

FCC Test Report

FCC ID : SUFHFNF03
Equipment : HIGH FREQ READER
Model No. : NF-03
Brand Name : DIGI
Applicant : DIGI SINGAPORE PTE. LTD.
Address : 4 Leng Kee Rd, #05-03/04/05&11, SIS Building,
Singapore 159088
Standard : 47 CFR FCC Part 15.225
Received Date : Jun. 03, 2021
Tested Date : Jun. 04 ~ Jun. 16, 2021

We, International Certification Corporation, would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:



Along Chen / Assistant Manager

Approved by:



Gary Chang / Manager



Table of Contents

1	GENERAL DESCRIPTION	5
1.1	Information.....	5
1.2	Local Support Equipment List	6
1.3	Test Setup Chart	6
1.4	The Equipment List	7
1.5	Test Standards	8
1.6	Deviation from Test Standard and Measurement Procedure.....	8
1.7	Measurement Uncertainty	8
2	TEST CONFIGURATION.....	9
2.1	Testing Facility	9
2.2	The Worst Test Modes and Channel Details	9
3	TRANSMITTER TEST RESULTS	10
3.1	Conducted Emissions.....	10
3.2	20dB and Occupied Bandwidth.....	15
3.3	Field Strength of Fundamental Emissions	17
3.4	Unwanted Emissions into Restricted Frequency Bands	19
3.5	Frequency Stability.....	24
4	TEST LABORATORY INFORMATION	26

Release Record

Report No.	Version	Description	Issued Date
FR140703-02	Rev. 01	Initial issue	Jun. 22, 2021

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV/m at 3m]: 0.177 52.45 (Margin -12.19dB)	Pass
15.225(a)~(c)	Field strength of fundamental emissions and spectrum mask	[dBuV/m at 3m]: 13.56 97.63 (Margin -7.76dB)	Pass
15.225(d)	Field strength of any emissions appearing outside of the 13.110-14.010 MHz band	Meet the requirement of limit	Pass
15.225(e)	Frequency tolerance	Meet the requirement of limit	Pass
15.215 (c)	20dB bandwidth	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information			
Frequency Range (MHz)	Modulation	Ch. Frequency (MHz)	Channel Number
13.553 – 13.567	ASK	13.56	1

1.1.2 Antenna Details

Ant. No.	Type	Gain (dBi)	Connector	Remark
1	PCB loop	0	---	---

1.1.3 EUT Operational Condition

Supply Voltage	5Vdc from host		
Operational Voltage	<input checked="" type="checkbox"/> Vnom (120 V)	<input checked="" type="checkbox"/> Vmax (138 V)	<input checked="" type="checkbox"/> Vmin (102 V)
Operational Climatic	<input checked="" type="checkbox"/> Tnom (20°C)	<input checked="" type="checkbox"/> Tmax (50°C)	<input checked="" type="checkbox"/> Tmin (-20°C)

1.1.4 Accessories

No.	Equipment	Description
1	USB cable	1.5m shielded without core (connected with EUT)

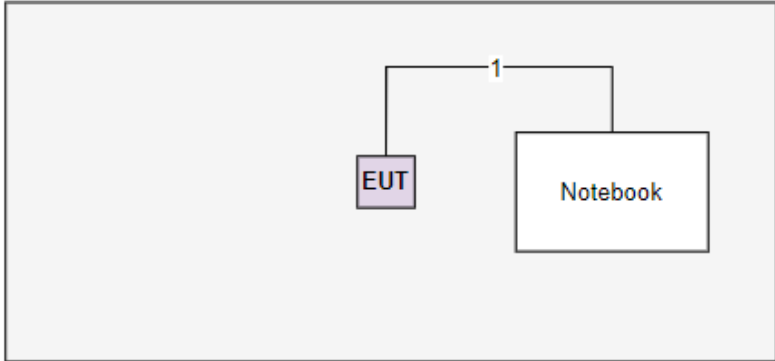
1.1.5 Test Tool and Power Index

Test Tool	ST25R3911B Discovery GUI, Ver. 1.2.12.0
Power Index	Default

1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Notebook	DELL	Latitude E5470	DoC	---

1.3 Test Setup Chart

Test Setup Diagram	
 <pre> graph TD EUT[EUT] --- 1 --- Notebook[Notebook] </pre>	
No.	Signal cable / Length (m)
1	USB, 1.5m shielded.

1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Jun. 16, 2021				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101658	Feb. 08, 2021	Feb. 07, 2022
LISN	R&S	ENV216	101579	Mar. 17, 2021	Mar. 16, 2022
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Dec. 29, 2020	Dec. 28, 2021
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 21, 2020	Oct. 20, 2021
50 ohm terminal (Support Unit)	NA	50	04	May 25, 2021	May 24, 2022
Measurement Software	AUDIX	e3	6.120210k	NA	NA

Note: Calibration Interval of instruments listed above is one year.

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Tested Date	Jun. 04 ~ Jun. 07, 2021				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Mar. 12, 2021	Mar. 11, 2022
Spectrum Analyzer	R&S	FSV40	101498	Dec. 04, 2020	Dec. 03, 2021
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 17, 2020	Nov. 16, 2021
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 10, 2020	Jul. 09, 2021
Preamplifier	EMC	EMC02325	980225	Jul. 03, 2020	Jul. 02, 2021
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 06, 2020	Oct. 05, 2021
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Oct. 06, 2020	Oct. 05, 2021
LF cable 11M	EMC	EMCCFD400-NW-N W-11000	200801	Oct. 06, 2020	Oct. 05, 2021
LF cable 1M	EMC	EMCCFD400-NM-N M-1000	160502	Oct. 06, 2020	Oct. 05, 2021
Measurement Software	AUDIX	e3	6.120210g	NA	NA

Note: Calibration Interval of instruments listed above is one year.

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Jun. 07, 2021				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101063	Apr. 19, 2021	Apr. 18, 2022
Power Meter	Anritsu	ML2495A	1241002	Nov. 04, 2020	Nov. 03, 2021
Power Sensor	Anritsu	MA2411B	1207366	Nov. 04, 2020	Nov. 03, 2021
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GTH-150-40-CP-AR-T	MAA1407-012	Sep. 10, 2020	Sep. 09, 2021
AC POWER SOURCE	APC	AFC-500W	F312060012	Dec. 04, 2020	Dec. 03, 2021
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

47 CFR FCC Part 15.225
ANSI C63.10-2013

1.6 Deviation from Test Standard and Measurement Procedure

None

1.7 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)).

Measurement Uncertainty	
Parameters	Uncertainty
Bandwidth	±34.130 Hz
Radiated emission ≤ 30MHz	±2.3 dB
Radiated emission ≤ 1GHz	±3.41 dB
Temperature	±0.4 °C

2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corporation
Test Site	CO01-WS, 03CH01-WS, TH01-WS
Address of Test Site	No.3-1, Lane 6, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 33381, Taiwan (R.O.C.)

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- ISED#: 10807A
- CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)
Field strength of fundamental emissions	RFID	13.56
Field strength of any emissions appearing outside of the 13.110-14.010 MHz band	RFID	13.56
Frequency tolerance	RFID	13.56
20dB bandwidth	RFID	13.56

NOTE:

1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Z-plane** results were found as the worst case and were shown in this report.

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

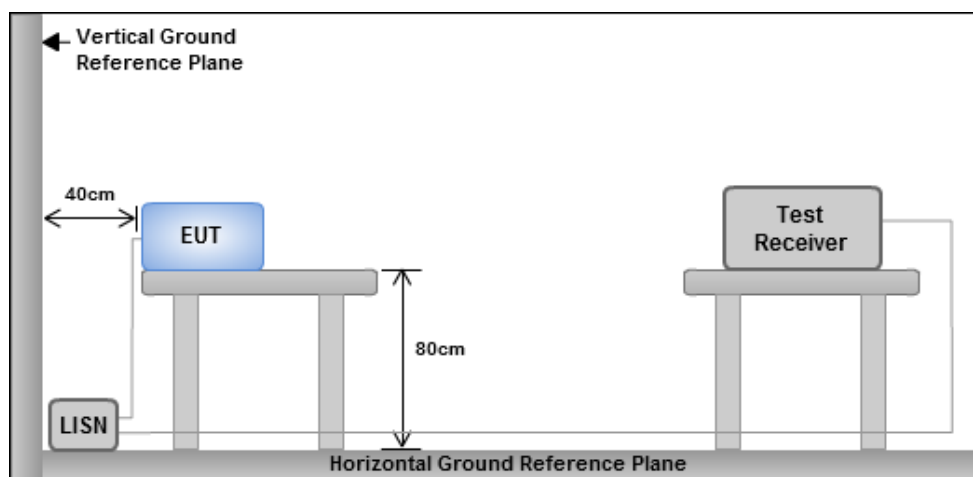
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: * Decreases with the logarithm of the frequency.

3.1.2 Test Procedures

1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V / 60Hz.

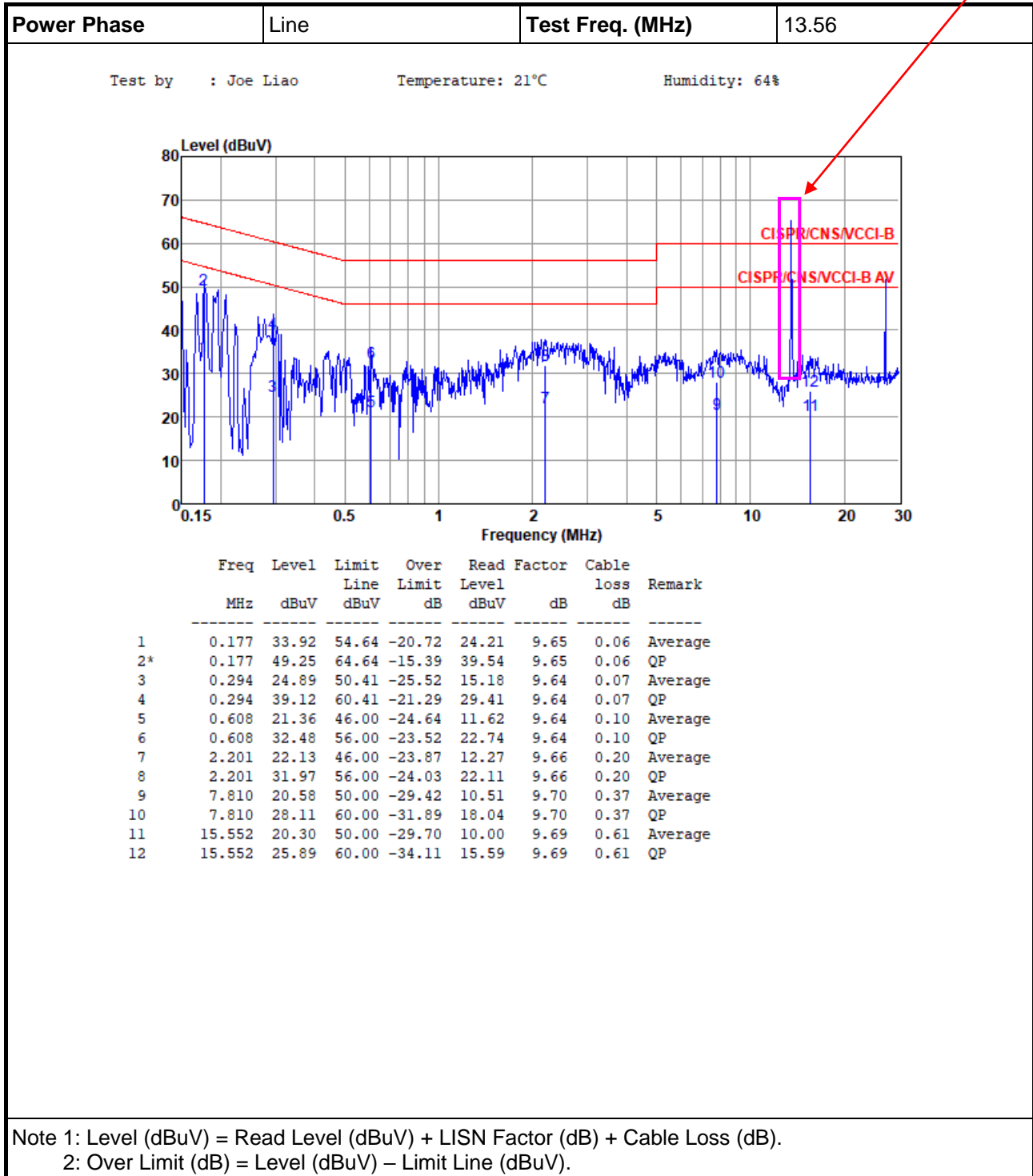
3.1.3 Test Setup



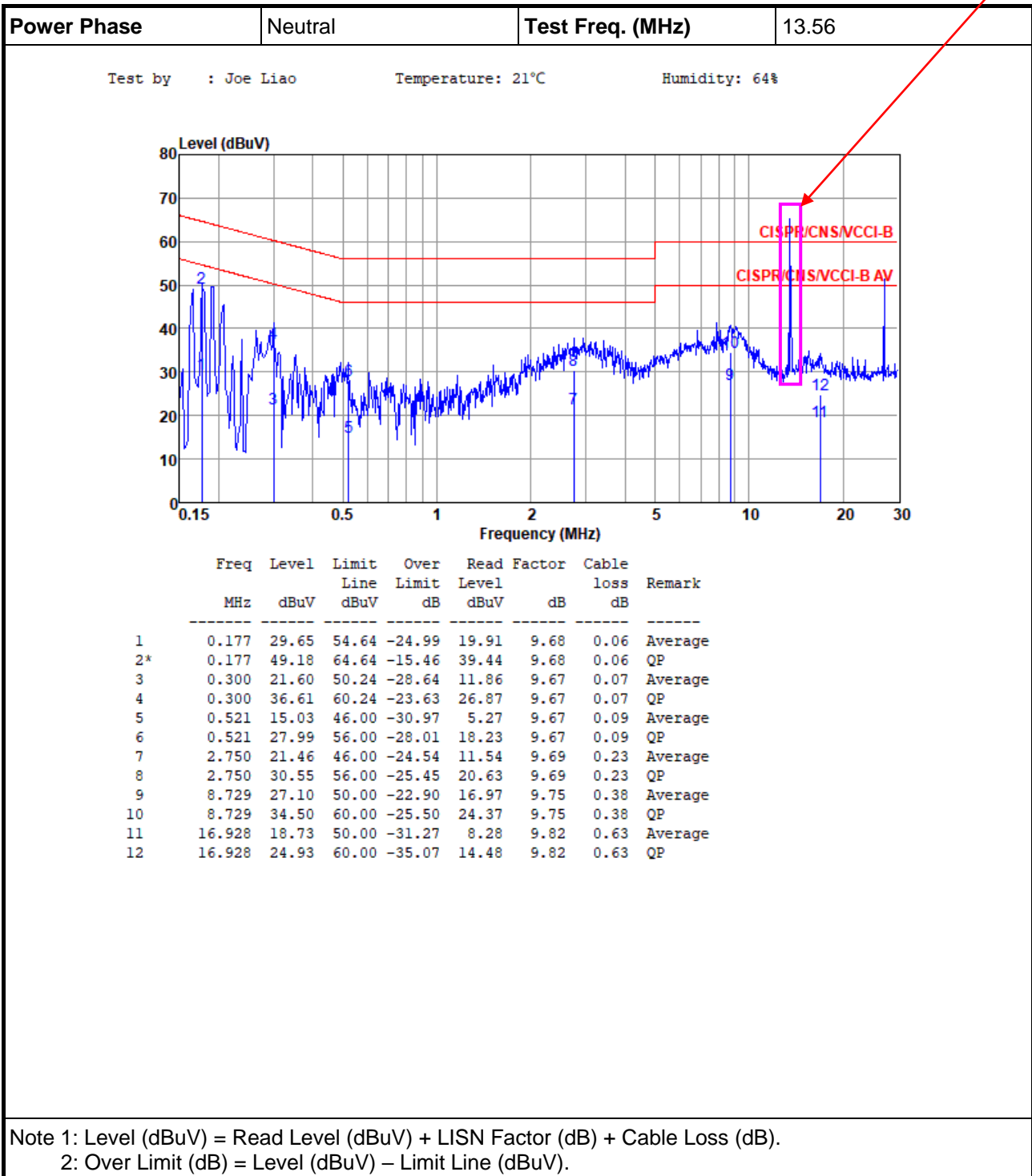
- Note: 1. Support units were connected to second LISN.
 2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.1.4 Test Result of Conducted Emissions - RFID Tx with antenna

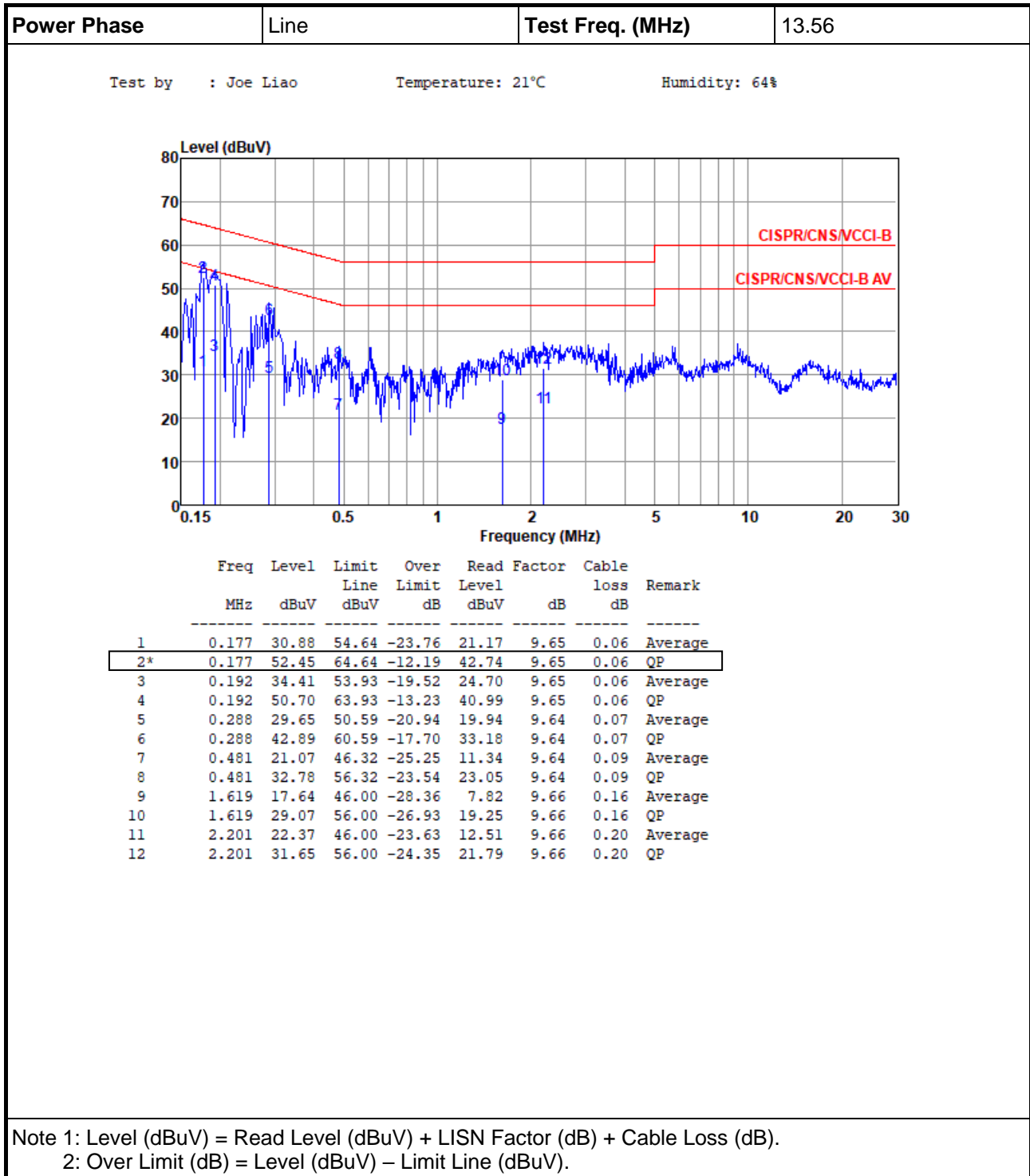
Fundamental emission



Fundamental emission

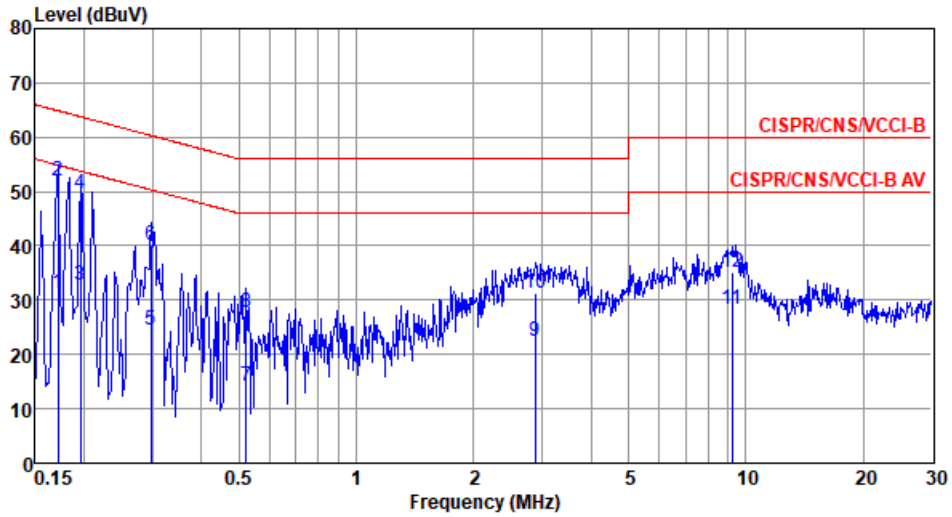


3.1.5 Test Result of Conducted Emissions - RFID Tx W/O antenna



Power Phase	Neutral	Test Freq. (MHz)	13.56
--------------------	---------	-------------------------	-------

Test by : Joe Liao Temperature: 21°C Humidity: 64%



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	Factor dB	Cable loss dB	Remark
1	0.171	31.42	54.90	-23.48	21.68	9.69	0.05	Average
2*	0.171	52.04	64.90	-12.86	42.30	9.69	0.05	QP
3	0.195	32.85	53.80	-20.95	23.11	9.68	0.06	Average
4	0.195	49.63	63.80	-14.17	39.89	9.68	0.06	QP
5	0.297	24.61	50.32	-25.71	14.87	9.67	0.07	Average
6	0.297	40.06	60.32	-20.26	30.32	9.67	0.07	QP
7	0.521	14.14	46.00	-31.86	4.38	9.67	0.09	Average
8	0.521	27.76	56.00	-28.24	18.00	9.67	0.09	QP
9	2.884	22.46	46.00	-23.54	12.52	9.70	0.24	Average
10	2.884	31.26	56.00	-24.74	21.32	9.70	0.24	QP
11	9.204	28.38	50.00	-21.62	18.24	9.75	0.39	Average
12	9.204	35.04	60.00	-24.96	24.90	9.75	0.39	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 20dB and Occupied Bandwidth

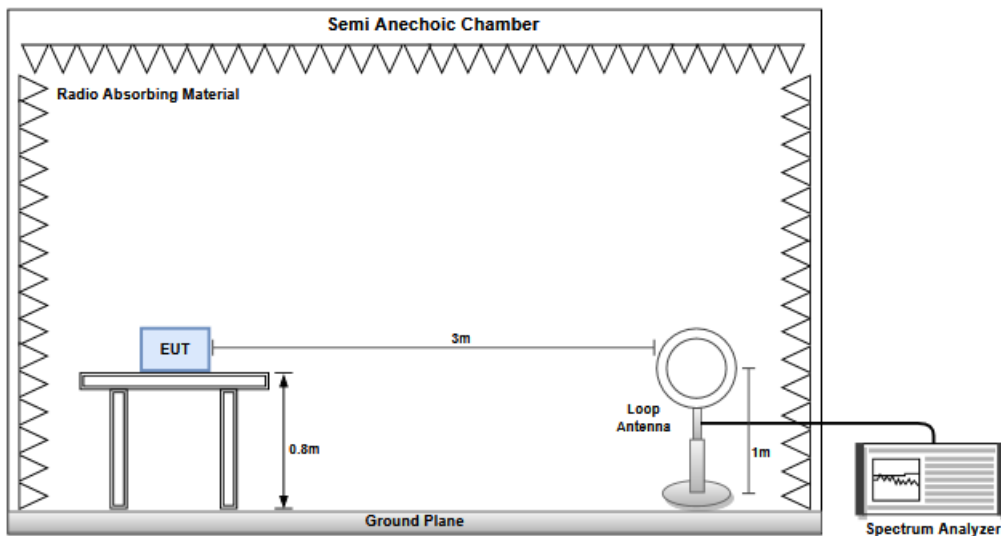
3.2.1 Limit of 20dB Bandwidth

The upper and lower frequency of the 20dB bandwidth shall within 13.553~13.567 MHz

3.2.2 Test Procedures

1. Set resolution bandwidth (RBW) = 1 kHz, Video bandwidth = 3 kHz.
2. Detector = Peak, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 20dB relative to the maximum level measured in the fundamental emission.

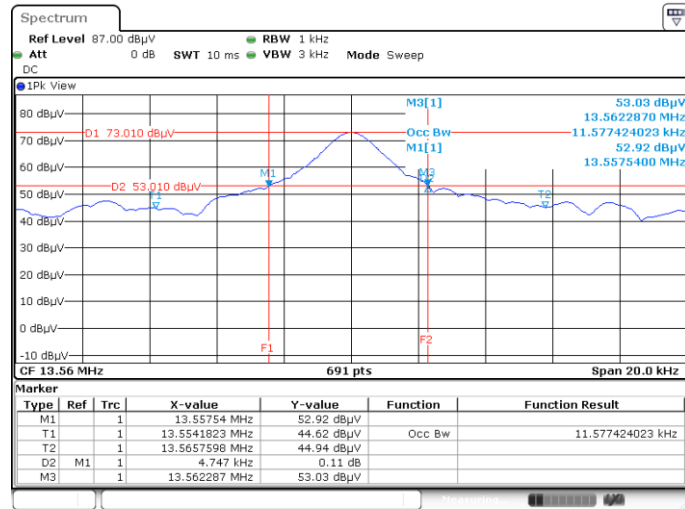
3.2.3 Test Setup



3.2.4 Test Result of 20dB and Occupied Bandwidth

Ambient Condition	24°C / 65%	Tested By	Roger Lu
-------------------	------------	-----------	----------

Modulation Mode	Freq. (MHz)	20dB Bandwidth (kHz)	F _L at 20dB BW (MHz)	F _H at 20dB BW (MHz)	99% Bandwidth (kHz)
RFID	13.56	4.747	13.55754	13.562287	11.57742402
Limit		N/A	13.553	13.567	N/A



3.3 Field Strength of Fundamental Emissions

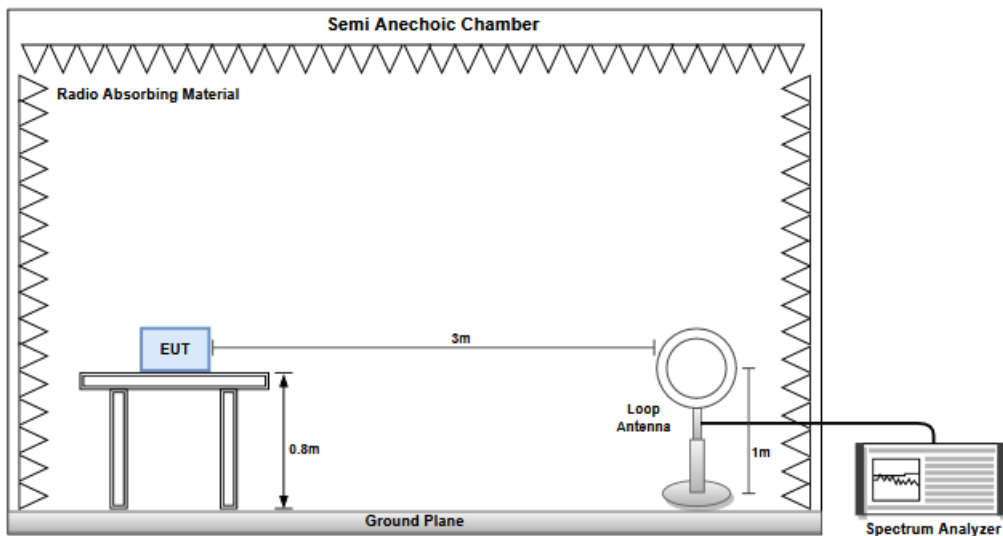
3.3.1 Field Strength of Fundamental Emissions

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

3.3.2 Test Procedures

1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at a height of 0.8 m test table above the ground plane.
2. Measurement is made with the antenna positioned in both the open and close planes of polarization. . Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, and the antenna rotated to repeat the measurements for both the open and close antenna polarizations.

3.3.3 Test Setup



3.3.4 Test Result of Field Strength of Fundamental Emissions

Ambient Condition	24°C / 65%	Tested By	Roger Lu
--------------------------	------------	------------------	----------

Field Strength of Fundamental Emissions Result							
Polarization	Emission Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	SA Reading (dBuV)	Factor	Remark
Open	13.56	97.63	105.39	-7.76	73.31	24.32	QP

Field Strength of Fundamental Emissions Result							
Polarization	Emission Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	SA Reading (dBuV)	Factor	Remark
Close	13.56	93.76	105.39	-11.63	69.44	24.32	QP

Note: Emission level = SA reading + Factor

3.4 Unwanted Emissions into Restricted Frequency Bands

3.4.1 Limit of Unwanted Emissions into Restricted Frequency Bands

- 1) 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.
- 2) 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.
- 3) 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 below table

Restricted Band Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
 Qusai-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit

Note 2:
 Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

3.4.2 Test Procedures

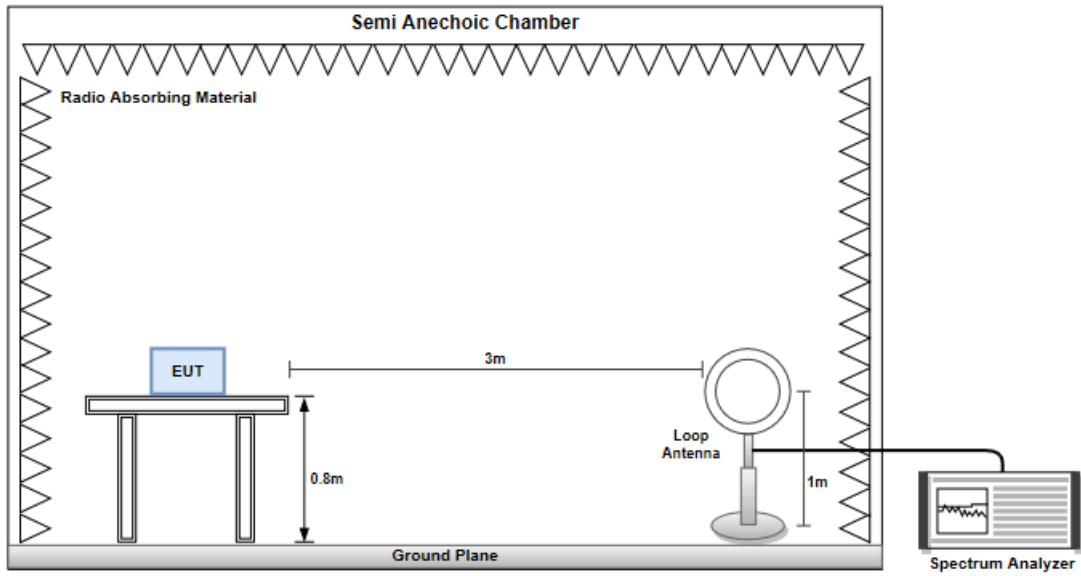
4. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at a height of 0.8 m test table above the ground plane.
5. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
6. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

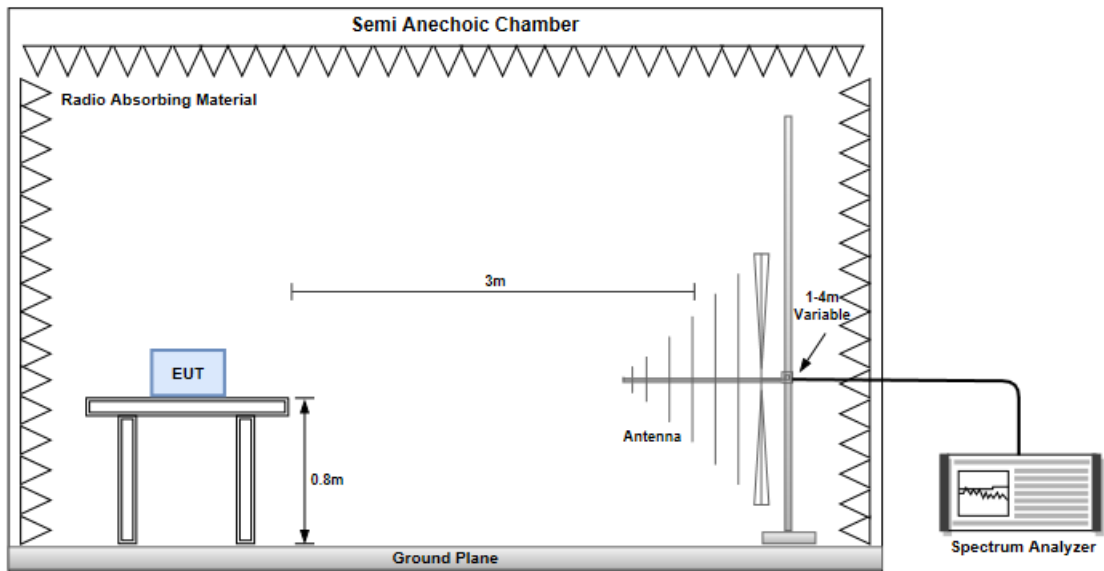
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.

3.4.3 Test Setup

Radiated Emissions below 30MHz



Radiated Emissions below 1 GHz



3.4.4 Transmitter Radiated Unwanted Emissions (Below 30MHz)

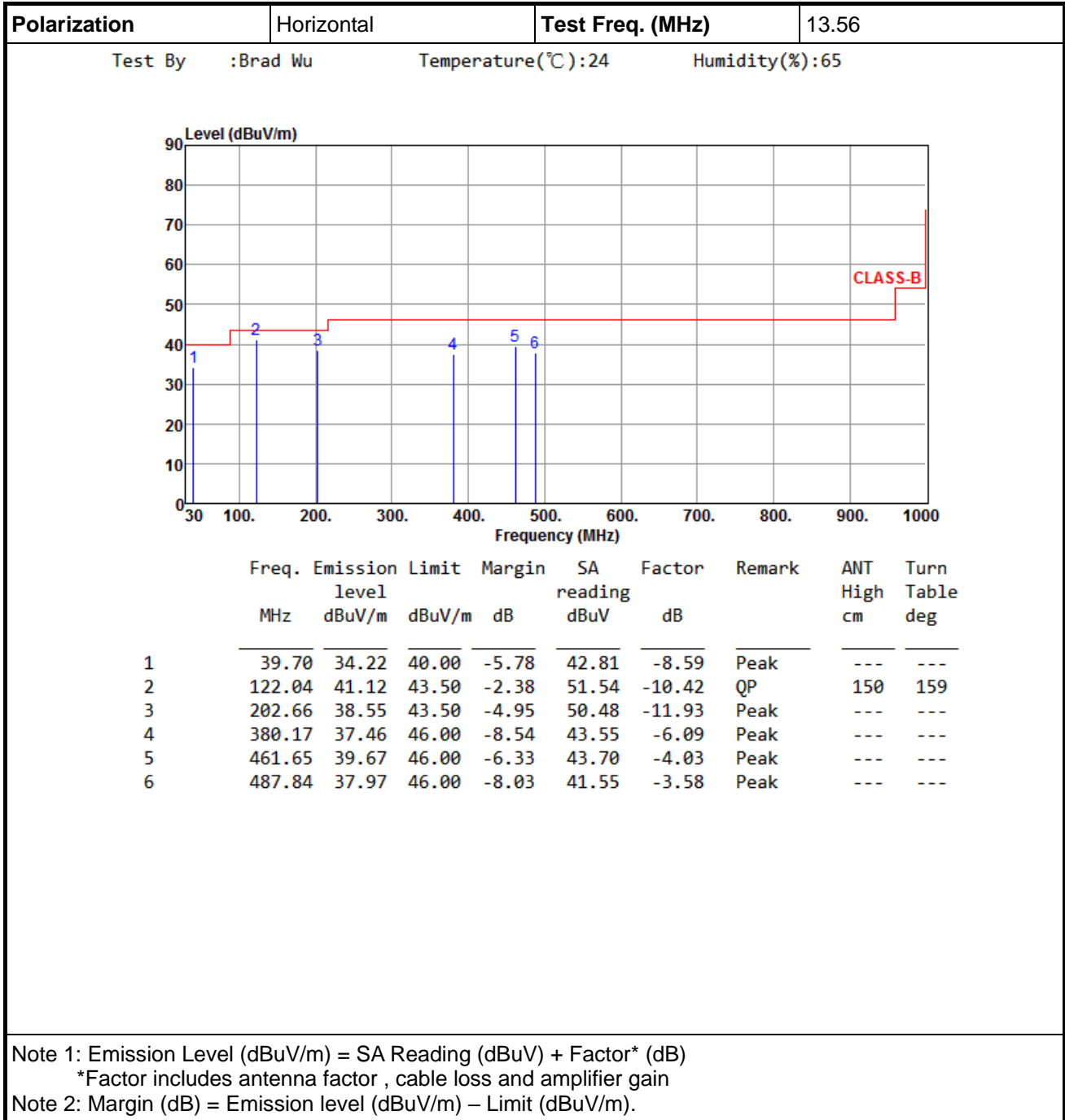
Ambient Condition	24°C / 65%	Tested By	Roger Lu
--------------------------	------------	------------------	----------

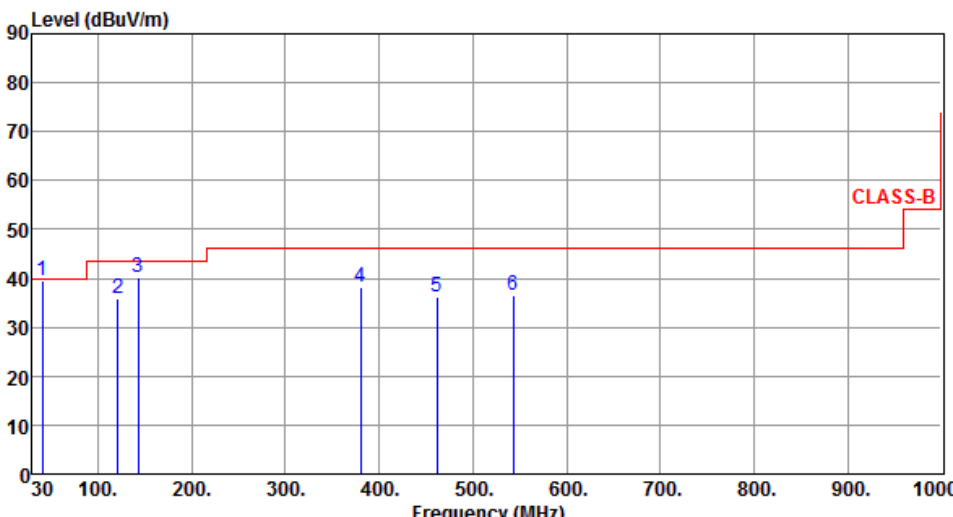
Field Strength of Fundamental Emissions Result							
Polarization	Emission Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	SA Reading (dBuV)	Factor(dB)	Remark
Open	13.41	56.36	62	-5.64	32.09	24.27	QP
Open	13.553	71.31	71.87	-0.56	47	24.31	QP
Open	13.567	71.41	71.86	-0.45	47.09	24.32	QP
Open	13.71	58.66	61.81	-3.15	34.3	24.36	QP
Open	27.12	31.73	49.54	-17.81	12	19.73	QP

Field Strength of Fundamental Emissions Result							
Polarization	Emission Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	SA Reading (dBuV)	Factor(dB)	Remark
Close	13.41	52.96	62	-9.04	28.69	24.27	QP
Close	13.553	67.91	71.87	-3.96	43.6	24.31	QP
Close	13.567	68.11	71.86	-3.75	43.79	24.32	QP
Close	13.71	55.36	61.81	-6.45	31	24.36	QP
Close	27.12	38.23	49.54	-11.31	18.5	19.73	QP

Note: Emission level = SA reading + Factor

3.4.5 Transmitter Radiated Unwanted Emissions (Above 30MHz)



Polarization	Vertical	Test Freq. (MHz)	13.56						
Test By	:Brad Wu	Temperature(°C):24	Humidity(%):65						
									
	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	40.68	39.61	40.00	-0.39	48.29	-8.68	QP	100	291
2	121.18	35.86	43.50	-7.64	46.53	-10.67	Peak	---	---
3	142.52	40.11	43.50	-3.39	49.11	-9.00	Peak	---	---
4	380.17	38.33	46.00	-7.67	44.42	-6.09	Peak	---	---
5	461.65	36.11	46.00	-9.89	40.14	-4.03	Peak	---	---
6	543.13	36.64	46.00	-9.36	39.15	-2.51	Peak	---	---

Note 1: Emission Level (dBUV/m) = SA Reading (dBUV) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m).

3.5 Frequency Stability

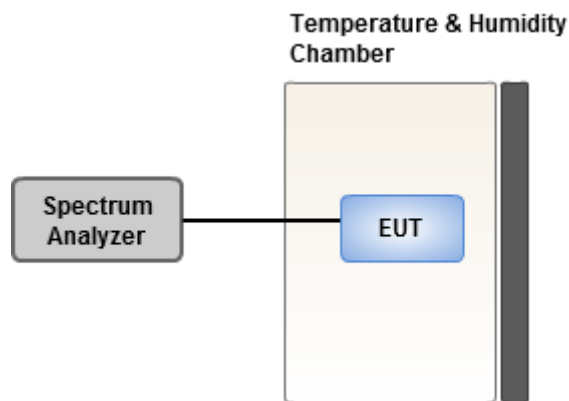
3.5.1 Frequency Stability Limit

Carrier frequency stability shall be maintained to $\pm 0.01\%$ (± 100 ppm).

3.5.2 Test Procedures

Test Method	
<input checked="" type="checkbox"/>	Refer as ANSI C63.10, clause 6.8 for frequency stability tests
<input checked="" type="checkbox"/>	Frequency stability with respect to ambient temperature
<input checked="" type="checkbox"/>	Frequency stability when varying supply voltage
<input type="checkbox"/>	For conducted measurement.
<input checked="" type="checkbox"/>	For radiated measurement. The equipment to be measured and the test antenna shall be oriented to obtain the maximum emitted power level.

3.5.3 Test Setup



3.5.4 Test Result of Frequency Stability

Ambient Condition	24°C / 65%	Tested By	Roger Lu
--------------------------	------------	------------------	----------

Frequency: 13.56 MHz	Frequency Drift (ppm)			
	0 minute	2 minutes	5 minutes	10 minutes
Temperature (°C)				
T20°C Vmax	-3.69	-2.95	-0.74	-1.47
T20°C Vmin	-7.37	-5.90	-5.16	-3.69
T50°C Vnom	-10.32	-8.85	-11.80	-11.06
T40°C Vnom	-8.11	-7.37	-8.11	-8.85
T30°C Vnom	-5.90	-5.16	-7.37	-4.42
T20°C Vnom	-3.69	-4.42	-5.90	-3.69
T10°C Vnom	-4.42	-5.16	-5.16	-5.16
T0°C Vnom	-4.42	-5.90	-5.90	-6.64
T-10°C Vnom	-7.37	-7.37	-9.59	-8.85
T-20°C Vnom	-13.27	-14.01	-14.75	-12.54
Vnom [V]: 120		Vmax [V]: 138		Vmin [V]: 102
Tnom [°C]: 20		Tmax [°C]: 50		Tmin [°C]: -20

4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corporation (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website <http://www.icertifi.com.tw>.

Linkou

Tel: 886-2-2601-1640

No.30-2, Ding Fwu Tsuen, Lin Kou
District, New Taipei City, Taiwan
(R.O.C.)

Kwei Shan

Tel: 886-3-271-8666

No.3-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)
No.2-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)

Kwei Shan Site II

Tel: 886-3-271-8640

No.14-1, Lane 19, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 333, Taiwan (R.O.C.)

If you have any suggestion, please feel free to contact us as below information.

Tel: 886-3-271-8666

Fax: 886-3-318-0345

Email: ICC_Service@icertifi.com.tw

==END==