

FCC Part 74 Subpart H

EMI TEST REPORT

of

E.U.T. : Wireless Tour Guide Transmitter
FCC ID : INGTG-98TA
Model No. : TG-98TA
Working Frequency : 470~608 MHz

for

APPLICANT : JTS Professional Co., Ltd.
ADDRESS : No. 148, Industry 9th Road, Tali Dist., Taichung
City 41280, Taiwan, R.O.C.

Test Performed by

ELECTRONICS TESTING CENTER (ETC) , TAIWAN
NO. 34. LIN 5, DINGFU VIL., LINKOU DIST.,
NEW TAIPEI CITY, TAIWAN, 24442, R.O.C.
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Report Number : 15-02-RBF-012-03

TEST REPORT CERTIFICATION

Applicant : JTS Professional Co., Ltd.
No. 148, Industry 9th Road, Tali Dist., Taichung City 41280,
Taiwan, R.O.C.

Manufacturer : JTS Professional Co., Ltd.
No. 148, Industry 9th Road, Tali Dist., Taichung City 41280,
Taiwan, R.O.C.

Description of EUT :

a) Type of EUT : Wireless Tour Guide Transmitter
b) Trade Name : JTS
c) Model No. : TG-98TA
d) FCC ID : INGTG-98TA
e) Working Frequency : 470~608 MHz
f) Power Supply : DC 1.5V Battery*2

Regulation Applied: FCC Rules and Regulations Part 74 Subpart H

I HEREBY CERTIFY THAT; The data shown in this report were made in accordance with the procedures given in ANSI C63.10-2013 and the energy emitted by the device was founded to be within the limits applicable. I assume full responsibility for accuracy and completeness of these data.

Issued Date : Sep. 08, 2017

Test Engineer : Brian Huang
(Brian Huang, Engineer)

Approve & Authorized Signer : S S Liou
S. S. Liou, Section Manager
EMC Dept. II of ELECTRONICS
TESTING CENTER, TAIWAN

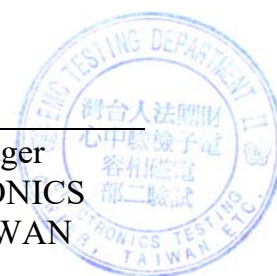


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1. GENERAL INFORMATION

1.1 Product Description

a) Type of EUT	:	Wireless Tour Guide Transmitter
b) Trade Name	:	JTS
c) Model No.	:	TG-98TA
d) FCC ID	:	INGTG-98TA
e) Working Frequency	:	470~608 MHz
f) Power Supply	:	DC 1.5V Battery*2
g) Emission Designator	:	93K6F3E 2M+2DK=2x(6kHz)+2x(40.8kHz)x1=93.6kHz

1.2 Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.10-2013. Test also follow “TIA-603-D(2010)-Land Mobile FM or PM Communications Equipment Measurement and Performance Standards” and section 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, and 2.1055 of Part 2 of CFR 47.

Measurement Software

Software	Version	Note
e3	Version 6.100618b	Radiated Emission Test
e3	Version 6.100421	Conducted Emission Test

1.3 Test Facility

Location of the Test site: No.34, Lin 5, Dingfu Vil., Linkou Dist., New Taipei City, Taiwan 24442, R.O.C.

Designation Number: TW2628.

2. REQUIREMENTS OF PROVISIONS

2.1 Definition

Intentional radiator:

A device that intentionally generates and emits radio frequency energy by radiation or induction.

2.2 Frequencies Available

According to sec. 74.802 of Part 74, the following frequencies are available for low power auxiliary station :

Frequencies (MHz)	
26.100-26.480	455.000-456.000
54.000-72.000	470.000-488.000
76.000-88.000	488.000-494.000
161.625-161.775	494.000-608.000
174.000-216.000	614.000-806.000
450.000-451.000	944.000-952.000

2.3 Requirements for Radio Equipment on Certification

(1) RF Output Power

For transmitters, the power output shall be measured at the RF output terminals.

(2) Modulation Characteristics

For 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.

(3) Occupied Bandwidth

For radiotelephone transmitter, other than single sideband or independent sideband transmitter, when modulated by a 2.5kHz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation.

(4) Spurious Emissions at Antenna Terminals

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminal when properly loaded with a suitable artificial antenna.

(5) Field Strength of Spurious Emissions

Measurements shall be made to detect spurious emission that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal condition of installation and operation.

(6) Frequencies Tolerance

- a) The frequency stability shall be measured with variation of ambient temperature.
- b) The frequency stability shall be measured with variation of primary supply voltage.

2.4 Labeling Requirement

Each equipment for which a type acceptance application is filed on or after May 1,1981, shall bear an identification plate or label pursuant to §2.925 (Identification of equipment) and §2.926 (FCC identifier) .

3. OUTPUT POWER MEASUREMENT

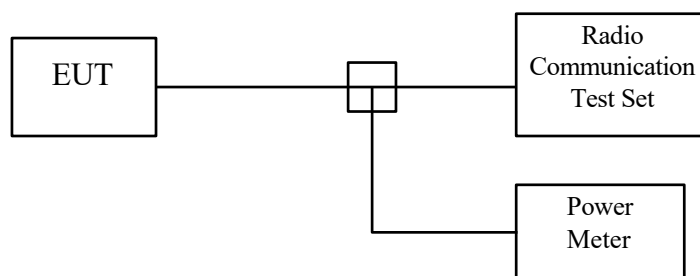
3.1 Provision Applicable

According to §74.861(e)(1)(ii), the output power shall not exceed 250 milliwatts.

3.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 1, and Install new batteries in the EUT. Turn on the EUT and set it to any one convenient frequency within its operating range.
3. Apply a 2.5 kHz modulation signal to EUT. Record the readings on the instrument.
4. Repeat above procedures until all frequencies measured were complete.

Figure 1: Transmit power measurement configuration.



3.3 Test Data

Operated mode : TX Test Date : Aug. 18, 2017
 Temperature : 25°C Humidity : 55 %

Frequency (MHz)	Transmit Power		Limit (mW)
	(dBm)	(mW)	
470.000	7.70	5.888	250.0
607.875	10.10	10.233	250.0

3.4 Test Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
POWER METER +SENSOR	ANRITSU	ML2487A +MA2491A	2017/05/11	2018/05/10
Communications Service Monitor	AEROFLEX	2945B	2017/01/09	2018/01/08

4. MODULATION CHARACTERISTICS

4.1 Provisions Applicable

According to §2.1047 (a), for Voice Modulated Communication Equipment, the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be measured.

4.2 Measurement Method

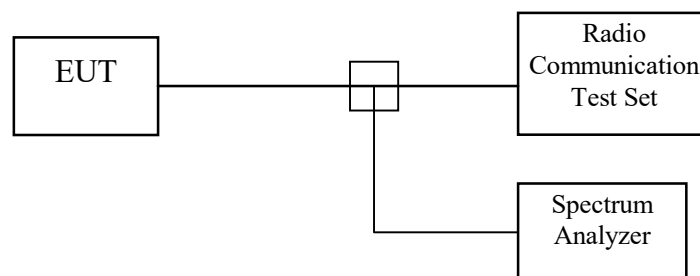
A) Modulation Limit

1. Position the EUT as shown in figure 3, adjust the audio input frequency to 100 Hz and the input level from 0V to maximum permitted input voltage with recording each carrier frequency deviation responding to respective input level.
2. Repeat step 1 with changing the input frequency for 200, 500, 1000, 3000, and 5000 Hz in sequence.

B) Frequency response of all circuits

1. Position the EUT as shown in figure 2.
2. Vary the modulating frequency from 100 Hz to 15000 Hz with constant input voltage (derived from 5.4(a) of this test report), and observe the change in output.

Figure 2 : Modulation characteristic measurement configuration



4.3 Measurement Instrument

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Communications Service Monitor	AEROFLEX	2945B	2017/01/09	2018/01/08
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02

4.4 Measurement Result

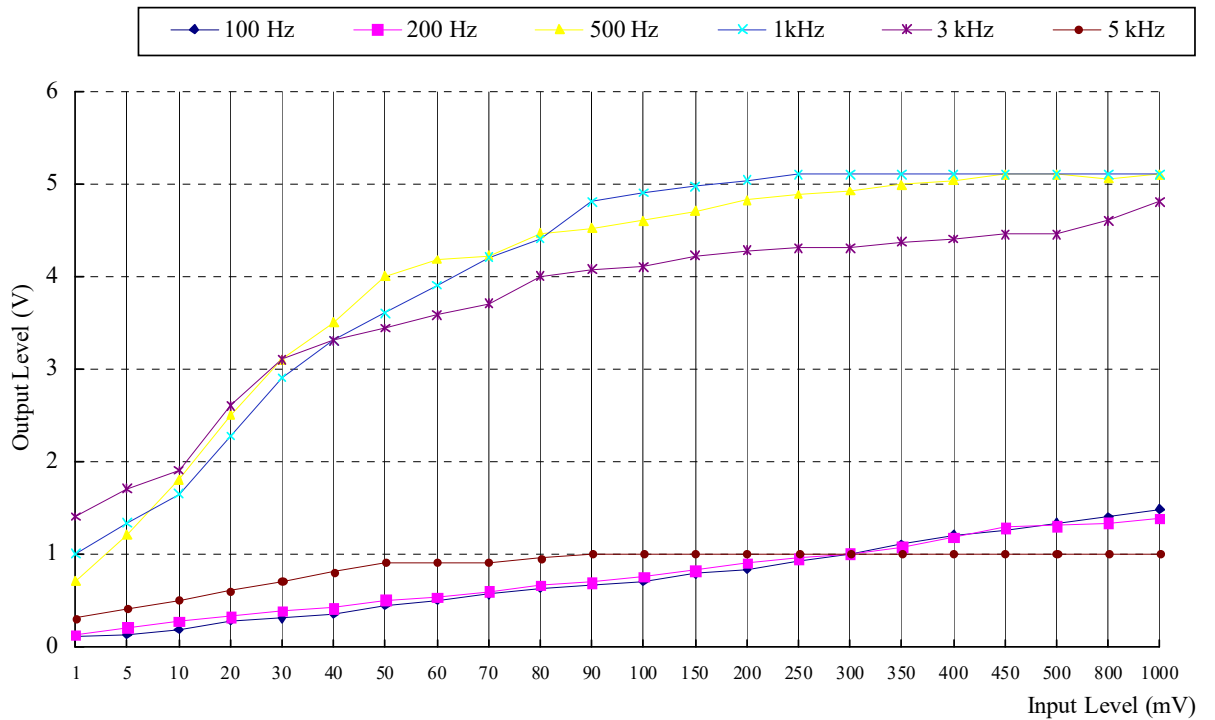
RF Frequency : 470.000MHz;

Test Date : Aug. 17, 2017

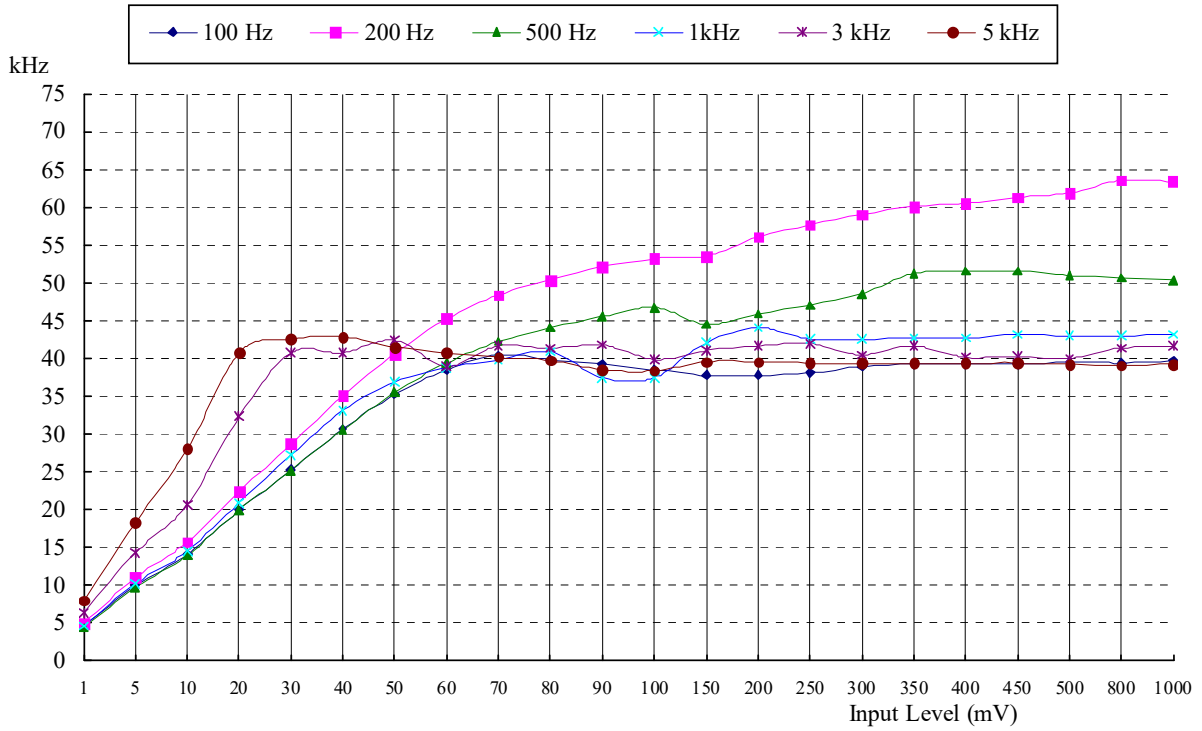
Temperature : 27 °C

Humidity : 68 %

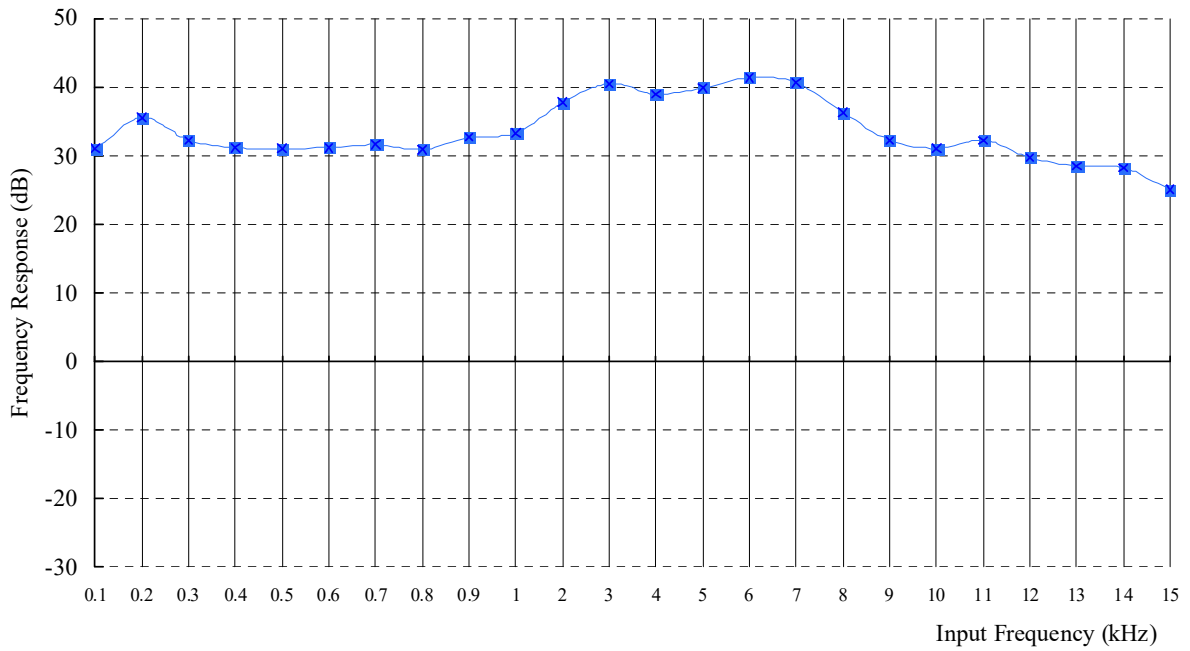
A). Frequency response



B). Modulation Limit



C). Frequency response of all circuits



5. OCCUPIED BANDWIDTH OF EMISSION

5.1 Provisions Applicable

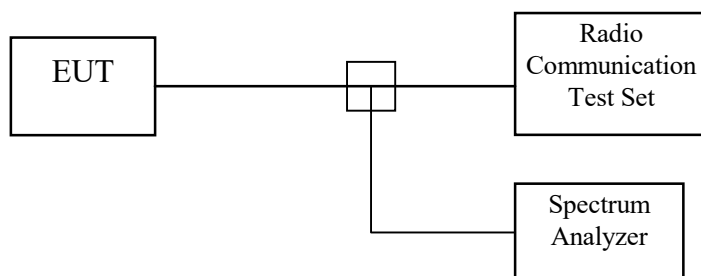
According to §2.1049 (c)(1), For radiotelephone transmitter, other than single sideband or indenpent sideband transmitter, when modulated by a 2.5kHz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation.

According to §74.861(e)(5), the frequency emission bandwidth shall not exceed 200 kHz.

5.2 Measurement Method

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 3, and Install new batteries in the EUT. Turn on the EUT ant set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Apply a 2.5 kHz modulation signal to EUT and measure the frequencies of the modulated signal from the EUT where it is the specified number of dB below the reference level set in step 2. This is the occupied bandwidth specified.

Figure 3 : Occupied bandwidth measurement configuration



5.3 Occupied Bandwidth Test Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Communications Service Monitor	AEROFLEX	2945B	2017/01/09	2018/01/08
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02

5.4 Bandwidth Measured

5.4.1 Input Level Derived

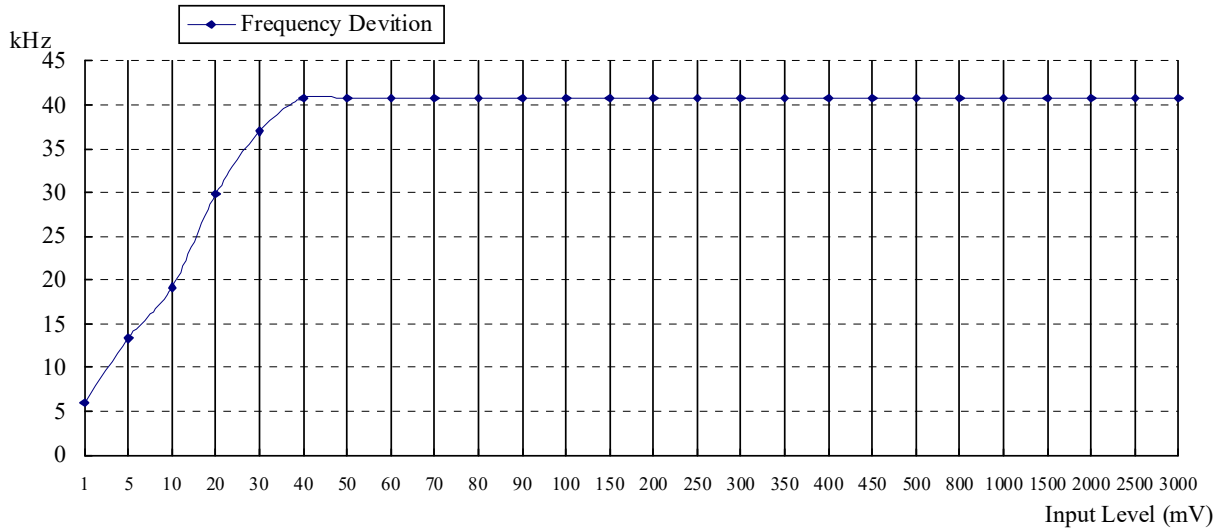
RF Frequency : 470.000 MHz;

Test Date : Aug. 17, 2017

Temperature : 27 °C

Humidity : 68 %

Input Audio Frequency : 2.5 kHz, Sine Wave



The Level input to produce 50% modulation is 10 mV, therefore the magnitude 16 dB greater than it is 63 mV.

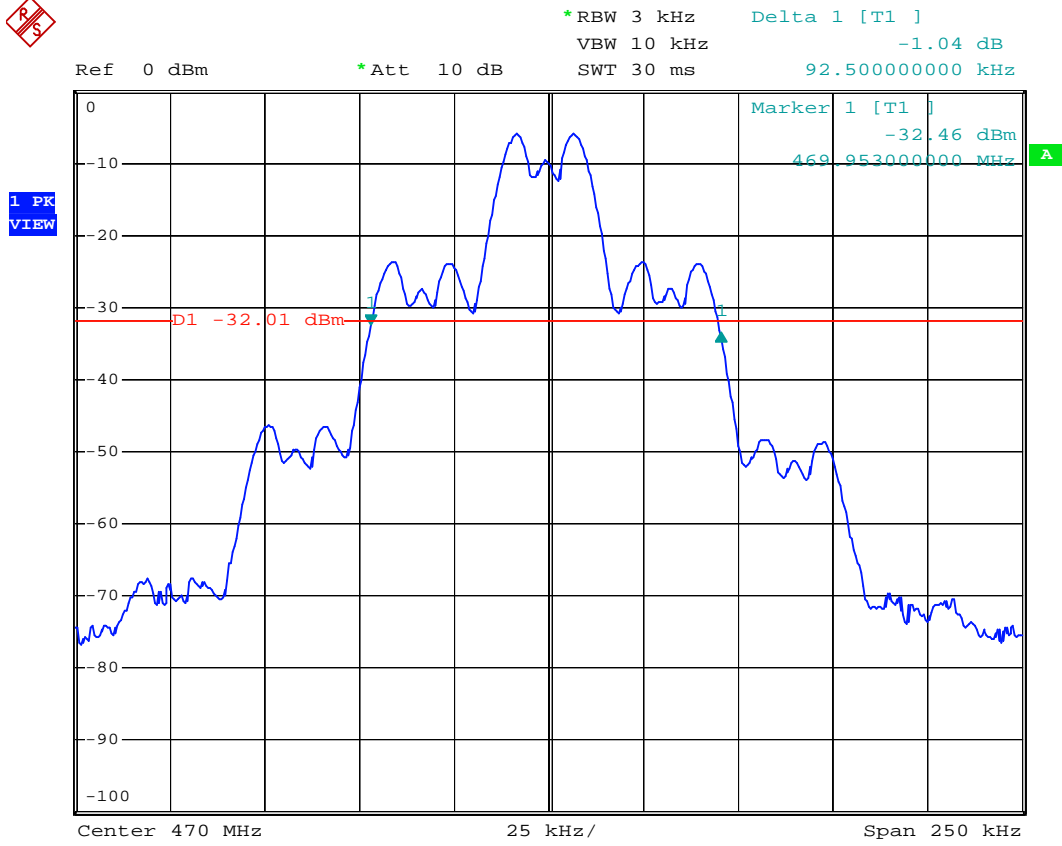
5.4.2 Occupied Bandwidth Plotted

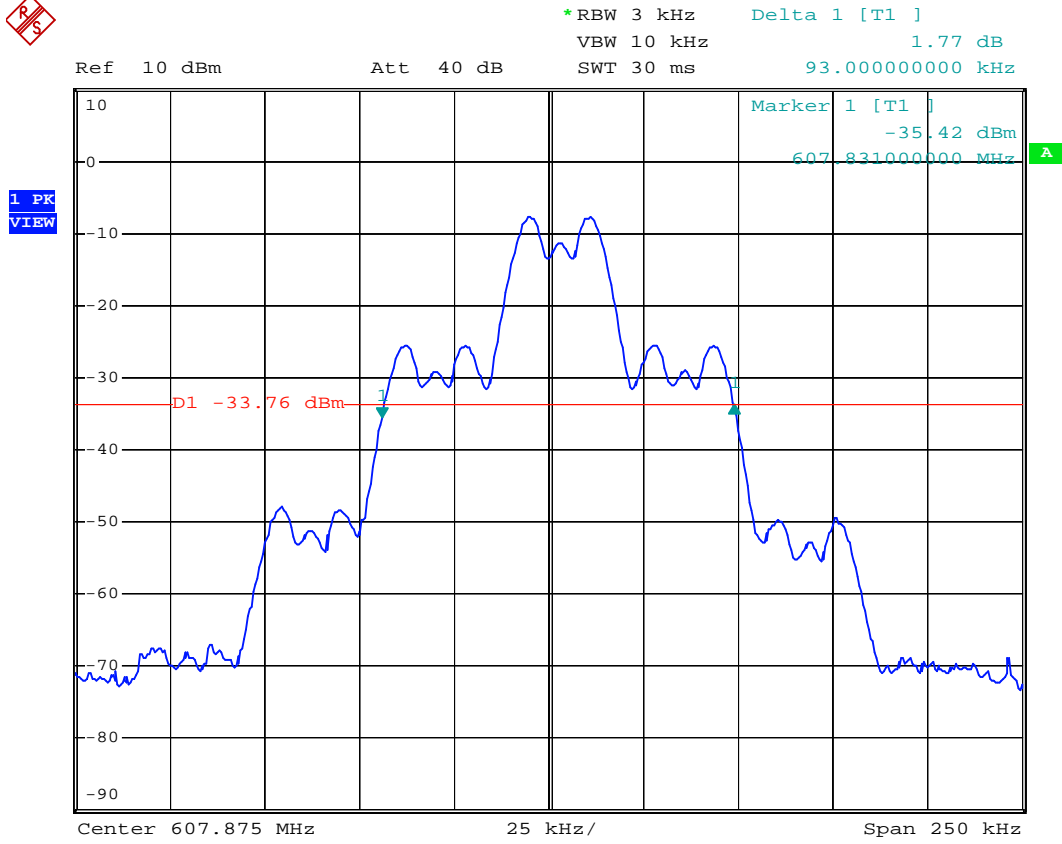
Test Date : Aug. 17, 2017

Temperature : 27 °C

Humidity : 68 %

RF Frequency (MHz)	26 dB Bandwidth (kHz)
470.000	92.5
607.875	93.0





6. FIELD STRENGTH OF EMISSION

6.1 Provisions Applicable

According to §2.1053, measurements shall be made to detect spurious emission that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal condition of installation and operation. Information submitted shall include the relative radiated power of spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from a halfwave dipole antenna.

According to §74.861(e)(6), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

- (i) on any frequency removed from the operating frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least 25 dB.
- (ii) on any frequency removed from the operating frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: at least 35 dB.
- (iii) on any frequency removed from the operating frequency by more than 250 percent of the authorized bandwidth shall be attenuated below the unmodulated carrier by at least 43 plus 10 Log(output power in watts) dB.

6.2 Measurement Procedure

1. Setup the configuration per figure 4 and 5 for frequencies measured below and above 1 GHz respectively, adjusting the input voltage to produce the maximum power as measured in chapter 3.
2. Adjust the analyzer for each frequency measured in chapter 6 on a 1 MHz frequency span and 1MHz resolution bandwidth.
3. The search antenna is to be raised and lowered over a range from 1 to 4 meters in horizontally polarized orientation. Position the antenna when the highest value is indicated on spectrum analyzer, then change the orientation of EUT on test table over a range from 0 ° to 360 °, and record the highest value indicated on spectrum analyzer as reference value.
4. Repeat step 3 until all frequencies need to be measured were complete.
5. Repeat step 4 with search antenna in vertical polarized orientations.
6. Replace the EUT with a tuned dipole antenna (horn antenna for above 1 GHz) relative to each frequency in horizontally polarized orientation and as the same polarized orientation with search antenna. Connect the tuned dipole antenna to a standard signal generator (SG) via a low loss cable. Power on the SG and tune the right frequency in measuring as well as set SG at a appreciated output level. Rise and lower the search antenna to get the highest value on spectrum analyzer, and then hold this position. Adjust the SG output to get a identical value derived from step 3 on spectrum analyzer. Record this value for result calculated.

7. Repeat step 6 until all frequencies need to be measured were complete.
8. Repeat step 7 with both dipole antenna (horn antenna for above 1 GHz) and search antenna in vertical polarized orientations.

Figure 4 : Frequencies measured below 1 GHz configuration

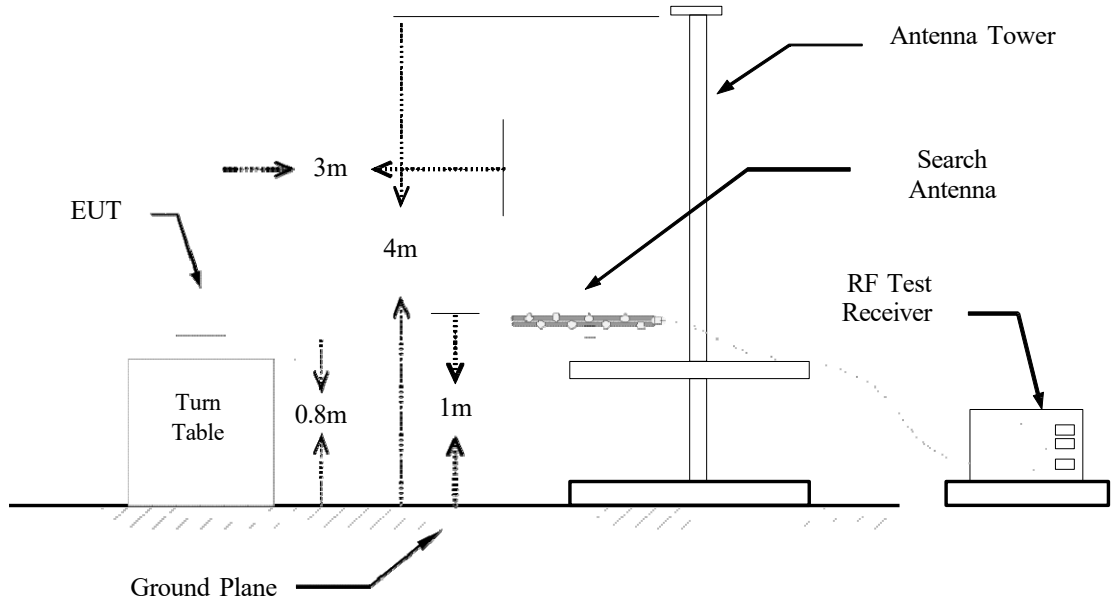
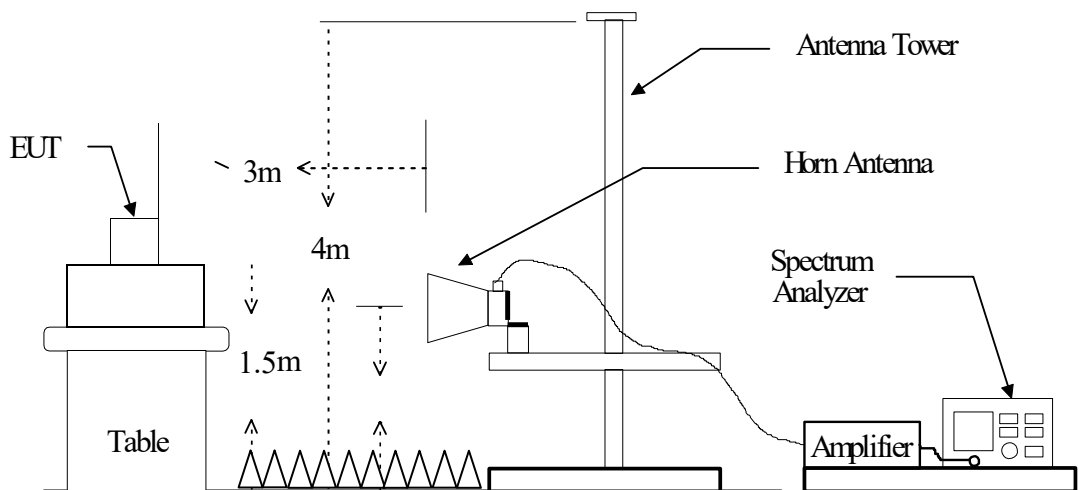


Figure 5 : Frequencies measured above 1 GHz configuration



6.3 Measuring Instrument

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Double Ridged Antenna	EMCO	3115	2016/10/05	2017/10/04
Log-periodic Antenna	EMCO	3146	2017/08/10	2018/08/09
Biconical Antenna	EMCO	3110	2017/07/04	2018/07/03
Amplifier	HP	8449B	2016/10/14	2017/10/13
Amplifier	HP	8447D	2016/12/05	2017/12/04
Signal generator	HP	83732B	2016/12/06	2017/12/05

Measuring instrument setup in frequency band measured is as following :

Frequency Band (MHz)	Instrument	Function	Resolution bandwidth	Video Bandwidth
30 to 1000	Spectrum Analyzer	Peak	100 kHz	100 kHz
Above 1000	Spectrum Analyzer	Peak	1 MHz	1 MHz

6.4 Measuring Data

6.4.1. Emission Test Data

a. Tx Frequency: 470.000MHz

Operated mode : TX

Test Date : Aug. 18, 2017

Temperature : 28°C

Humidity : 65%

Unmodulated carrier output power is 7.70 dBm , or 5.888 mW (ERP).

The limit of spurious or harmonics is calculated as following :

$$7.70 - [43 + 10 \log(\text{carrier output power in W})], \text{ or } -13 \text{ dBm}$$

Frequency (MHz)	Meter Reading (dB μ V)		SG Reading (dBm)		Amp Gain	Antenna Gain Corr'	Cable Loss (dB)	Result (dBm)		Limit (dBm)	Margin (dB)
	H	V	H	V				H	V		
940.000	47.7	49.0	-29.1	-24.2	26.4	-2.0	2.9	-58.4	-53.5	-13.0	-40.5

Frequency (MHz)	Meter Reading (dB μ V)		SG Reading (dBm)		Antenna Gain	Antenna Gain Corr'	Cable Loss (dB)	Result (dBm)		Limit (dBm)	Margin (dB)
	H	V	H	V				H	V		
1410.000	56.2	58.4	-54.6	-52.3	7.4	-2.0	2.5	-49.7	-49.4	-13.0	-36.4
1880.000	---	---	---	---	7.6	-2.0	2.9	---	---	-13.0	---
2350.000	---	---	---	---	8.8	-2.0	3.2	---	---	-13.0	---
2820.000	---	---	---	---	9.0	-2.0	3.6	---	---	-13.0	---
3290.000	---	---	---	---	9.2	-2.0	3.9	---	---	-13.0	---
3760.000	---	---	---	---	9.1	-2.0	4.2	---	---	-13.0	---
4230.000	---	---	---	---	9.5	-2.0	4.4	---	---	-13.0	---
4700.000	---	---	---	---	9.9	-2.0	4.7	---	---	-13.0	---

Note :

1. Remark “---“ means that the emission level is too weak to be detected.
2. For measured frequency below 1GHz, a tuned dipole antenna is used.
3. Result calculation is as following :

$$\text{Result} = \text{SG Reading} - \text{Cable Loss} + \text{Antenna Gain} + \text{Antenna Gain Corrected}$$

Antenna Gain Corrected : is used for antenna other than dipole to convert radiated power to ERP.

b. Tx Frequency: 607.875 MHz

Operated mode : TX
Temperature : 28°C

Test Date : Aug. 18, 2017
Humidity : 65%

Unmodulated carrier output power is 10.10 dBm , or 10.233 mW (ERP).

The limit of spurious or harmonics is calculated as following :

$$10.10 - [43 + 10 \log(\text{carrier output power in W})], \text{ or } -13 \text{ dBm}$$

Frequency (MHz)	Meter Reading (dB μ V)		SG Reading (dBm)		Antenna Gain	Antenna Gain Corr'	Cable Loss (dB)	Result (dBm)		Limit (dBm)	Margin (dB)
	H	V	H	V				H	V		
1215.750	57.9	57.9	-53.8	-53.7	6.6	-2.0	2.3	-51.5	-51.4	-13.0	-38.4
1823.625	50.7	51.0	-58.2	-57.9	7.6	-2.0	2.8	-55.4	-55.1	-13.0	-42.1
2431.500	51.4	52.7	-55.3	-53.9	9.0	-2.0	3.3	-51.6	-50.2	-13.0	-37.2
3039.375	57.7	58.7	-46.9	-45.8	8.9	-2.0	3.7	-43.7	-42.6	-13.0	-29.6
3647.250	56.4	60.6	-45.7	-41.7	9.3	-2.0	4.1	-42.5	-38.5	-13.0	-25.5
4255.125	55.4	56.2	-44.9	-44.3	9.5	-2.0	4.4	-41.8	-41.2	-13.0	-28.2
4863.000	51.5	52.1	-48.0	-47.3	9.7	-2.0	4.8	-45.1	-44.4	-13.0	-31.4
5470.875	---	---	---	---	10.0	-2.0	5.1	---	---	-13.0	---
6078.750	---	---	---	---	10.8	-2.0	5.3	---	---	-13.0	---

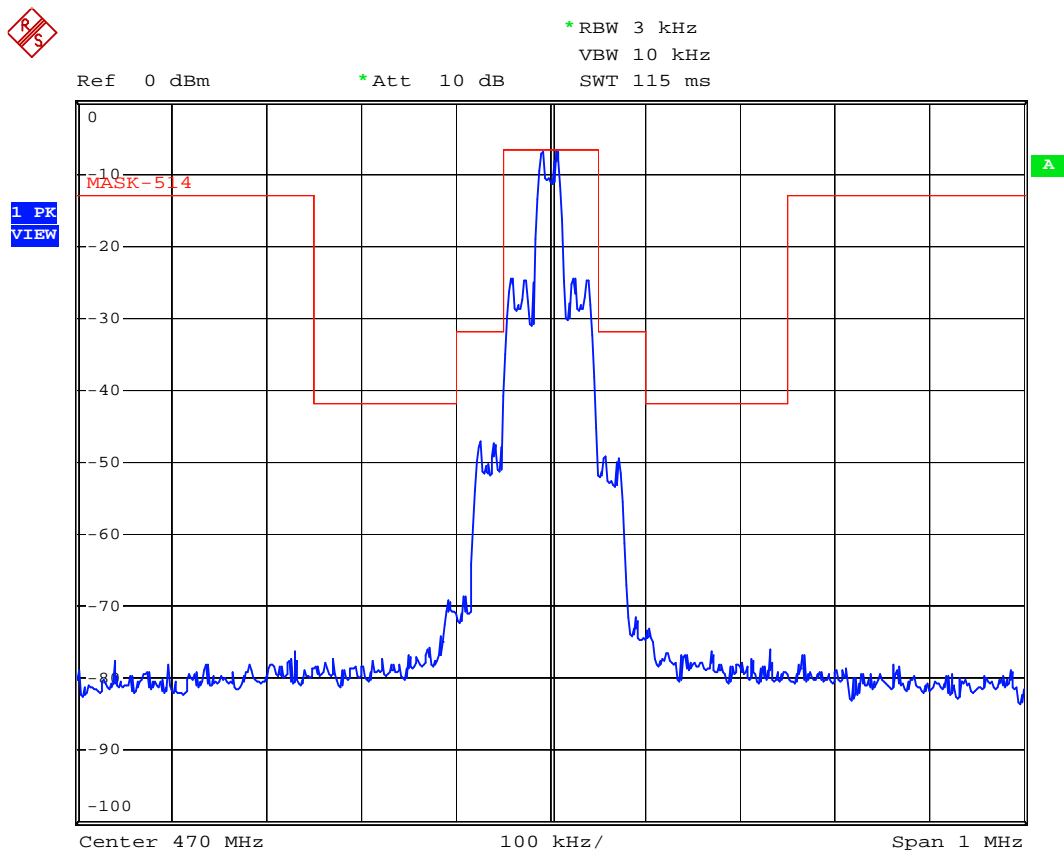
Note :

1. Remark “---“ means that the emission level is too weak to be detected.
2. For measured frequency below 1GHz, a tuned dipole antenna is used.
3. Result calculation is as following :

$$\text{Result} = \text{SG Reading} - \text{Cable Loss} + \text{Antenna Gain} + \text{Antenna Gain Corrected}$$

Antenna Gain Corrected : is used for antenna other than dipole to convert radiated power to ERP.

6.4.2 Emission mask plots



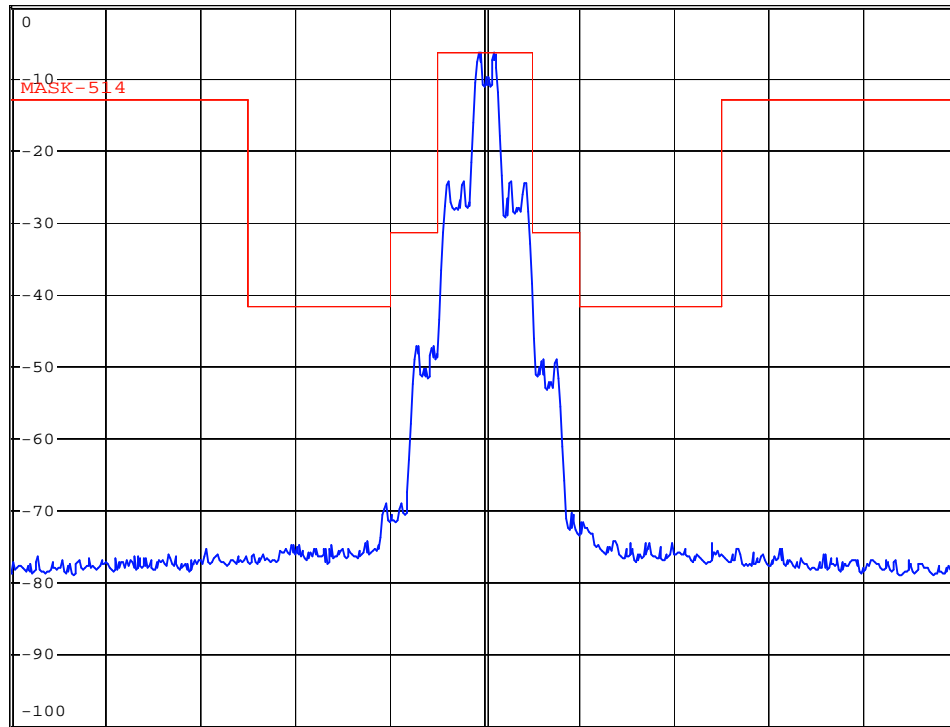


*RBW 3 kHz
VBW 10 kHz
SWT 115 ms

Ref 0 dBm

Att 30 dB

1 PK
VIEW



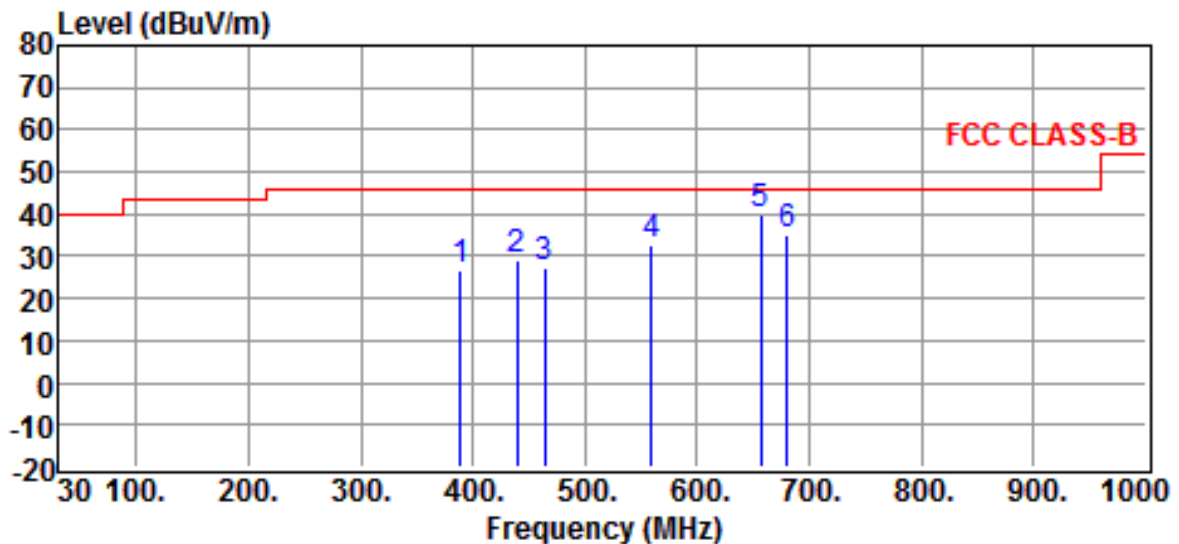
Center 607.875 MHz

100 kHz/

Span 1 MHz

6.5 Other Emission

a) Emission frequencies below 1 GHz

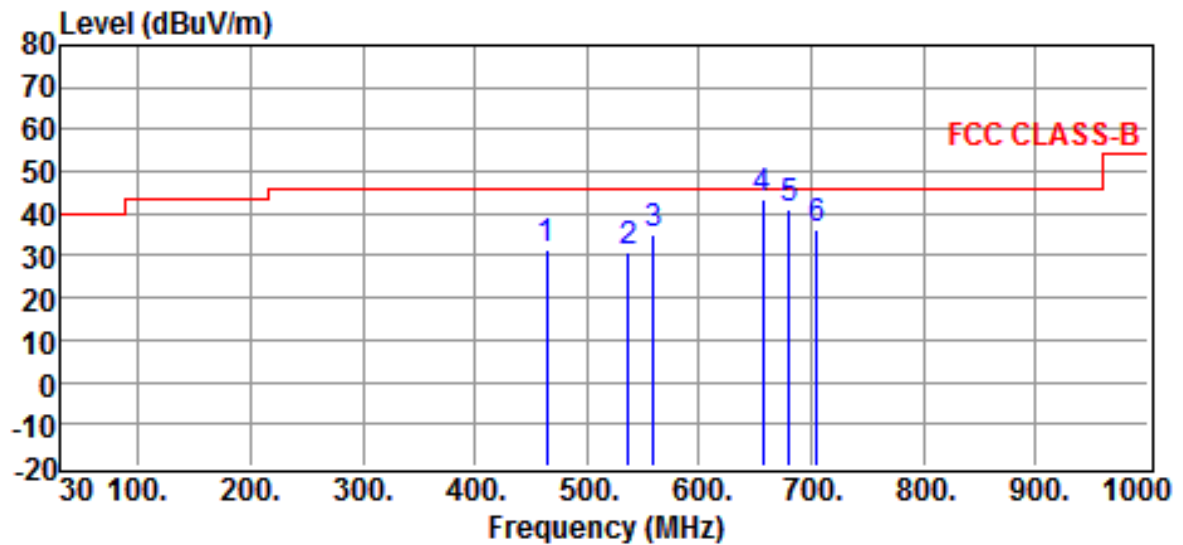


Site	:Open Site	Date	:2017-08-22
Limit	:FCC CLASS-B	Ant. Pol.	:HORIZONTAL
EUT	:Wireless Tour Guide Transmitter	Model	:TG-98TA
Power Rating	:DC 3V	Temp.	:27 °C
Engineer	:Brian Huang	Humi.	:60 %
Test Mode	:TX Mode		

Freq MHz	Reading dB μ V	Correction Factor dB	Result dB μ V/m	Limits dB μ V/m	Over limit dB	Detector
388.9000	7.6	19.0	26.6	46.0	-19.4	Peak
439.3400	8.8	20.2	29.0	46.0	-17.0	Peak
464.5600	6.5	20.9	27.4	46.0	-18.6	Peak
559.6200	9.8	22.7	32.5	46.0	-13.5	Peak
656.6200	15.3	24.5	39.8	46.0	-6.2	Peak
679.9000	10.2	25.1	35.3	46.0	-10.7	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss
3. The margin value=Limit - Result



Site	:Open Site	Date	:2017-08-22
Limit	:FCC CLASS-B	Ant. Pol.	:VERTICAL
EUT	:Wireless Tour Guide Transmitter	Model	:TG-98TA
Power Rating	:DC 3V	Temp.	:27 °C
Engineer	:Brian Huang	Humi.	:60 %
Test Mode	:TX Mode		

Freq MHz	Reading dB μ V	Correction Factor dB	Result dB μ V/m	Limits dB μ V/m	Over limit dB	Detector
464.5600	10.8	20.9	31.7	46.0	-14.3	Peak
536.3400	8.3	22.4	30.7	46.0	-15.3	Peak
559.6200	12.3	22.7	35.0	46.0	-11.0	Peak
656.6200	19.1	24.5	43.6	46.0	-2.4	Peak
679.9000	15.7	25.1	40.8	46.0	-5.2	Peak
705.1200	10.6	25.6	36.2	46.0	-9.8	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss
3. The margin value=Limit - Result

b) Emission frequencies above 1 GHz

Radiated emission frequencies above 1 GHz to 25 GHz were too low to be measured with a pre-amplifier of 35 dB.

6.6 Radiated Measurement Photos



7. FREQUENCY STABILITY MEASUREMENT

7.1 Provisions Applicable

According to §2.1055 (a)(1), the frequency stability shall be measured with variation of ambient temperature from -30°C to $+50^{\circ}\text{C}$ centigrade, and according to §2.1055 (d)(2), the frequency stability shall be measured with variation of primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

According to §74.861(e)(4), the frequency tolerance of the transmitter shall be 0.005 percent.

7.2 Measurement Procedure

A) Frequency stability versus environmental temperature

1. Setup the configuration per figure 6 for frequencies measured at ambient temperature if it is within 15°C to 25°C . Otherwise, an environmental chamber set for a temperature of 20°C shall be used.
2. Turn on EUT and set SA center frequency to the right frequency needs to be measured. Then set SA RBW to 30 kHz, VBW to 100kHz and frequency span to 500 kHz. Record this frequency to be a reference.
3. Set the temperature of chamber to 50°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 lowest temperature -30°C is measured, record all measurement frequencies.

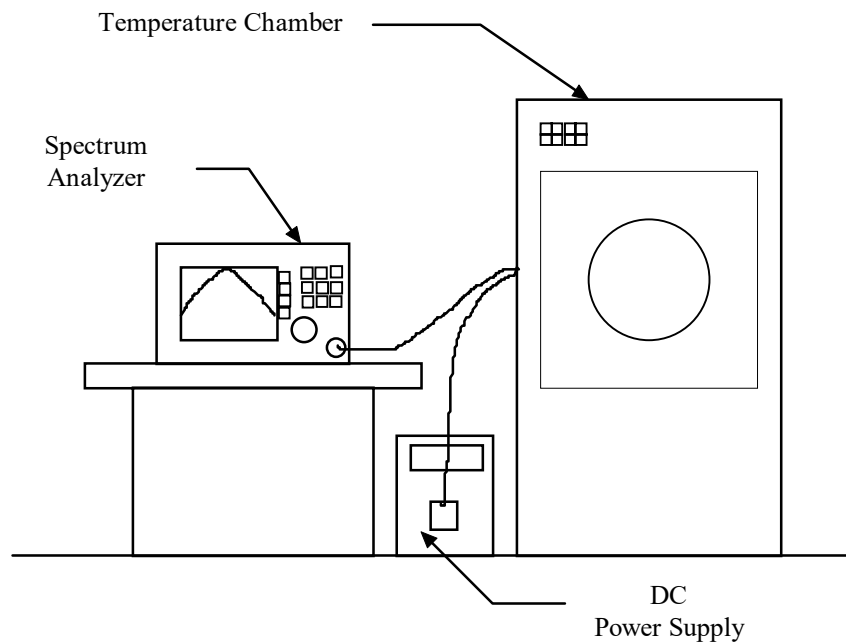
B) Frequency stability versus input voltage

1. Setup the configuration per figure 6 for frequencies measured at ambient temperature if it is within 15°C to 25°C . Otherwise, an environmental chamber set for a temperature of 20°C shall be used. Install new batteries in the EUT.

2. Set SA center frequency to the right frequency needs to be measured. Then set SA RBW to 30 kHz, VBW to 100kHz and frequency span to 500 kHz. Record this frequency to be a reference.

3. For non hand carried, battery operated device, supply the EUT primary voltage with 85 and 115 percent of the nominal value and record the frequency.

Figure 6 : Frequency stability measurement configuration



7.3 Measurement Instrument

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/07/06	2017/07/05
Temperature Chamber	MALLIER	MCT-2X-M	2015/12/15	2016/12/14

7.4 Measurement DataTest Date : Aug. 19, 2017Temperature : 25 °CHumidity : 63 %**A. Tx Frequency 470.000MHz****A1. Frequency stability versus environment temperature**

Reference Frequency :470.000 MHz		Limit : 0.005%					
Environment Temperature (°C)	Power Supplied (Vdc)	Frequency measured with time elapsed					
		2 minute		5 minute		10 minute	
		(MHz)	(%)	(MHz)	(%)	(MHz)	(%)
50	3.0	469.9866	-0.00285	469.9866	-0.00285	469.9868	-0.00281
40		469.9890	-0.00234	469.9890	-0.00234	469.9890	-0.00234
30		469.9925	-0.00160	469.9925	-0.00160	469.9926	-0.00157
20		469.9939	-0.00130	469.9939	-0.00130	469.9941	-0.00126
10		469.9956	-0.00094	469.9956	-0.00094	469.9957	-0.00091
0		469.9979	-0.00045	469.9979	-0.00045	469.9979	-0.00045
-10		469.9991	-0.00019	469.9992	-0.00017	469.9992	-0.00017
-20		470.0005	0.00011	470.0005	0.00011	470.0007	0.00015
-30		470.0017	0.00036	470.0018	0.00038	470.0018	0.00038

A2. Frequency stability versus supplied voltage

Reference Frequency : 470.000 MHz		Limit : 0.005%					
Environment Temperature (°C)	Power Supplied (Vdc)	Frequency measured with time elapsed					
		2 minute		5 minute		10 minute	
		(MHz)	(%)	(MHz)	(%)	(MHz)	(%)
25	2.5	469.9929	-0.00151	469.9929	-0.00151	469.9929	-0.00151
25	3.5	469.9929	-0.00151	469.9931	-0.00147	469.9931	-0.00147

8 CONDUCTED EMISSION MEASUREMENT

8.1 Standard Applicable

This EUT is excused from investigation of conducted emission, for it is powered by DC battery only. According to §15.207 (d), measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines.