	155.01	12.5	10 W	7.59	9.50	11.25

Digital Modulation :

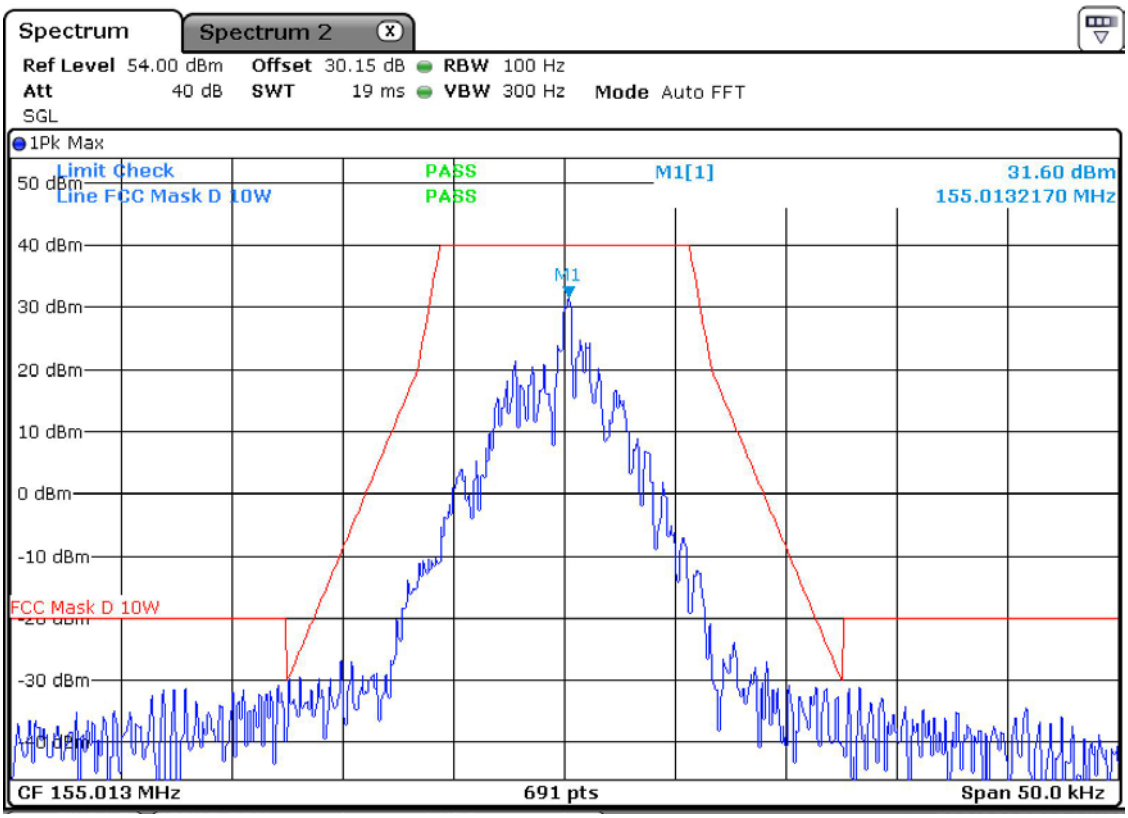
99% Occupied Bandwidth



26 dB Emissions Bandwidth 12.5 kHz, 155.01 MHz (10 W)



Emission Mask D with 10 W 12.5 kHz, 155.01 MHz



3.2.4 SPURIOUS EMISSIONS AT ANTENNA

Applicable Standard

Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

1) For any frequency removed from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0, 0 dB.
2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.626 kHz but no more than 12.5 kHz, at least 7.27 (f_d – 2.88 kHz) dB.
3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ((f_d in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two or three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emission mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (o) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, an alternate procedure may be used provided prior Commission approval is obtained.

Test Procedure

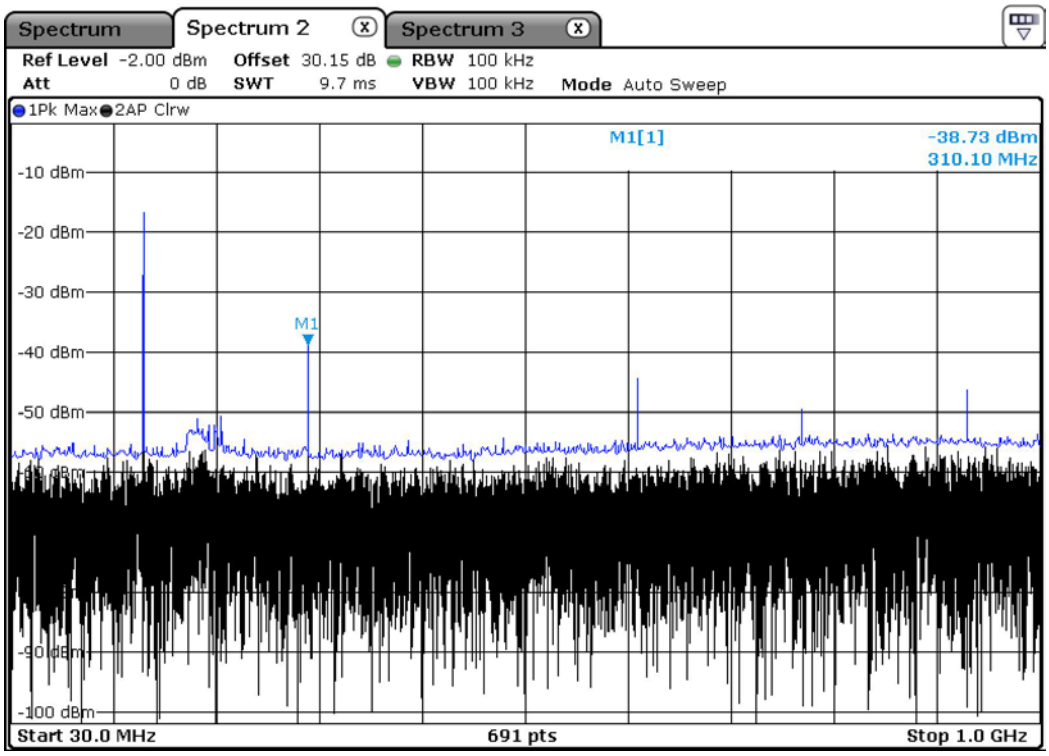
The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz for below 1 GHz, and 1 MHz for above 1 GHz. sufficient scans were taken to show any out of band emissions up to 10th harmonic.

Test Result : Compliance.

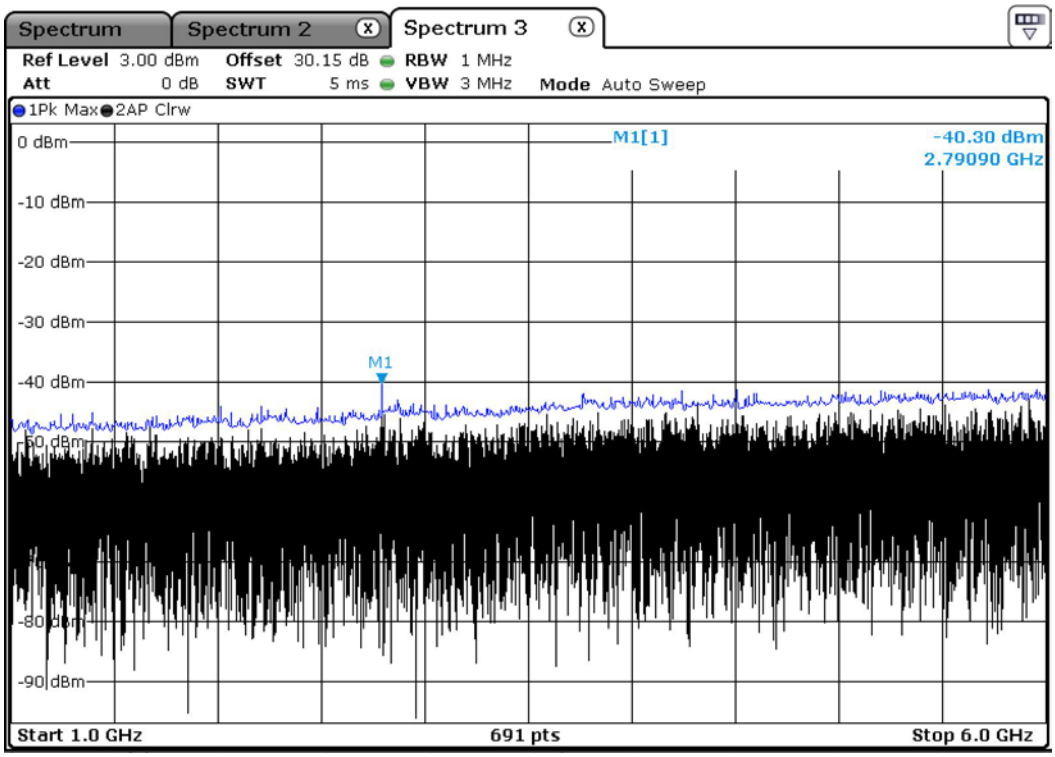
Modulation	Frequency (MHz)	Channel Space (kHz)	Maximum Conducted Spurious Emissions Below 1 GHz		Maximum Conducted Spurious Emissions Above 1 GHz		FCC Limit
			Frequency (MHz)	Results (dBm)	Frequency (MHz)	Results (dBm)	
Digital(10W)	155.01	12.5	310.10	-38.73	2790.90	-40.30	-20 dBm

Digital Modulation :

30 MHz – 1 GHz, Spacing Channel 12.5 kHz, 155.01 MHz



1 GHz – 6 GHz, Spacing Channel 12.5 kHz, 155.01 MHz



3.2.5 RADIATED SPURIOUS EMISSIONS

Applicable Standard

FCC §2.1053 and §90.210

Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load, which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT .The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to teeth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB =10 1g (TXpwr in Watts/0.001)-the absolute level

Spurious attenuation limit in dB =50+10 Log_{10} (power out in Watts) for EUT with a 12.5 kHz channel bandwidth.

Spurious attenuation limit in dB =55+10 Log_{10} (power out in Watts) for EUT with a 6.25 kHz channel bandwidth.

Test Result : Compliance.

Measurement Data: Transmitting

30 MHz – 2GHz

Frequency (MHz)	Receiver Reading (dBµV)	Turn Table Angle Degree	Rx Antenna		Substituted			Absolute Level (dBm)	FCCpart90	
			Height (m)	Polar (H/V)	SG Level (dBm)	Cable Loss (dB)	Antenna Gain (dB)		Limit (dBm)	Margin (dB)
Digital Modulation 155.01 MHz, Channel Spacing 12.5 KHz										
47.95	42.20	221	4.0	H	-48.77	1.79	12.98	-37.58	-20	17.58
74.01	48.60	255	4.0	H	-40.06	1.86	11.34	-30.58	-20	10.58
105.99	48.69	20	2.2	H	-44.33	1.97	10.04	-36.26	-20	16.26
254.80	40.68	147	1.0	V	-37.06	2.31	12.23	-27.14	-20	7.14
736.20	48.49	89	4.0	H	-46.22	4.16	22.66	-27.72	-20	7.72
747.50	41.50	133	4.0	H	-44.09	4.96	24.37	-24.68	-20	4.68

Note : Absolute Level = SG Level-Cable loss + Antenna Gain

Margin = Limit – Absolute Level

3.2.6 FREQUENCY STABILITY

Applicable Standard

FCC §2.1055 and §90.213

Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.

For Digital Modulation

Reference Frequency : 155.01 MHz, Limit : ±2.5 ppm, 12.5 kHz			
Test Environment		Frequency Measure with Time Elapsed	
Temperature (℃)	Power Supplied (V_{DC})	Measured Frequency (MHz)	Frequency Error (ppm)
Frequency Stability versus Input Temperature			
50	10	155.010157	0.264
40	10	155.010148	0.229
30	10	155.010140	0.210
20	10	155.010144	0.222
10	10	155.010121	0.287
0	10	155.010136	0.295
-10	10	155.010142	0.388
-20	10	155.010139	0.278
-30	10	155.010142	0.388
Frequency Stability versus Input Voltage			
20	4.5	155.010120	0.280

3.2.7 TRANSIENT FREQUENCY BEHAVIOR

Applicable Standard

Regulations: FCC §90.214
Test method:TIA-603-E-2016, section 2.2.19.3

Test Procedure

a) Connect the EUT and test equipment as shown on the following block diagram.

b) Set the Spectrum Analyzer to measure FM deviation, and tune the RF frequency to the transmitter assigned frequency.

c) Set the signal generator to the assigned transmitter frequency and modulate it with a 1 kHz tone at ±12.5 kHz deviation and set its output level to -100 dBm.

d) Turn on the transmitter.

e) Supply sufficient attenuation via the RF attenuator to provide an input level to the Spectrum Analyzer that is 40 dB below the maximum allowed input power when the transmitter is operating at its rated power level. Note this power level on the Spectrum Analyzer as P_0.

f) Turn off the transmitter.

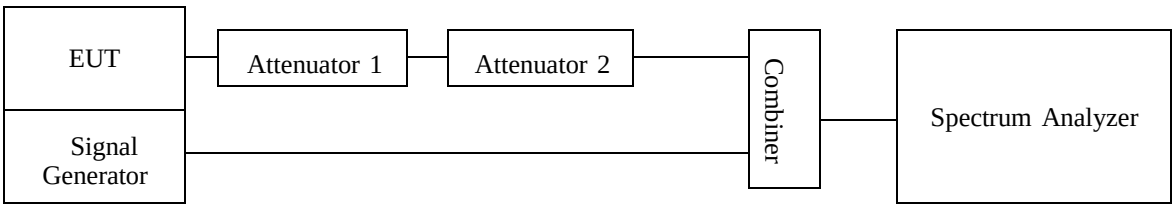
g) Adjust the RF level of the signal generator to provide RF power equal to P_0. This signal generator RF level shall be maintained throughout the rest of the measurement.

h) Remove the attenuation 1, so the input power to the Spectrum Analyzer is increased by 30 dB when the transmitter is turned on.

i) Adjust the vertical amplitude control of the spectrum analyzer to display the 1000 Hz at ±4 divisions vertically centered on the display. Set trigger mode of the Spectrum Analyzer to “Video”, and tune the “trigger level” on suitable level. Then set the “tiger offset” to -10ms for turn on and -15 ms for turn off.

j) Turn on the transmitter and the transient wave will be captured on the screen of Spectrum Analyzer. Observe the stored display. The instant when the 1 kHz test signal is completely suppressed is considered to be t_{on}. The trace should be maintained within the allowed divisions during the period t_1 and t_2.

k) Then turn off the transmitter, and another transient wave will be captured on the screen of Spectrum Analyzer. The trace should be maintained within the allowed divisions during the period t_3.



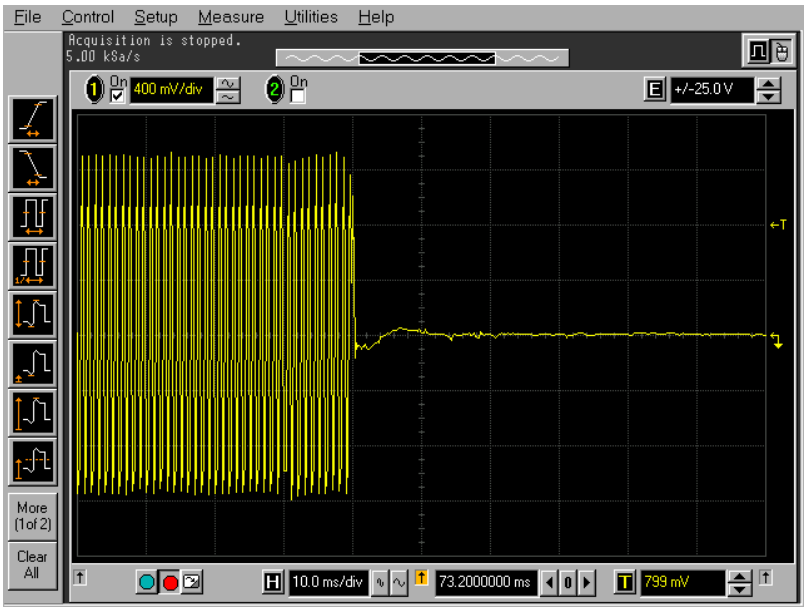
Measurement Data: Transmitting

Channel Separation (kHz)	Transient Period (ms)	Transient Frequency	Result
12.5	10 (t1)	<+/- 12.5 kHz	Compliance
	25 (t2)	<+/- 6.25 kHz	
	10 (t3)	<+/- 12.5 kHz	

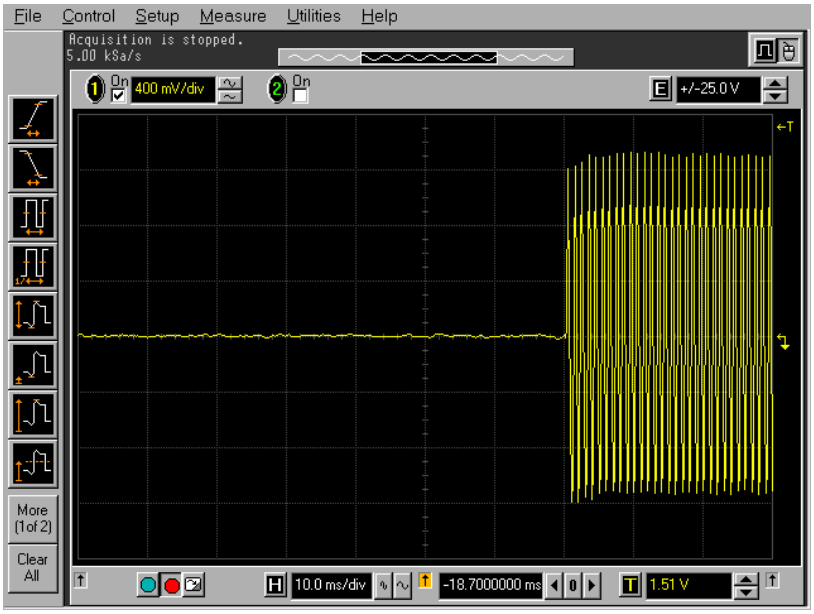
Please refer to the following plots.

Channel Spacing 12.5 kHz

Trun ON



Trun OFF



APPENDIX

TEST EQUIPMENT USED FOR TESTS

	Use	Description	Model No.	Serial No.	Manufacturer	Interval	Last Cal. Date
1	■	Signal Analyzer (9 kHz ~ 30 GHz)	FSV30	100757	R&S	1 year	2019-09-07
2		Signal Generator (~3.2 GHz)	8648C	3623A02597	HP	1 year	2020-03-20
3		SYNTHESIZED CW GENERATOR	83711B	US34490456	HP	1 year	2020-03-20
4		Attenuator (3 dB)	8491A	37822	HP	1 year	2019-09-07
5		Attenuator (10 dB)	8491A	63196	HP	1 year	2019-09-07
6	■	EMI Test Receiver (~7 GHz)	ESCI7	100722	R&S	1 year	2019-09-07
7		RF Amplifier (~1.3 GHz)	8447D OPT 010	2944A07684	HP	1 year	2019-09-07
8		RF Amplifier (1~26.5 GHz)	8449B	3008A02126	HP	1 year	2019-03-21
9		Horn Antenna (1~18 GHz)	3115	00114105	ETS	2 year	2020-08-04
10		DRG Horn (Small)	3116B	81109	ETS-Lindgren	2 year	2020-03-18
11		DRG Horn (Small)	3116B	133350	ETS-Lindgren	2 year	2020-03-18
12	■	TRILOG Antenna	VULB 9160	9160-3237	SCHWARZBECK	2 year	2021-03-20
13		Temp.Humidity Data Logger	SK-L200TH II A	00801	SATO	1 year	2020-03-20
14		Splitter (SMA)	ZFSC-2-2500	SF617800326	Mini-Circuits	-	-
15	■	DC Power Supply	6674A	3637A01657	Agilent	-	-
17	■	Power Meter	EPM-441A	GB32481702	HP	1 year	2020-03-20
18	■	Power Sensor	8481A	3318A94972	HP	1 year	2019-09-07
19		Audio Analyzer	8903B	3729A18901	HP	1 year	2019-09-07
20		Modulation Analyzer	8901B	3749A05878	HP	1 year	2019-09-07
21		TEMP & HUMIDITY Chamber	YJ-500	LTAS06041	JinYoung Tech	1 year	2019-09-07
22		Stop Watch	HS-3	812Q08R	CASIO	2 year	2020-03-18
23		LISN	KNW-407	8-1430-1	Kyoritsu	1 year	2019-09-07
24		Two-Lime V-Network	ESH3-Z5	893045/017	R&S	1 year	2020-03-18
25		UNIVERSAL RADIO COMMUNICATION TESTER	CMU200	106243	R&S	1 year	2020-03-18
26		Highpass Filter	WHKX1.5/15G-10SS	74	Wainwright Instruments	1 year	2020-03-18
27		Highpass Filter	WHKX3.0/18G-10SS	118	Wainwright Instruments	1 year	2020-03-18
28		OSP120 BASE UNIT	OSP120	101230	R&S	1 year	2020-03-18
29		Signal Generator(100 kHz ~ 40 GHz)	SMB100A03	177621	R&S	1 year	2020-03-18
30	■	Signal Analyzer (10 Hz ~ 40 GHz)	FSV40	101367	R&S	1 year	2020-03-18
31	■	Active Loop Antenna	FMZB 1519	1519-031	SCHWARZBECK	2 year	2021-02-26