ACCREDITED
TESTING LABORATORY
CERTIFICATE#4323.01

FCC PART 15.225

TEST REPORT

For

Tersus GNSS Inc.

Rm 210, Building A, No. 666 Zhangheng Road, Zhangjiang Hi-tech Park, Pudong,Shanghai, P.R.C Shanghai, China

FCC ID: 2AMDJ-TC20

Report Type:	**Product Type:**
Original Report	TC20 Controller

Test Engineer:	Hope Zhang
Report Number:	RSHA181129001-00E
Report Date:	2019-02-25
Reviewed By:	Oscar Ye RF Leader
Prepared By:	Bay Area Compliance Laboratories Corp. (Kunshan) No.248 Chenghu Road,Kunshan,Jiangsu province,China Tel: +86-0512-86175000 Fax: +86-0512-88934268 www.baclcorp.com.cn

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	Tersus GNSS Inc.
Tested Model	TC20
Product Type	TC20 Controller
Dimension	209mm(L)*87mm(W)*31mm(H)
Power Supply	DC 5.0V from adapter,lithium battery voltage 3.7V

**All measurement and test data in this report was gathered from production sample serial number: 20181129001. (Assigned by the BACL. The EUT supplied by the applicant was received on 2018-11-29)*

Objective

This Type approval report is prepared on behalf of Tersus GNSS Inc. in accordance with Part 2- Subpart J, and Part 15-Subparts A and C of the Federal Communication Commission's rules.

The objective is to determine the compliance of the EUT with FCC rules, sec 15.203, 15.205, 15.207, 15.209 and 15.225.

Related Submittal(s)/Grant(s)

FCC Part 15.247 DSS, Part 15.247 DTS, Part 22H24E27 PCB submissions with FCC ID: 2AMDJ-TC20.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Lab Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19 dB
RF conducted test with spectrum		0.9dB
Radiated emission	9kHz~30MHz	6.07dB
	30MHz~1GHz	6.11dB
Occupied Bandwidth		0.5kHz
Temperature		1.0℃
Humidity		6%

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road, Kunshan, Jiangsu province, China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 under the FCC KDB 974614 D01. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

SYSTEM TEST CONFIGURATION

Justification

The system was configured for testing in a typical fashion (as normally used by a typical user).

EUT Exercise Software

The EUT is tested in the engineering mode.

Equipment Modifications

No modification on the EUT.

Support Equipment List and Details

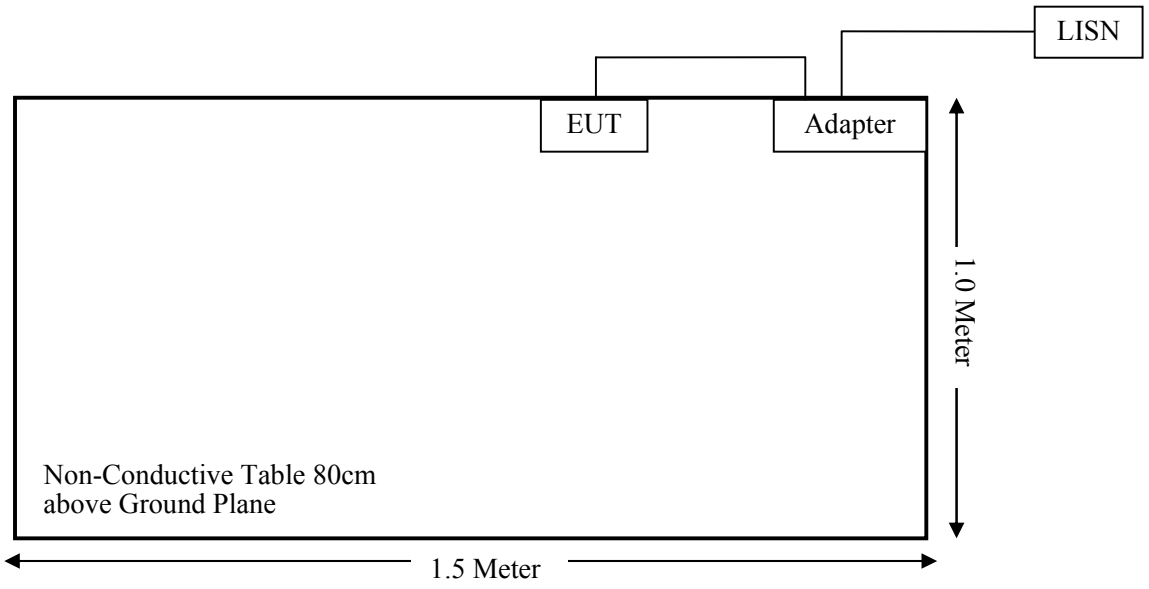
Manufacturer	Description	Model	Serial Number
Huntkey	Adapter(5V/2A)	HKC0115021-2D	711GS186L000007

External I/O Cable

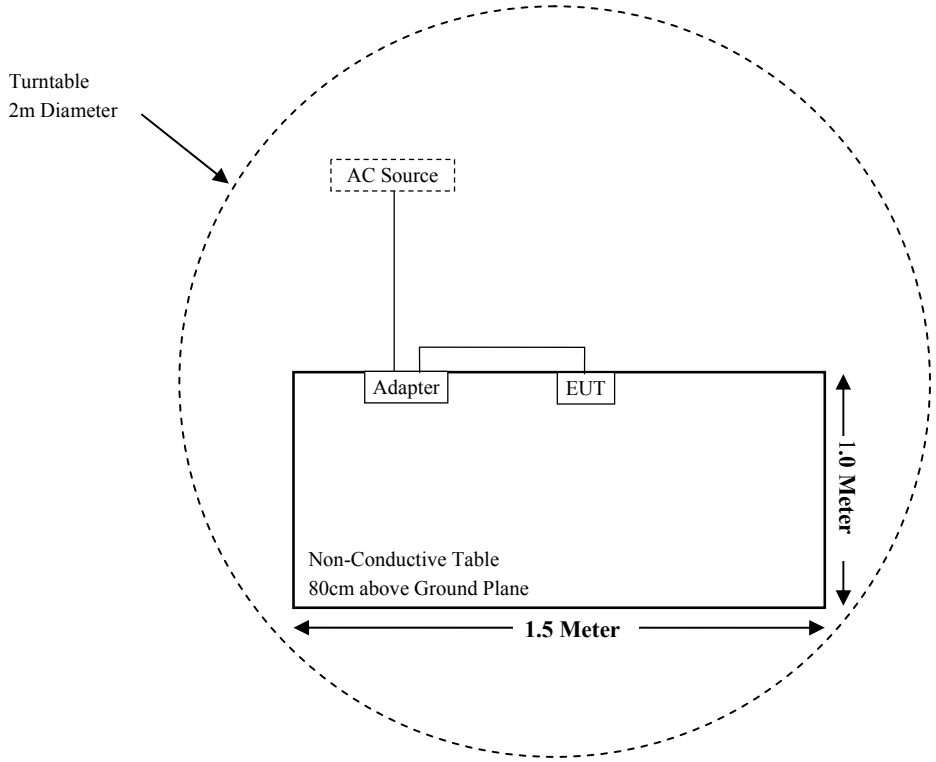
Cable Description	Length (m)	From Port	To
Power Cable	0.8	EUT	Adapter

Block Diagram of Test Setup

For Conducted Emissions:



For Radiated Emissions(Below &Above 30MHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.225 §15.209 §15.205	Radiated Emission Test	Compliance
§15.225(e)	Frequency Stability	Compliance
§15.215(c)	20dB Emission Bandwidth Testing	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test（Chamber 1#）					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2018-11-12	2019-11-11
Sunol Sciences	Broadband Antenna	JB3	A090413-1	2016-12-26	2019-12-25
Sonoma Instrunent	Pre-amplifier	310N	171205	2018-08-15	2019-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-8	008	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2018-08-15	2019-08-14
Radiated Emission Test（Chamber 2#）					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2018-08-27	2019-08-26
ETS-LINDGREN	PASSIVE LOOP	6512	108100	2016-01-09	2019-01-08
ETS-LINDGREN	PASSIVE LOOP	6512	108100	2019-01-09	2022-01-08
Sonoma Instrunent	Pre-amplifier	310N	185700	2018-08-15	2019-08-14
A.H.Systems, inc	Amplifier	2641-1	466	2018-09-11	2019-09-10
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2018-08-15	2019-08-14
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2018-11-30	2019-11-29
ETS-LINDGREN	PASSIVE LOOP	6512	108100	2016-01-09	2019-01-08
ETS-LINDGREN	PASSIVE LOOP	6512	108100	2019-01-09	2022-01-08
BEST	DC Power Supply	PS-1502D+	DC001	2018-10-10	2019-10-09
BACL	Temperature & Humidity Chamber	BTH-150	30023	2018-10-10	2019-10-09
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	834115/007	2018-11-12	2019-11-11
Rohde & Schwarz	LISN	ENV216	3560655016	2018-11-12	2019-11-11
BACL	Auto test Software	BACL-EMC	CE001	/	/
Narda	Attenuator/6dB	10690812-2	26850-6	2018-01-10	2019-01-09
Narda	Attenuator/6dB	10690812-2	26850-6	2019-01-10	2020-01-09
MICRO-COAX	Coaxial Cable	Cable-15	015	2018-08-15	2019-08-14

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.203 - ANTENNA REQUIREMENT

Applicable Standard

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

Antenna Connected Construction

The EUT has a coil antenna and antenna gain is 0dBi, which was permanently attached, fulfill the requirement of this section, please refer to the EUT photos.

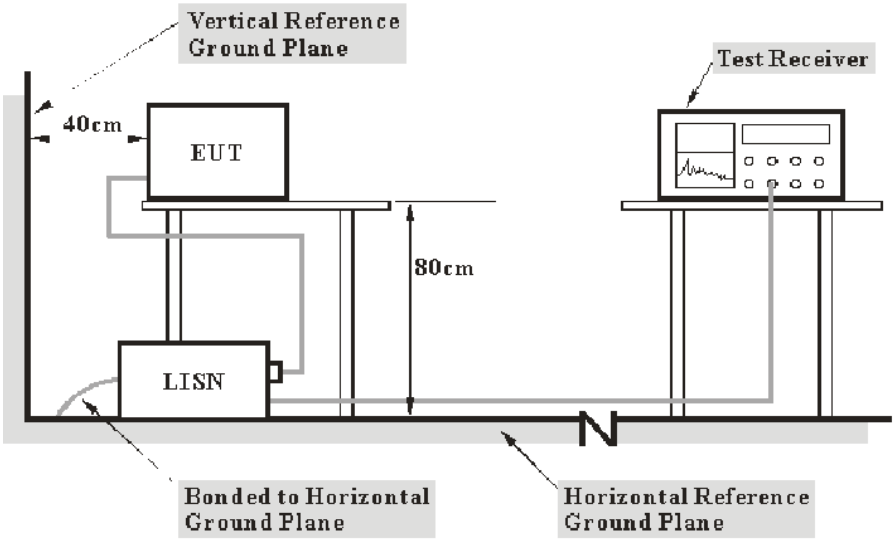
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Corrected Factor = LISN VDF + Cable Loss

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Limit – Reading

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

Test Data

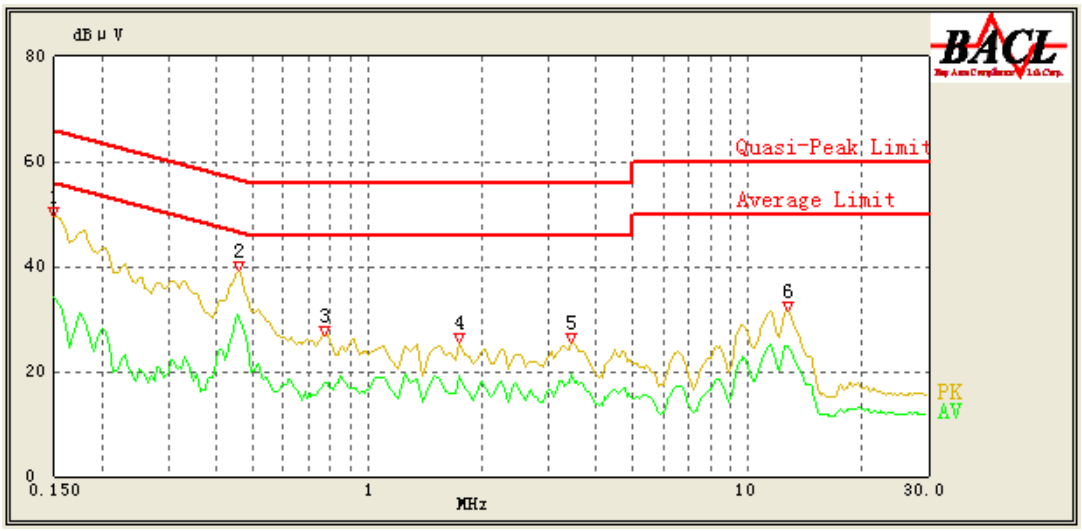
Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	48 %
ATM Pressure:	101.3 kPa

The testing was performed by Hope Zhang on 2019-01-09.

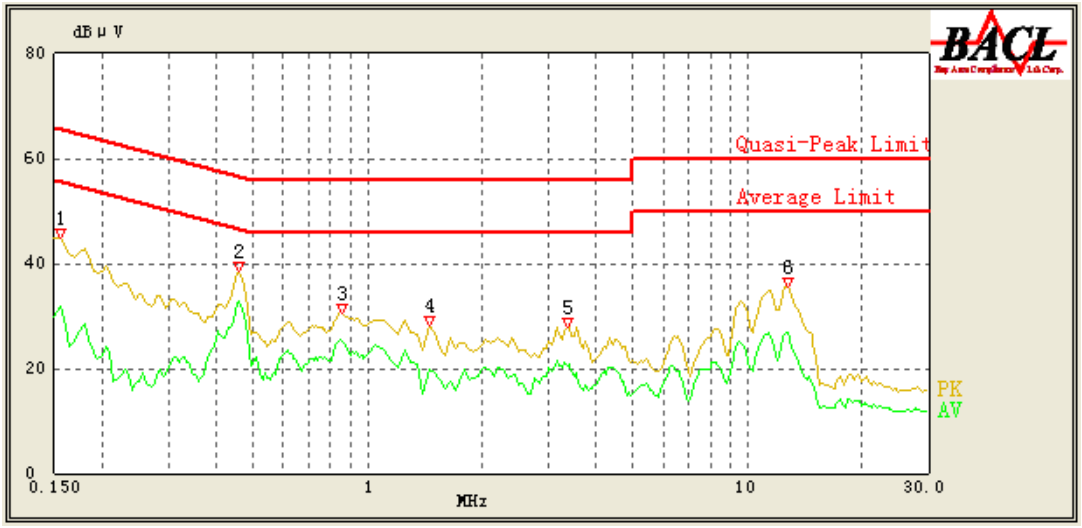
EUT operation mode: Transmitting

AC 120V/60 Hz, Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Corrected Factor (dB)	Limit (dBµV)	Margin (dB)	Comment
0.150	49.46	QP	9.000	L1	16.06	66.00	16.54	Compliance
0.150	34.06	AV	9.000	L1	16.06	56.00	21.94	Compliance
0.460	39.33	QP	9.000	L1	16.07	56.69	17.36	Compliance
0.460	30.52	AV	9.000	L1	16.07	46.69	16.17	Compliance
0.770	26.94	QP	9.000	L1	15.93	56.00	29.06	Compliance
0.770	17.99	AV	9.000	L1	15.93	46.00	28.01	Compliance
1.750	25.39	QP	9.000	L1	15.86	56.00	30.61	Compliance
1.750	19.22	AV	9.000	L1	15.86	46.00	26.78	Compliance
3.450	25.48	QP	9.000	L1	15.85	56.00	30.52	Compliance
3.450	19.48	AV	9.000	L1	15.85	46.00	26.52	Compliance
12.750	31.57	QP	9.000	L1	16.14	60.00	28.43	Compliance
12.750	24.96	AV	9.000	L1	16.14	50.00	25.04	Compliance

AC 120V/60 Hz, Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Corrected Factor (dB)	Limit (dBµV)	Margin (dB)	Comment
0.155	44.85	QP	9.000	N	16.06	65.73	20.88	Compliance
0.155	31.69	AV	9.000	N	16.06	55.73	24.04	Compliance
0.460	38.35	QP	9.000	N	16.10	56.69	18.34	Compliance
0.460	32.86	AV	9.000	N	16.10	46.69	13.83	Compliance
0.855	30.57	QP	9.000	N	15.96	56.00	25.43	Compliance
0.855	25.22	AV	9.000	N	15.96	46.00	20.78	Compliance
1.450	28.02	QP	9.000	N	15.93	56.00	27.98	Compliance
1.450	19.93	AV	9.000	N	15.93	46.00	26.07	Compliance
3.350	27.96	QP	9.000	N	15.89	56.00	28.04	Compliance
3.350	20.64	AV	9.000	N	15.89	46.00	25.36	Compliance
12.750	35.57	QP	9.000	N	16.00	60.00	24.43	Compliance
12.750	26.97	AV	9.000	N	16.00	50.00	23.03	Compliance

Note:
1) Corrected Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation
2) Margin = Limit – Reading

FCC§15.225, §15.205 & §15.209 - RADIATED EMISSIONS TEST

Applicable Standard

As per FCC Part 15.225

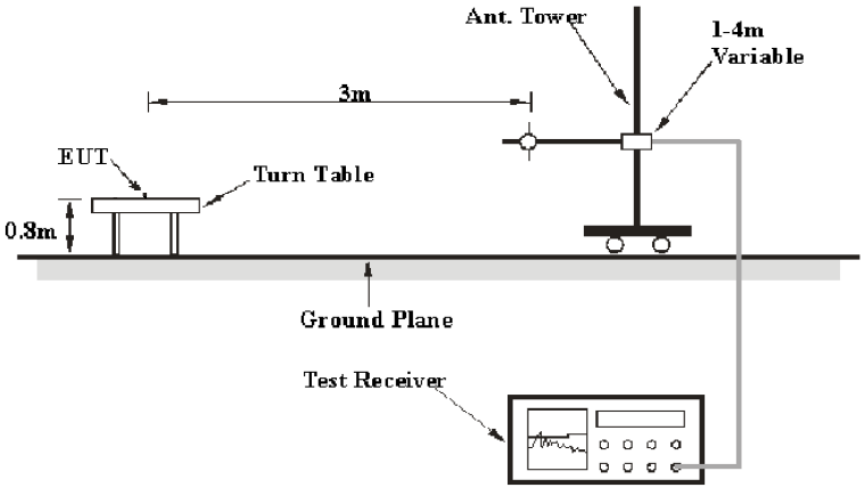
(a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

(b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

EUT Setup



The radiated emission tests were performed in the 3-meter chamber a test site, using the setup accordance with the ANSI C63.10. The specification used was the FCC Part Subpart C limits.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

According to FCC Rules, 47 CFR 15.33, the EUT emissions were investigated up to 1000 MHz.

During the radiated emission test, the EMI test Receiver was set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Detector
9 kHz – 150 kHz	200 Hz	1 kHz	/	QP
150 kHz –30 MHz	9 kHz	30 kHz	/	QP
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Factor = Antenna Factor + Cable Loss- Amplifier Gain
Corrected Amplitude = Meter Reading + Corrected Factor

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Limit – Corrected Amplitude

Test Results Summary

According to the data in the following table, the EUT complied with the FCC Part 15.209, 15.205, 15.225.

Test Data

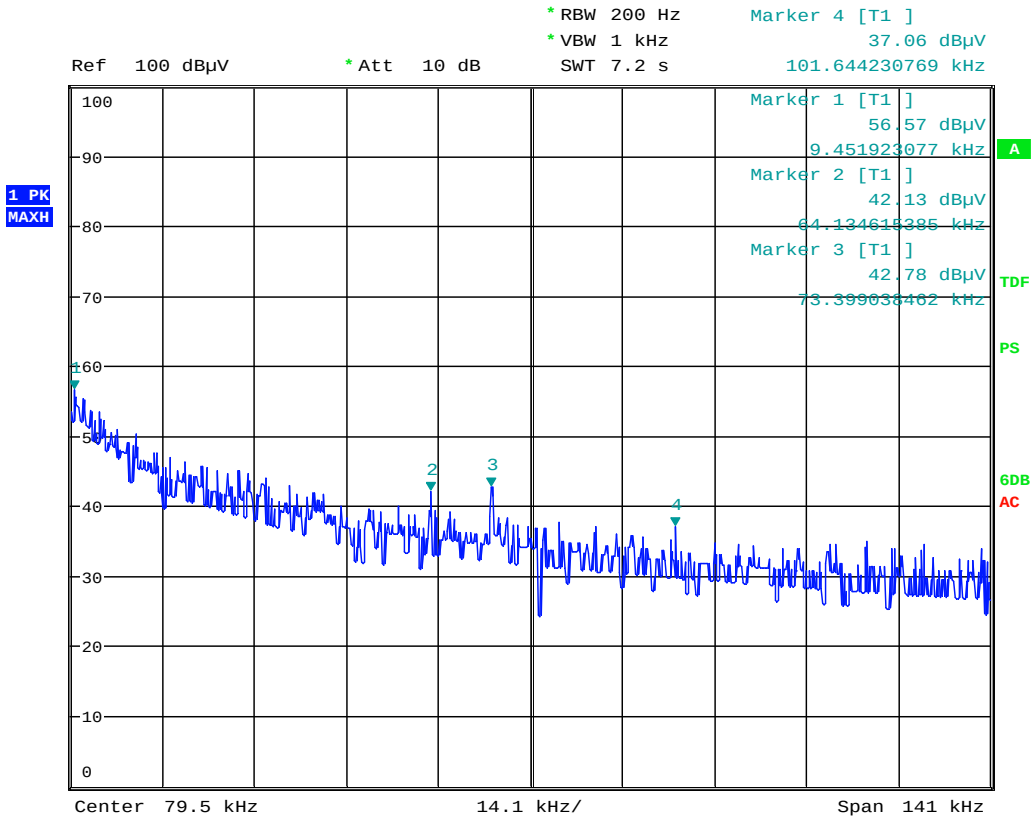
Environmental Conditions

Temperature:	23.1 ℃-23.2 ℃
Relative Humidity:	50 %-55%
ATM Pressure:	101.1 kPa -101.3 kPa

The testing was performed by Hope Zhang on 2018-12-30~2019-02-23.

Test mode: Transmitting

1) Spurious Emissions (9 kHz~150 kHz):



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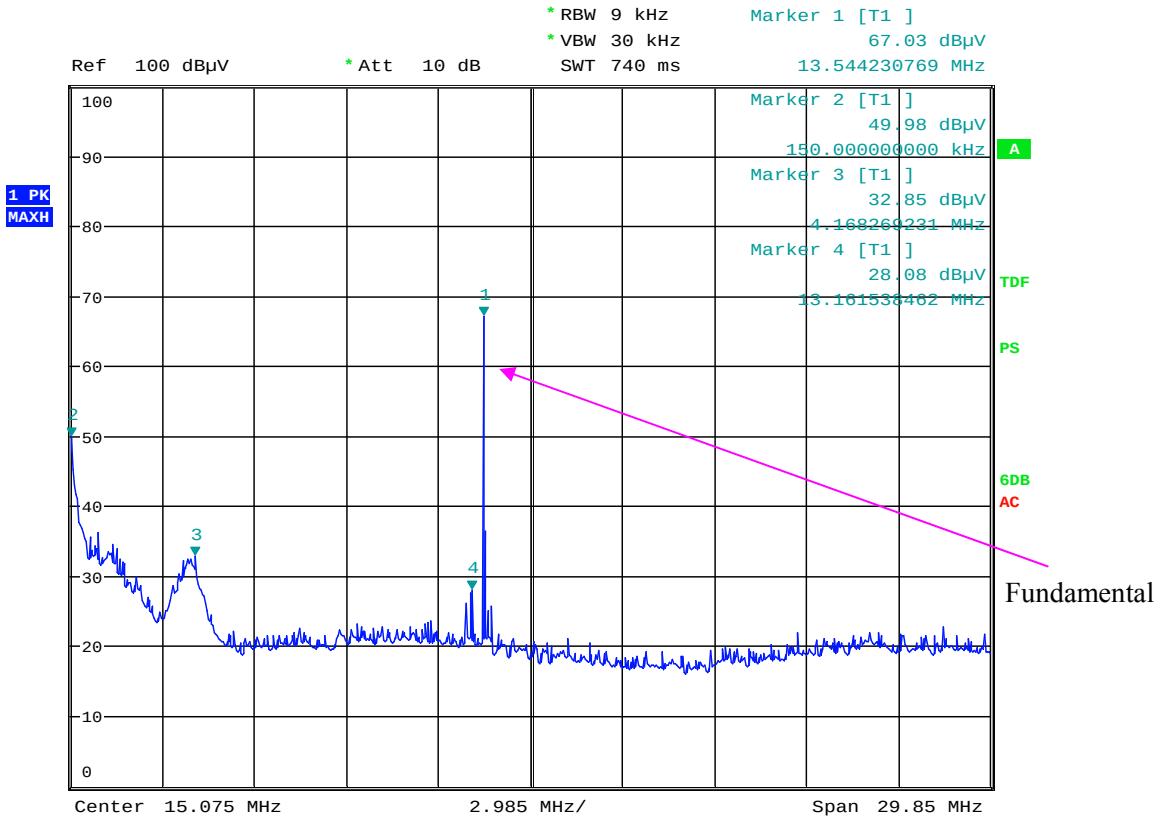
Frequency (MHz)	Corrected Amplitude (dBµV/m) @3m	Detector PK/QP/Ave.	Corrected Factor (dB/m)	FCC Part 15.225\15.209	
				Limit (dBµV/m) @3m	Margin (dB)
0.009	56.57	PK	86.3	128.52	71.95
0.064	42.13	PK	69.86	111.35	69.22
0.073	42.78	PK	68.99	110.29	67.51
0.102	37.06	PK	66.29	107.43	70.37
0.113	35.87	PK	65.67	106.54	70.67
0.137	35.23	PK	64.33	104.87	69.64

Note1: The EMI Test Receiver only can mark 4 points, and there are 2 points recorded by manual.
Note2: The average emissions which fall into frequencies 9-90 kHz, 110-490 kHz was not recorded, because the peak emissions are below the average limit.
Note3;The QP emissions was not recorded, because the peak emissions are below the limit.

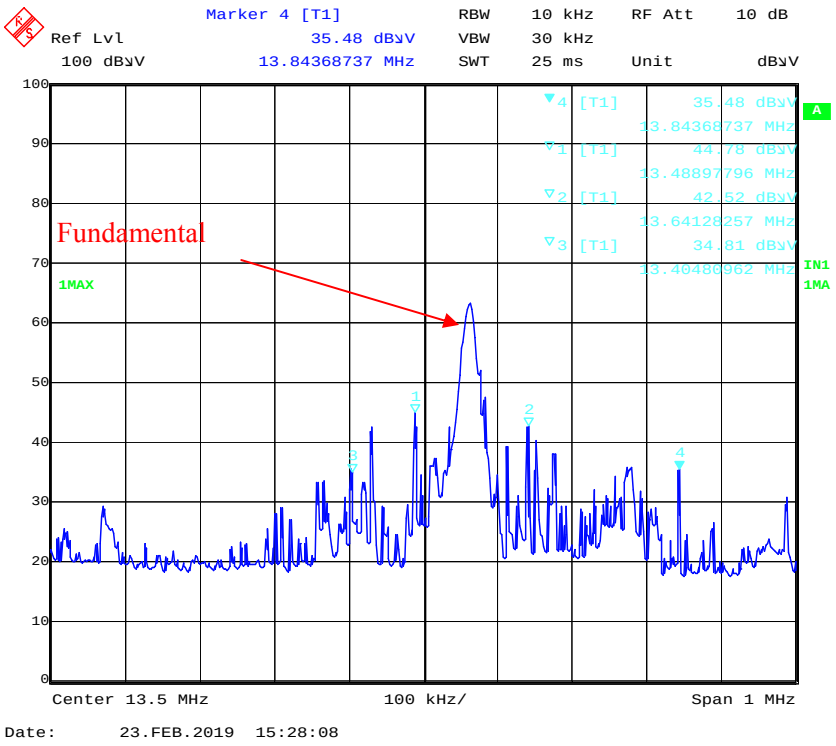
2) Spurious Emissions (150 kHz~30MHz):



Frequency (MHz)	Corrected Amplitude (dBµV/m) @3m	Detector PK/QP/Ave.	Corrected Factor (dB/m)	FCC Part 15.225\15.209	
				Limit (dBµV/m) @3m	Margin (dB)
0.150	49.98	PK	63.6	104.08	54.10
4.168	32.85	PK	38.08	69.54	36.69
7.536	24.83	PK	35.89	69.54	44.71
13.161	28.08	PK	35.37	90.50	62.42
13.560	67.03	PK	35.32	124.00	56.97
14.754	22.67	PK	35.28	69.54	46.87

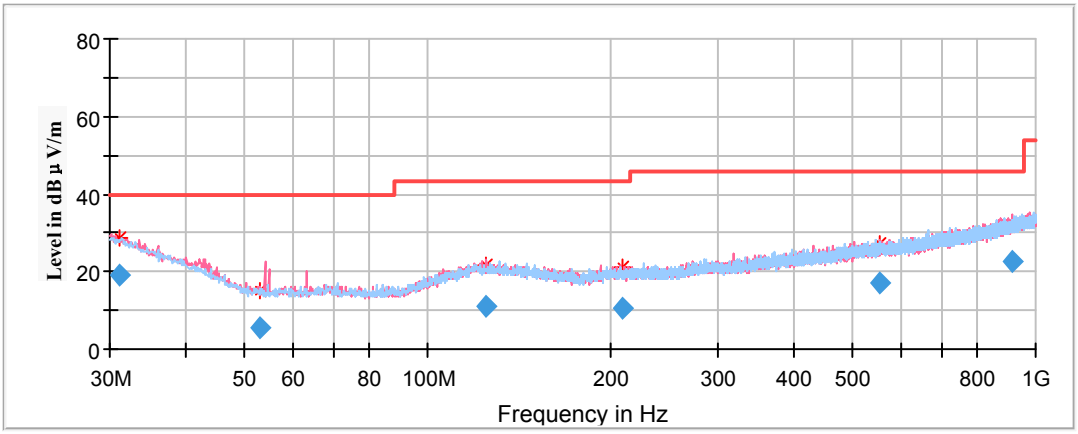
Note1: The EMI Test Receiver only can mark 4 points, and there are 2 points recorded by manual.
Note2: The average emissions which fall into frequencies 9-90 kHz, 110-490 kHz was not recorded, because the peak emissions are below the average limit.
Note3;The QP emissions was not recorded, because the peak emissions are below the limit.

3) Spurious Emissions (13MHz~14MHz):



Frequency (MHz)	Corrected Amplitude (dBµV/m) @3m	Detector PK/QP/Ave.	Corrected Factor (dB/m)	FCC Part 15.225\15.209	
				Limit (dBµV/m) @3m	Margin (dB)
13.4889	44.78	PK	35.31	90.50	45.72
13.6412	42.52	PK	35.32	90.50	47.98
13.4048	34.81	PK	35.31	80.50	45.69
13.8436	35.48	PK	35.32	80.50	45.02

3) Spurious Emissions (30 MHz ~1 GHz):



Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV/m)	Height (cm)	Polar (H/V)				
31.193915	28.70	200.0	V	187.0	-4.0	40.00	11.30
52.835400	15.18	100.0	V	269.0	-17.7	40.00	24.82
124.824500	21.51	200.0	V	310.0	-11.4	43.50	21.99
208.871350	21.25	200.0	V	351.0	-12.3	43.50	22.25
555.972600	27.00	200.0	V	320.0	-5.6	46.00	19.00
913.682700	32.35	200.0	V	359.0	0.4	46.00	13.65

Note:
Corrected Amplitude = Corrected Factor + Reading
Corrected Factor = Antenna factor (Rx) + cable loss – amplifier factor
Margin = Limit - Corrected Amplitude

FCC§15.225(e) - FREQUENCY STABILITY

Applicable Standard

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Test Procedure

a) Supply the EUT with a nominal ac voltage or install a new or fully charged battery in the EUT. If possible, a dummy load shall be connected to the EUT because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, then the EUT shall be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn ON the EUT and tune it to one of the number of frequencies shown in 5.6.

b) Couple the unlicensed wireless device output to the measuring instrument by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away), or by connecting a dummy load to the measuring instrument, through an attenuator if necessary.
NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory agency is the recommended measuring instrument.

c) Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

d) Turn the EUT OFF and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.

e) Set the temperature control on the chamber to the highest specified in the regulatory requirements for the type of device and allow the oscillator heater and the chamber temperature to stabilize.

f) While maintaining a constant temperature inside the environmental chamber, turn the EUT ON and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.

g) Measure the frequency at each of frequencies specified in 5.6.

h) Switch OFF the EUT but do not switch OFF the oscillator heater.

i) Lower the chamber temperature by not more that 10 °C, and allow the temperature inside the chamber to stabilize.

j) Repeat step f) through step i) down to the lowest specified temperature.

Test Data

Environmental Conditions

Temperature:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

The testing was performed by Hope Zhang on 2018-12-30.

Test Mode: Transmitting.

Test Result: Pass

F_0=13.56MHz				
Power Supply(V_{DC})	**Temperature (℃)**	**Measured Frequency (MHz)**	**Frequency Error**	**Part 15.225 Limit**
3.7	-20	13.56061	0.0045%	±0.01%
	-10	13.56072	0.0053%	±0.01%
	0	13.56025	0.0018%	±0.01%
	10	13.56012	0.0009%	±0.01%
	20	13.56029	0.0021%	±0.01%
	30	13.56084	0.0062%	±0.01%
	40	13.56126	0.0093%	±0.01%
	50	13.56114	0.0084%	±0.01%
3.4	20	13.56067	0.0049%	±0.01%
4.2	20	13.56029	0.0021%	±0.01%

§15.215(c) - 20dB EMISSION BANDWIDTH TESTING

Requirement

Per 15.215 (c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Test 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 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then 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. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.

Test Data

Environmental Conditions

Temperature:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

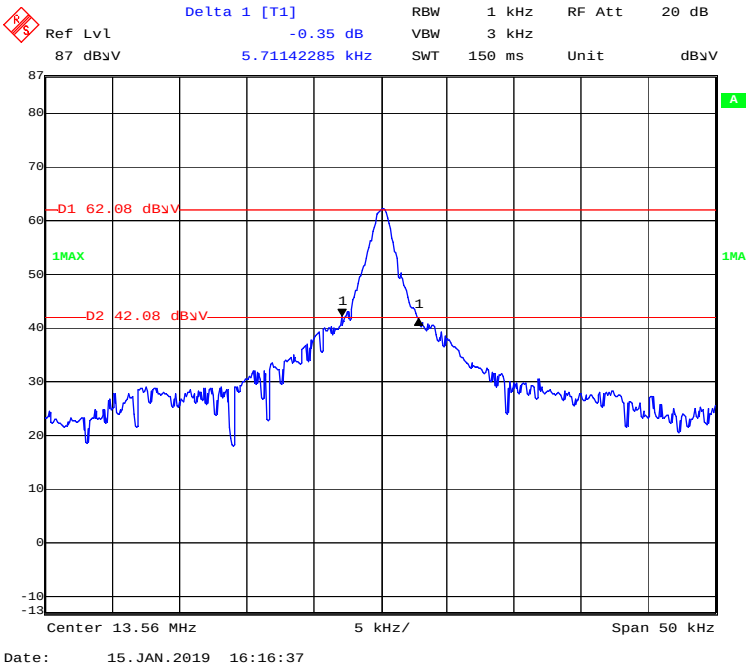
The testing was performed by Hope Zhang on 2019-01-15.

Test Mode: Transmitting

Test Result: Pass

Frequency (MHz)	20 dB Bandwidth (kHz)
13.56	5.71

20 dB Emission Bandwidth



******* END OF REPORT *******