



# **EMC TEST REPORT**

## **ETSI EN 301 489-1 V2.2.1 (2019-11)**

## **ETSI EN 301 489-3 V2.1.1 (2019-03)**

**Product:** LoRa Module

**Trade Mark:**



**Model Name:** Ra-01SH

**Family Model:** N/A

**Report No.:** S20110203402001

### **Prepared for**

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**TEST RESULT CERTIFICATION****Applicant's name** ..... : Shenzhen Ai-Thinker Technology Co., LtdAddress ..... : 410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road,  
Gushu Community, Xixiang Street, Baoan District, Shenzhen,  
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Gushu Community, Xixiang Street, Baoan District, Shenzhen,  
China**Product description**

Product name : LoRa Module

Trademark ..... :



Model and/or type reference : Ra-01SH

Family Model ..... : N/A

**Standards** ..... : ETSI EN 301 489-1 V2.2.1 (2019-11)  
ETSI EN 301 489-3 V2.1.1 (2019-03)

This device described above has been tested by NTEK, and the test results show that the equipment under test (EUT) is in compliance with the of article 3.1(b) of the Directive 2014/53/EU requirements. And it is applicable only to the tested sample identified in the report.

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**Date of Test** .....

Date (s) of performance of tests ..... 02 Nov. 2020 ~04 Dec. 2020

Date of Issue ..... 04 Dec. 2020

Test Result ..... **Pass**

Testing Engineer :

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Technical Manager :

(Jason Chen)

Authorized Signatory :

(Alex Li)



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## 1. TEST SUMMARY

Test procedures according to the technical standards:

ETSI EN 301 489-1 V2.2.1 (2019-11)

ETSI EN 301 489-3 V2.1.1 (2019-03)

EMC Emission				
Standard	Test Item	Limit	Judgment	Remark
EN 55032:2015	Conducted Emission	Class B	PASS	
	Radiated Emission	Class B	PASS	
EN61000-3-2:2014	Harmonic Current Emission	Class A or D	N/A	
EN 61000-3-3:2013	Voltage Fluctuations & Flicker	-----	N/A	
EMC Immunity				
Section	Test Item	Performance Criteria	Judgment	Remark
EN 61000-4-2:2009	Electrostatic Discharge	B	PASS	
EN 61000-4-3:2006+A1:2008+A2:2010	RF electromagnetic field	A	PASS	
EN 61000-4-4:2012	Fast transients	B	N/A	
EN 61000-4-5:2006	Surges	B	N/A	
EN 61000-4-6:2009	Injected Current	A	N/A	
EN 61000-4-11:2004	Volt. Interruptions Volt. Dips	B / C / C NOTE (2)	N/A	

### NOTE:

(1) "N/A" denotes test is not applicable in this Test Report

(2) Voltage dip: 100% reduction – Performance Criteria **B**

Voltage dip: 30% reduction – Performance Criteria **C**

Voltage Interruption: 100% Interruption – Performance Criteria **C**

(3) For client's request and manual description, the test will not be executed.

## 1.1 TEST FACILITY

Shenzhen NTEK Testing Technology Co., Ltd

Add. : 1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao'an District, Shenzhen P.R. China.

FCC FRN Registration Number: 463705; IC Registration Number:9270A-1

CNAS Registration No.:L5516

## 1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement  $y \pm U$ , where expanded uncertainty  $U$  is based on a standard uncertainty multiplied by a coverage factor of  $k=2$ , providing a level of confidence of approximately **95 %**.

### A. Conducted Measurement :

Test Site	Method	Measurement Frequency Range	U,(dB)	NOTE
NTEKC01	ANSI	150 KHz ~ 30MHz	3.2	



### B. Radiated Measurement :

Test Site	Method	Measurement Frequency Range	U,(dB)	NOTE
NTEKA01	ANSI	30MHz ~ 1000MHz	4.7	
		1GHz ~6GHz	5.0	



## 2. GENERAL INFORMATION

### 2.1 GENERAL DESCRIPTION OF EUT

Equipment	LoRa Module
Trade Mark	 , 
Model Name	Ra-01SH
Family Model	N/A
Model Difference	N/A
Frequency Bands:	Band AA: 863MHz-870MHz
Receiver category	2
Power Rating	DC 3.3V
Battery	N/A
Antenna Designation:	Spring Antenna
Connecting I/O Port(s)	Please refer to the User's Manual
Hardware Version	N/A
Software Version	N/A

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

## 2.1 DESCRIPTION OF TEST MODES

To investigate the maximum EMI emission characteristics generated from EUT, the test system was pre-scanning tested based on the consideration of following EUT operation mode or test configuration mode which possibly have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

Pretest Mode	Description
Mode 1	Working

For Radiated Test	
Final Test Mode	Description
Mode 1	Working

For Conducted Test	
Final Test Mode	Description
Mode 1	Working

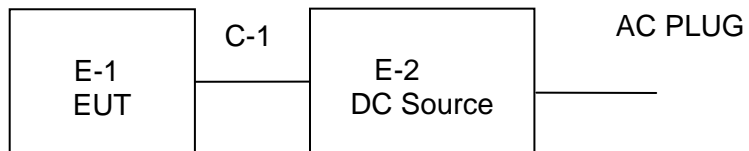
For EMS Test	
Final Test Mode	Description
Mode 1	Working

NOTE: The test modes were carried out for all operation modes. The final test mode of the EUT was the worst test mode for EMI, and its test data was showed.

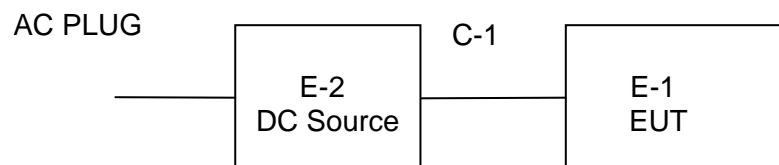


## 2.2 DESCRIPTION OF TEST SETUP

CE





RE



## 2.3 DESCRIPTION TEST PERIPHERAL AND EUT PERIPHERAL

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
E-1	LoRa Module	 , 	Ra-01S	N/A	EUT
E-2	DC source	N/A	N/A	N/A	Peripherals

Item	Type	Shielded Type	Ferrite Core	Length	Note
C-1	Power Cable	NO	Yes	1.2m	

## Note:

- (1) The support equipment was authorized by Declaration of Confirmation.
- (2) For detachable type I/O cable should be specified the length in cm in 『Length』 column.
- (3) “YES” is means “shielded” “with core”; “NO” is means “unshielded” “without core”.

## 2.4 MEASUREMENT INSTRUMENTS LIST

## 2.4.1 CONDUCTED TEST SITE 2.4.1 CONDUCTED EMISSION

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	LISN	R&S	ENV216	101313	May. 12, 2020	May. 11, 2021	1 year
2	LISN	SCHWARZBECK	NNLK 8129	8129245	May. 12, 2020	May. 11, 2021	1 year
3	Pulse Limiter	SCHWARZBECK	VTSD 9561F	9716	May. 12, 2020	May. 11, 2021	1 year
4	50Ω Switch	ANRITSU CORP	MP59B	6200983704	May. 12, 2020	May. 11, 2023	3 year
5	Test Cable	N/A	C01	N/A	Apr. 20, 2020	Apr. 19, 2023	3 year
6	Test Cable	N/A	C02	N/A	Apr. 20, 2020	Apr. 19, 2023	3 year
7	Test Cable	N/A	C03	N/A	Apr. 20, 2020	Apr. 19, 2023	3 year
8	EMI Test Receiver	R&S	ESCI	101160	May. 12, 2020	May. 11, 2021	1 year
9	Universal radio communication tester	R&S	CMU200	1100.008.02	May. 12, 2020	May. 11, 2021	1 year
10	Wideband Radio Communication Tester Specifications	R&S	CMW500	148500	May. 12, 2020	May. 11, 2021	1 year

## 2.4.2 RADIATED TEST SITE

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Bilog Antenna	TESEQ	CBL6111D	31216	May. 12, 2020	May. 11, 2021	1 year
2	Test Cable	N/A	R-01	N/A	Apr. 20, 2020	Apr. 19, 2023	3 year
3	Test Cable	N/A	R-02	N/A	Apr. 20, 2020	Apr. 19, 2023	3 year
4	EMI Test Receiver	R&S	ESCI-7	101318	May. 12, 2020	May. 11, 2021	1 year
5	Antenna Mast	EM	SC100_1	N/A	N/A	N/A	N/A
6	Turn Table	EM	SC100	060531	N/A	N/A	N/A
7	50Ω Switch	Anritsu Corp	MP59B	6200983705	May. 12, 2020	May. 11, 2021	1 year
8	Spectrum Analyzer	Aglient	E4407B	MY45108040	May. 12, 2020	May. 11, 2021	1 year
9	Horn Antenna	EM	EM-AH-10180	2011071402	May. 12, 2020	May. 11, 2021	1 year
10	Amplifier	EMC	EMC051835SE	980246	May. 12, 2020	May. 11, 2021	1 year
11	Universal radio communication tester	R&S	CMU200	1100.008.02	May. 12, 2020	May. 11, 2021	1 year



12	Wideband Radio Communication Tester Specifications	R&S	CMW500	148500	May. 12, 2020	May. 11, 2021	1 year
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#### 2.4.3 HARMONICS AND FILCK

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Harmonic & Flicker	EM TEST	DPA500	0303-04	May. 12, 2020	May. 11, 2021	1 year
2	AC Power Source	EM TEST	ACS500	0203-01	May. 12, 2020	May. 11, 2021	1 year
3	Unversal radio communication tester	R&S	CMU200	1100.008.02	May. 12, 2020	May. 11, 2021	1 year
4	Wideband Radio Communication Tester Specifications	R&S	CMW500	148500	May. 12, 2020	May. 11, 2021	1 year

#### 2.4.4 ESD

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Electrostatic Discharge Generator	Lioncel	ESD-203B	ESD203B0150402	May. 12, 2020	May. 11, 2021	1 year
2	Unversal radio communication tester	R&S	CMU200	1100.008.02	May. 12, 2020	May. 11, 2021	1 year
3	Wideband Radio Communication Tester Specifications	R&S	CMW500	148500	May. 12, 2020	May. 11, 2021	1 year

## 2.4.5 RS

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	PSG Analog Signal Generator	Agilent	E8257D	MY51110112	May. 12, 2020	May. 11, 2021	1 year
2	Bilog Antenna	ETS	3142E(Frequency range 30MHz to 6 GHz)	00214344	May. 12, 2020	May. 11, 2021	1 year
3	Power Amplifier	rflight	NTWPA-00810200	17063153	May. 12, 2020	May. 11, 2021	1 year
4	Broadband Amplifier	AR	60S1G6	0350414	May. 12, 2020	May. 11, 2021	1 year
5	Power Amplifier	AR	25S1G4A	308598	May. 12, 2020	May. 11, 2021	1 year
6	Universal radio communication tester	R&S	CMU200	1100.008.02	May. 12, 2020	May. 11, 2021	1 year
7	Audio Power Amplifier	Brüel & Kjær	4602B	2185667	May. 12, 2020	May. 11, 2021	1 year
8	Mouth Simulator	Brüel & Kjær	2669	2143265	May. 12, 2020	May. 11, 2021	1 year
9	Sound Calibrator	Brüel & Kjær	4185	2194825	May. 12, 2020	May. 11, 2021	1 year
10	1/2" Pressure-field Microphone	Brüel & Kjær	735	2641678	May. 12, 2020	May. 11, 2021	1 year
11	Wideband Radio Communication Testers	R&S	CMW500	148500	May. 12, 2020	May. 11, 2021	1 year
12	Telephone Test Head	Brüel & Kjær	4185	2631728	May. 12, 2020	May. 11, 2021	1 year
13	Audio Analyzer	R&S	UPV	100419	May. 12, 2020	May. 11, 2021	1 year
14	Ear Simulator for Telephonometry	Brüel & Kjær	4185	2553612	May. 12, 2020	May. 11, 2021	1 year
15	Power Meter	Agilent	E4419B	MY45102538	May. 12, 2020	May. 11, 2021	1 year
16	Power Sensor	Agilent	E9301A	MY41495644	May. 12, 2020	May. 11, 2021	1 year
17	Power Sensor	Agilent	E9301A	US39212148	May. 12, 2020	May. 11, 2021	1 year

## 2.4.6 SURGE, EFT/BURST, VOLTAGE INTERRUPTION/DIPS

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Surge Generator	EVERFINE	EMS61000-5A-V1	1101002	May. 12, 2020	May. 11, 2021	1 year
2	DIPS Generator	EVERFINE	EMS61000-11K	1011002	May. 12, 2020	May. 11, 2021	1 year
3	EFT/B Generator	EVERFINE	EMS61000-4A-V2	1012005	May. 12, 2020	May. 11, 2021	1 year
4	Universal radio communication tester	R&S	CMU200	1100.008.02	May. 12, 2020	May. 11, 2021	1 year
5	Wideband Radio Communication Tester Specifications	R&S	CMW500	148500	May. 12, 2020	May. 11, 2021	1 year



## 2.4.7 INJECTION CURRENT

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Signal Generator	R&S	SML03	100954	May. 12, 2020	May. 11, 2021	1 year
2	Power Amplifier	TESEQ	CBA 230M-080	T44376	May. 12, 2020	May. 11, 2021	1 year
3	Coupling and Decoupling Network	TESEQ	CDN M016	38722	May. 12, 2020	May. 11, 2021	1 year
4	EM Clamp	FCC	F-203I-23MM	504	May. 12, 2020	May. 11, 2021	1 year
5	Attenuator	TESEQ	ATN 6075	38411	N/A	N/A	N/A
6	RF Cable	TESEQ	RF Cable	N/A	N/A	N/A	N/A
7	Universal radio communication tester	R&S	CMU200	1100.008.02	May. 12, 2020	May. 11, 2021	1 year
8	Audio Power Amplifier	Brüel & Kjær	4602B	2185667	May. 12, 2020	May. 11, 2021	1 year
9	Mouth Simulator	Brüel & Kjær	2669	2143265	May. 12, 2020	May. 11, 2021	1 year
10	Sound Calibrator	Brüel & Kjær	4185	2194825	May. 12, 2020	May. 11, 2021	1 year
11	1/2" Pressure-field Microphone	Brüel & Kjær	735	2641678	May. 12, 2020	May. 11, 2021	1 year
12	Audio Analyzer	R&S	UPV	100419	May. 12, 2020	May. 11, 2021	1 year
13	Ear Simulator for Telephonometry	Brüel & Kjær	4185	2553612	May. 12, 2020	May. 11, 2021	1 year
14	Telephone Test Head	Brüel & Kjær	4185	2631728	May. 12, 2020	May. 11, 2021	1 year
15	Wideband Radio Communication Tester Specifications	R&S	CMW500	148500	May. 12, 2020	May. 11, 2021	1 year

### 3. EMC EMISSION TEST

#### 3.1 CONDUCTED EMISSION MEASUREMENT

##### 3.1.1 POWER LINE CONDUCTED EMISSION (Frequency Range 150KHz-30MHz)

FREQUENCY (MHz)	Class A (dBuV)		Class B (dBuV)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 -0.5	79.00	66.00	66 - 56 *	56 - 46 *
0.50 -5.0	73.00	60.00	56.00	46.00
5.0 -30.0	73.00	60.00	60.00	50.00

Note:

- (1) The tighter limit applies at the band edges.
- (2) The limit of " \* " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

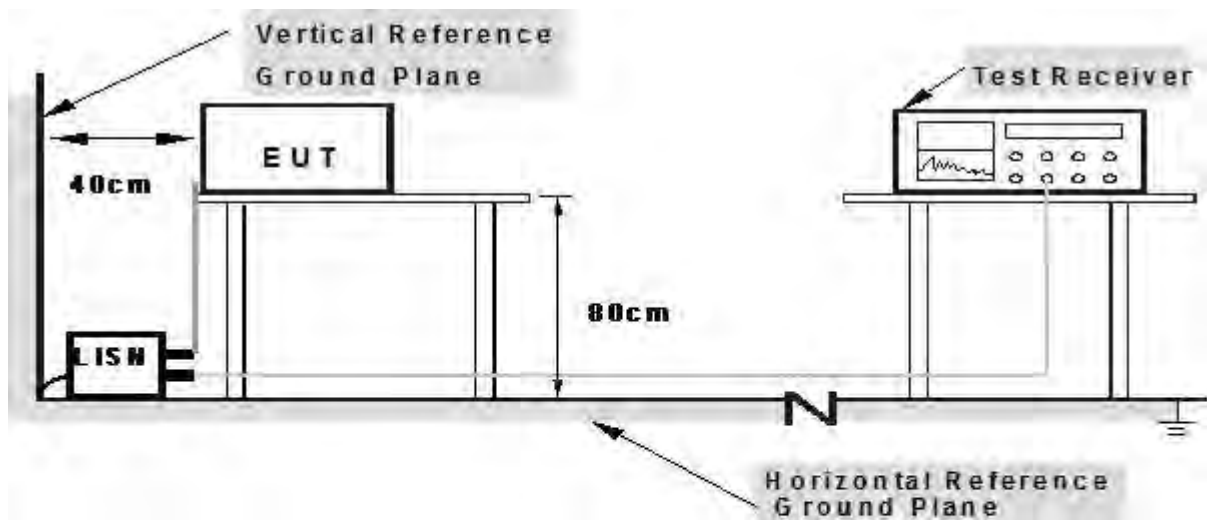
The following table is the setting of the receiver

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

### 3.1.2 TEST PROCEDURE

- The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
- I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
- LISN at least 80 cm from nearest part of EUT chassis.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

### 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 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.



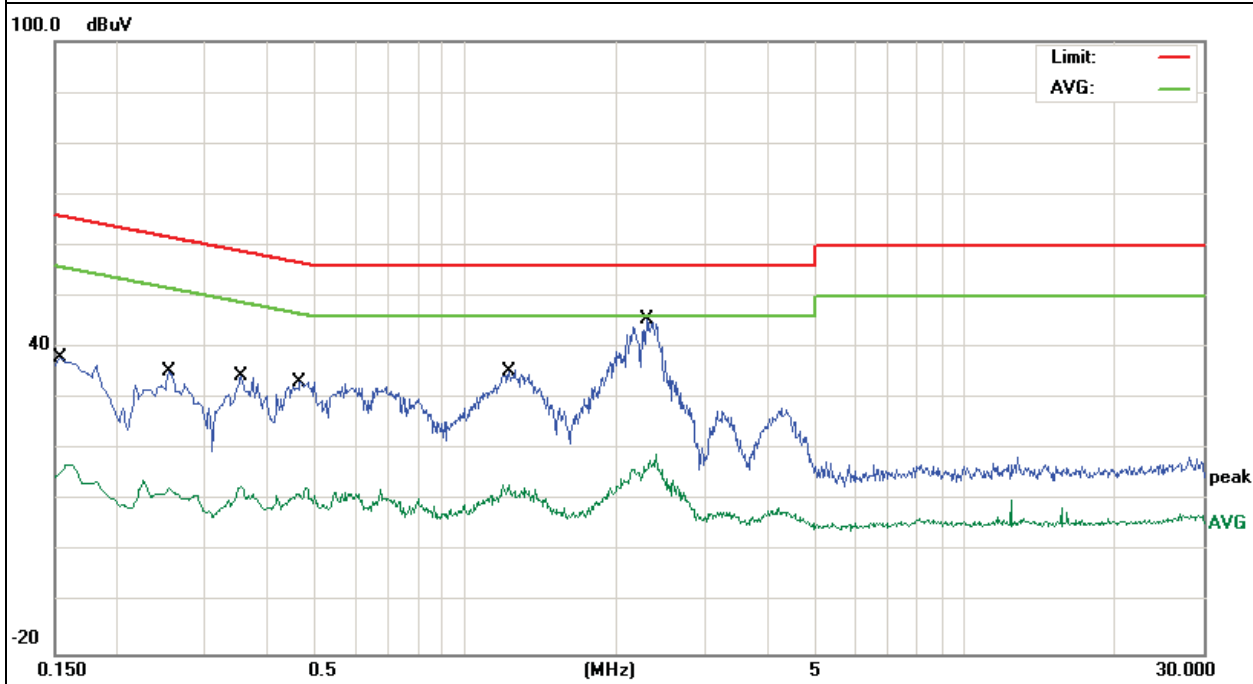
## 3.1.5 TEST RESULTS

EUT:	LoRa Module	Model Name :	Ra-01SH
Temperature:	22 °C	Relative Humidity:	52%
Pressure :	1010hPa	Phase :	L
Test Voltage :	DC 3.3V	Test Mode :	Mode 1

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Remark
(MHz)	(dBμV)	(dB)	(dBμV)	(dBμV)	(dB)	
0.1539	28.5	9.56	38.06	65.78	-27.72	QP
0.1539	7.58	9.56	17.14	55.78	-38.64	AVG
0.254	25.75	9.54	35.29	61.62	-26.33	QP
0.254	3.00	9.54	12.54	51.62	-39.08	AVG
0.354	24.94	9.55	34.49	58.87	-24.38	QP
0.354	3.19	9.55	12.74	48.87	-36.13	AVG
0.466	23.78	9.55	33.33	56.58	-23.25	QP
0.466	2.94	9.55	12.49	46.58	-34.09	AVG
1.218	26.23	9.56	35.79	56	-20.21	QP
1.218	3.66	9.56	13.22	46	-32.78	AVG
2.302	35.97	9.58	45.55	56	-10.45	QP
2.302	9.48	9.58	19.06	46	-26.94	AVG

Remark:

1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.

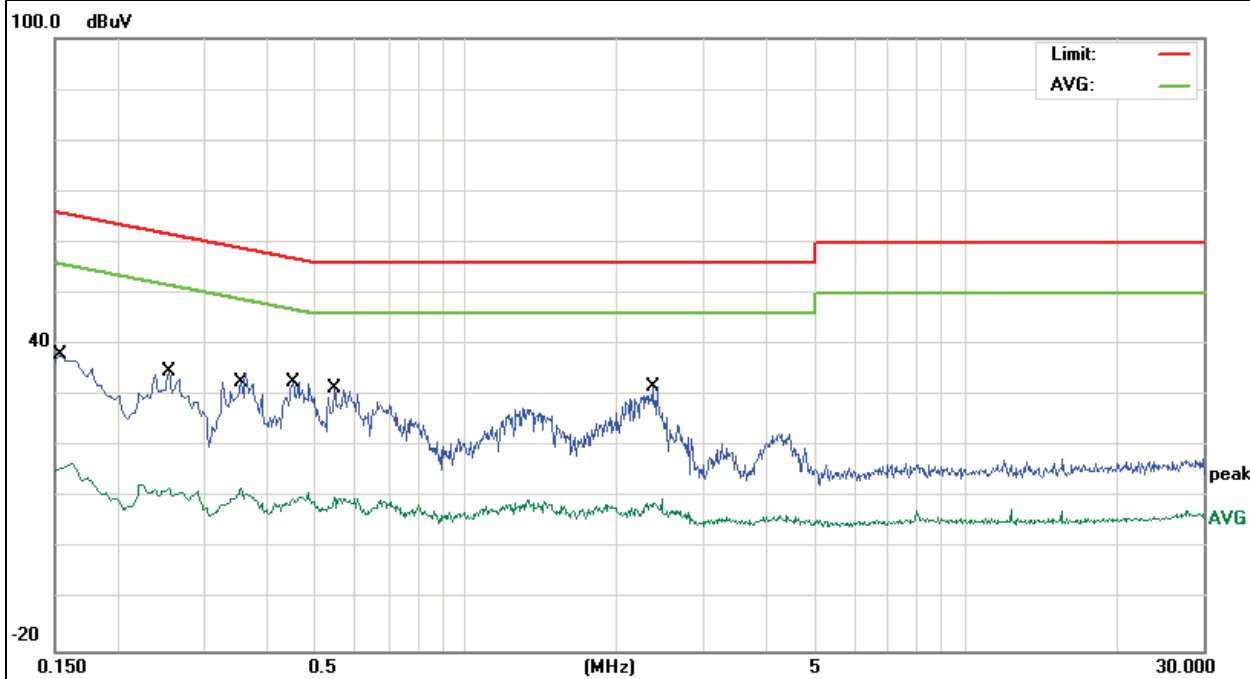


EUT:	LoRa Module	Model Name :	Ra-01SH
Temperature:	22 °C	Relative Humidity:	52%
Pressure :	1010hPa	Phase :	N
Test Voltage :	DC 3.3V	Test Mode :	Mode 1

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Remark
(MHz)	(dBμV)	(dB)	(dBμV)	(dBμV)	(dB)	
0.1539	28.61	9.55	38.16	65.78	-27.62	QP
0.1539	7.19	9.55	16.74	55.78	-39.04	AVG
0.254	25.33	9.53	34.86	61.62	-26.76	QP
0.254	2.42	9.53	11.95	51.62	-39.67	AVG
0.354	25.04	9.54	34.58	58.87	-24.29	QP
0.354	2.37	9.54	11.91	48.87	-36.96	AVG
0.45	23.05	9.54	32.59	56.87	-24.28	QP
0.45	0.6	9.54	10.14	46.87	-36.73	AVG
0.546	22.01	9.54	31.55	56	-24.45	QP
0.546	0.47	9.54	10.01	46	-35.99	AVG
2.3699	22.16	9.57	31.73	56	-24.27	QP
2.3699	-0.64	9.57	8.93	46	-37.07	AVG

Remark:

1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.



Note: The test modes were carried out for all operation modes. The worst test mode for test data was showed in the report.

### 3.2 RADIATED EMISSION MEASUREMENT

#### 3.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT (Below 1000MHz)

FREQUENCY (MHz)	Class A		Class B	
	At 10m	At 3m	At 10m	At 3m
	dBuV/m	dBuV/m	dBuV/m	dBuV/m
30 – 230	40	50	30	40
230 – 1000	47	57	37	47

#### 3.2.2 LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

FREQUENCY (MHz)	Class A (at 3m) dBuV/m		Class B (at 3m) dBuV/m	
	Peak	Avg	Peak	Avg
1000-3000	76	56	70	50
3000-6000	80	60	74	54

Notes:

- (1) The limit for radiated test was performed according to as following:  
EN 55032.
- (2) The tighter limit applies at the band edges.
- (3) Emission level (dBuV/m)=20log Emission level (uV/m).

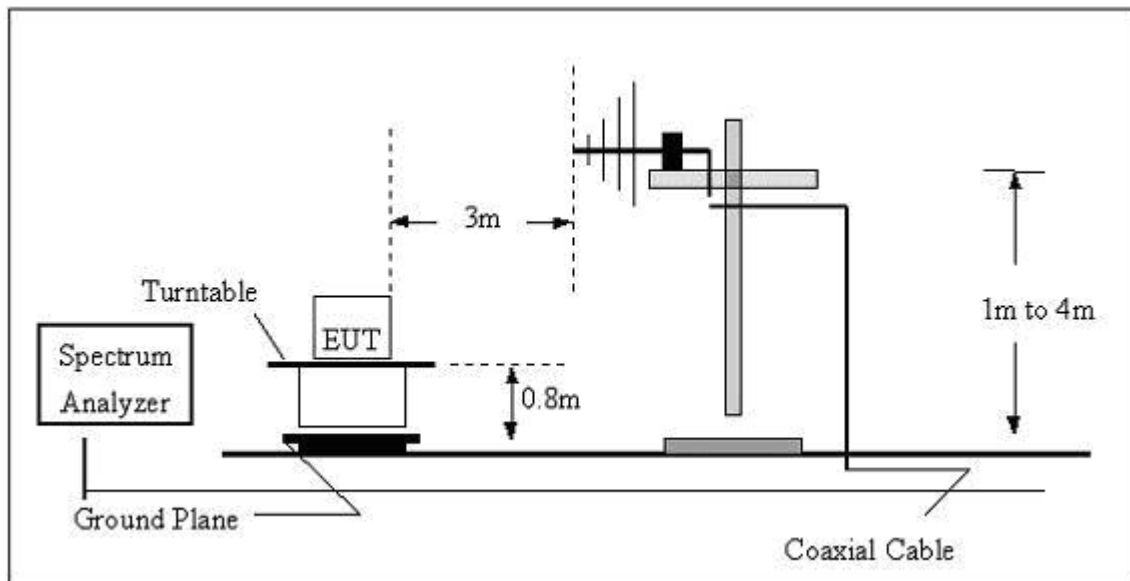
#### 3.2.3 TEST PROCEDURE

- The measuring distance of at 3 m shall be used for measurements at frequency up to 1GHz. For frequencies above 1GHz, any suitable measuring distance may be used.
- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 10 meter open area test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- The height of the equipment or of the substitution antenna shall be 0.8 m; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured, above 1G Average detector mode will be instead.
- If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP(AV) Limits and then no additional QP Mode measurement performed.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

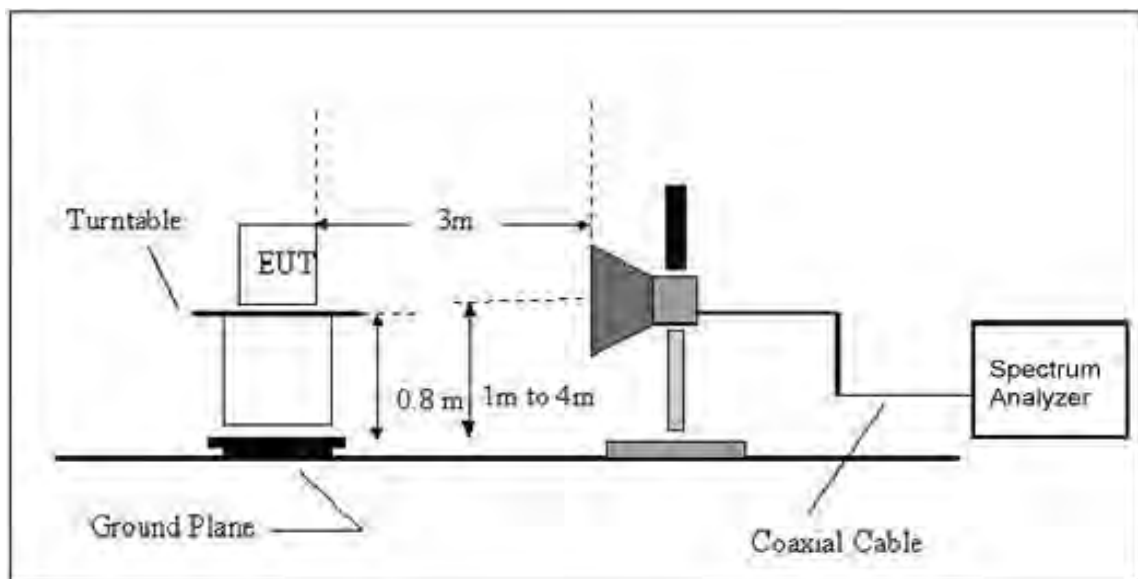


### 3.2.4 TEST SETUP

#### (A) Radiated Emission Test Set-Up Frequency Below 1 GHz



#### (B) Radiated Emission Test Set-Up Frequency Above 1GHz



### 3.2.5 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

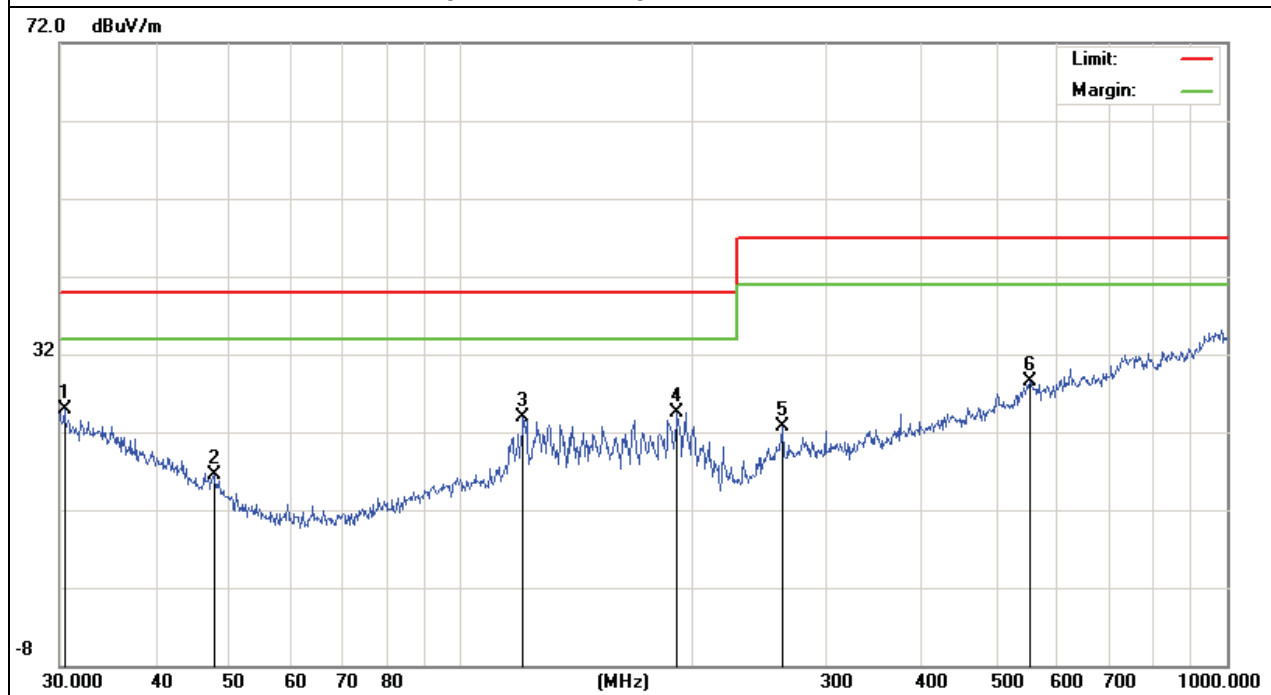
## 3.2.6 TEST RESULTS

EUT:	LoRa Module	Model Name :	Ra-01SH
Temperature:	23 °C	Relative Humidity:	54%
Pressure:	1010 hPa	Polarization :	Horizontal
Test Voltage:	DC 3.3V	Test Mode:	Mode 1

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Remark
30.4237	6.24	18.62	24.86	40	-15.14	QP
47.6584	5.62	10.83	16.45	40	-23.55	QP
120.6991	11.54	12.39	23.93	40	-16.07	QP
191.745	15.55	9.05	24.6	40	-15.4	QP
262.8955	8	14.63	22.63	47	-24.37	QP
552.8832	5.99	22.54	28.53	47	-18.47	QP

Remark:

1. Emission Level= Meter Reading+ Factor, Margin= Emission Level- Limit.

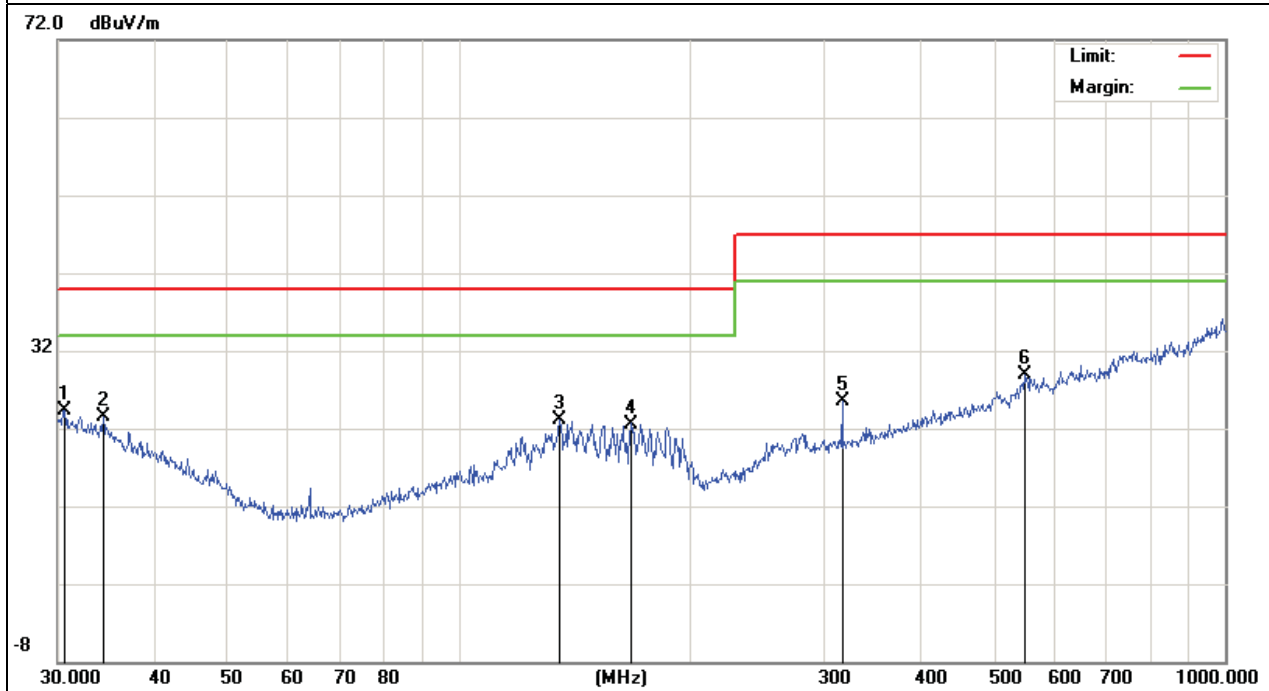


EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	23 °C	Relative Humidity:	54%
Pressure:	1010 hPa	Polarization :	Vertical
Test Voltage:	DC 3.3V	Test Mode:	Mode 1

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Remark
30.6378	5.75	18.5	24.25	40	-15.75	QP
34.3963	6.34	17.07	23.41	40	-16.59	QP
135.5062	10.55	12.49	23.04	40	-16.96	QP
167.8242	11.88	10.72	22.6	40	-17.4	QP
316.589	10.37	15.21	25.58	47	-21.42	QP
547.0977	6.65	22.33	28.98	47	-18.02	QP

Remark:

1. Emission Level= Meter Reading+ Factor, Margin= Emission Level- Limit.



## 3.2.7 TEST RESULTS (1000~6000MHz)

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	55%
Test Power:	DC 3.3V	Test Mode:	Mode 1

Polar (H/V)	Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Remark
	(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
V	1262.5	41.19	2.13	43.32	70	-26.68	peak
V	1525	41.13	2.53	43.66	70	-26.34	peak
V	2150	39.17	5.9	45.07	70	-24.93	peak
V	2987.5	39.04	6.39	45.43	70	-24.57	peak
V	4287.5	38.14	11.81	49.95	74	-24.05	peak
V	5587.5	35.93	13.49	49.42	74	-24.58	peak
H	1175	41.56	1.74	43.3	70	-26.7	peak
H	1575	40.81	2.81	43.62	70	-26.38	peak
H	2087.5	39.34	6.16	45.5	70	-24.5	peak
H	2775	40.11	5.91	46.02	70	-23.98	peak
H	4412.5	37.9	12.34	50.24	74	-23.76	peak
H	5562.5	36.12	13.44	49.56	74	-24.44	peak

**Remark:**

Emission Level= Meter Reading+ Factor, Margin= Emission Level- Limit

Note: The test modes were carried out for all operation modes. The worst test mode for test data was showed in the report.



### 3.3 HARMONICS CURRENT

#### 3.3.1 LIMITS OF HARMONICS CURRENT

Harmonic Current Test Limit (Class C)

Harmonic order (n)	Maximum permissible harmonic current Expressed as a percentage of the input Current at the fundamental frequency (%)
2	2
3	$30\lambda$
5	10
7	7
9	5
$15 \leq n \leq 39$ (odd harmonics only)	3
<b>Remark:</b> $\lambda$ is the circuit power factor	

Note: Reference standard of the table above: EN61000-3-2.

### 3.3.1.1 TEST PROCEDURE

a. The EUT was placed on the top of a wooden table 0.8 meters above the ground and operated to produce the maximum harmonic components under normal operating conditions.

b. The classification of EUT is according to section 5 of EN 61000-3-2. The EUT is classified as follows:

Class A: Balanced three-phase equipment, Household appliances excluding equipment as Class D, Tools excluding portable tools, Dimmers for incandescent lamps, audio equipment, equipment not specified in one of the three other classes.

Class B: Portable tools. Portable tools.; Arc welding equipment which is not professional equipment.

Class C: Lighting equipment.

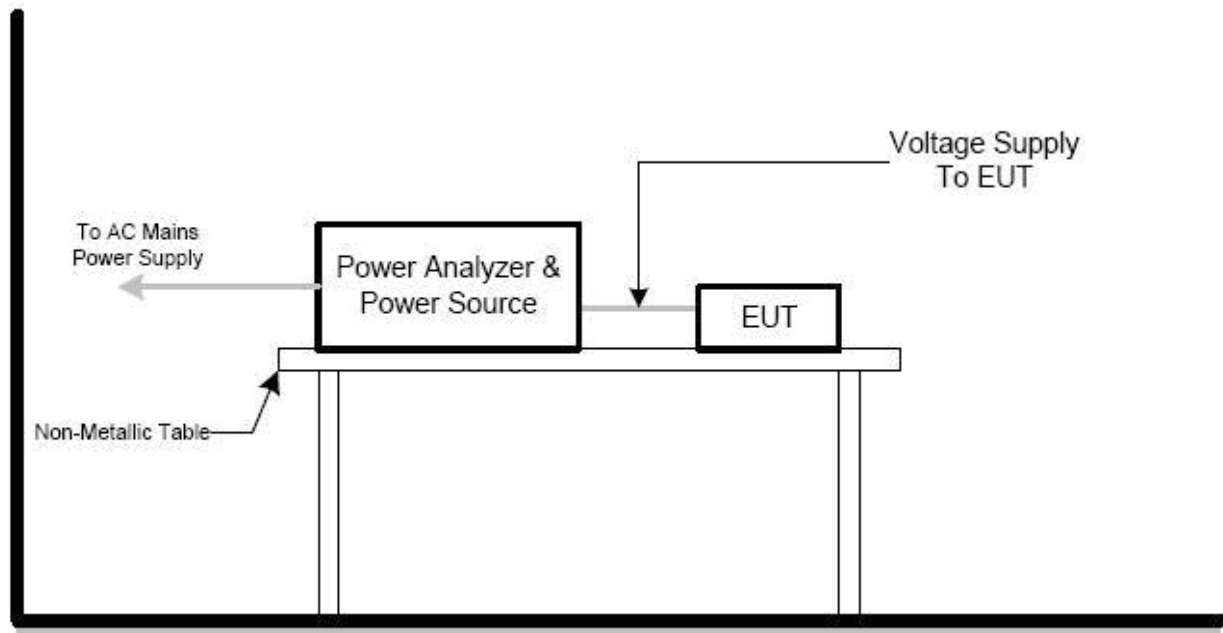
Class D: Equipment having a specified power less than or equal to 600W of the following types: Personal computers and personal computer monitors and television receivers.

c. The correspondent test program of test instrument to measure the current harmonics emanated from EUT is chosen. The measure time shall be not less than the time necessary for the EUT to be exercised.

### 3.3.1.2 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

### 3.3.1.3 TEST SETUP



## 3.3.2 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	45%
Pressure:	1010 hPa	Test Mode:	N/A
Test Power:	N/A		

Note: The active input power of the EUT is less than 75 W. No limits apply for equipment with an active input power up to and including 75W.

### 3.4 VOLTAGE FLUCTUATION AND FLICKERS

#### 3.4.1 LIMITS OF VOLTAGE FLUCTUATION AND FLICKERS

Test items	Limits(EN61000-3-3)	Descriptions
$P_{st}$	$\leq 1.0$ , $T_p=10\text{min}$	short-term flicker indicator
$P_{lt}$	$\leq 0.65$ , $T_p=2\text{h}$	long-term flicker indicator
$d_c$	$\leq 3.3\%$	relative steady-state voltage change
$d_{max}$	$\leq 4\%$ (or $6\%$ <sup>Note(1)</sup> , $7\%$ <sup>Note(2)</sup> )	maximum relative voltage change:
$d_{(t)}$	$\leq 3.3\%$ , more than 500ms	relative voltage change characteristic

Note:

1. 6 % for equipment which is:
  - a. switched manually, or
  - b. switched automatically more frequently than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds), or manual restart, after a power supply interruption.
2. 7 % for equipment which is:
  - a. attended whilst in use (for example: hair dryers, vacuum cleaners, kitchen equipment such as mixers, garden equipment such as lawn mowers, portable tools such as electric drills), or
  - b. switched on automatically, or is intended to be switched on manually, no more than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds) or manual restart, after a power supply interruption.

##### 3.4.1.1 TEST PROCEDURE

###### a. Harmonic Current Test:

Test was performed according to the procedures specified in Sub-clause 6.2 of IEC/EN 61000-3-2 depend on which standard adopted for compliance measurement.

###### b. Fluctuation and Flickers Test:

Tests was performed according to the Test Conditions/Assessment of Voltage Fluctuations specified in Clause 6.0/4.0 of IEC/EN 61000-3-3 depend on which standard adopted for compliance measurement.

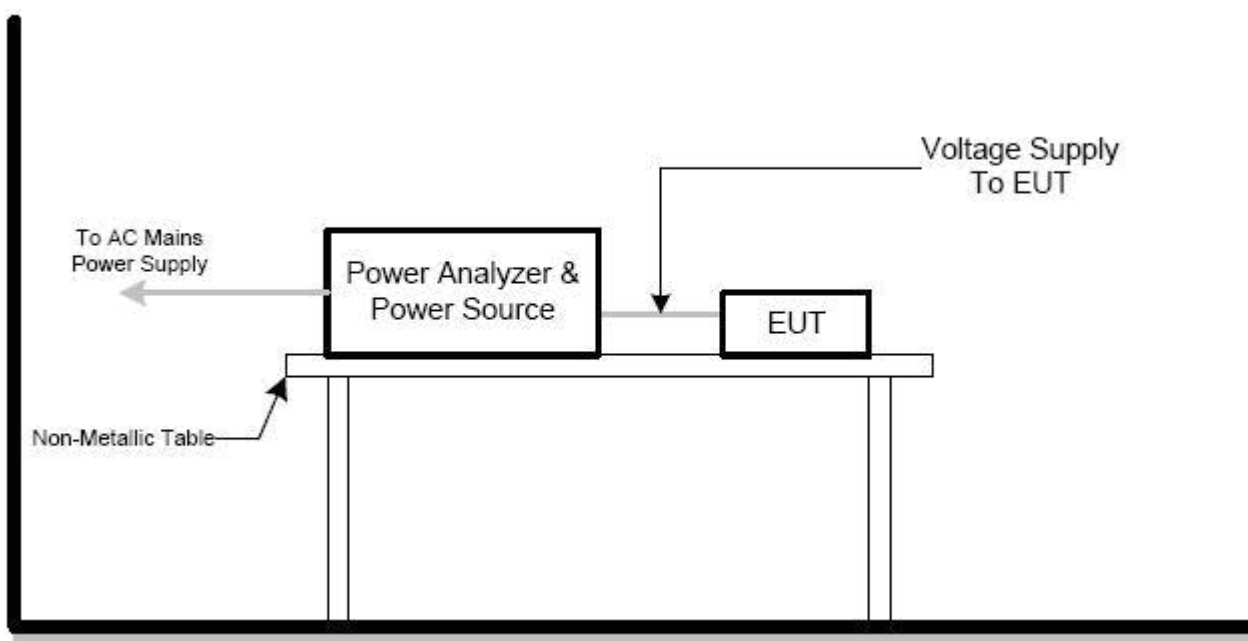
c. All types of harmonic current and/or voltage fluctuation in this report are assessed by direct measurement using flicker-meter.

##### 3.4.1.2 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

##### 3.4.1.3 TEST SETUP





## 3.4.2 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	45%
Pressure :	1010 hPa	Test Power :	DC 3.3V
Test Mode	Mode 1		

	EUT values	Limit	Result
Pst	0.033	1.00	PASS
Plt	0.033	0.65	PASS
dc [%]	0.017	3.30	PASS
dmax [%]	0.102	4.00	PASS
dt [%]	0.000	0.50	PASS

#### 4. EMC IMMUNITY TEST

##### 4.1 STANDARD COMPLIANCE/SERVIRITY LEVEL/CRITERIA

Tests Standard No.	TEST SPECIFICATION	Test Mode Test Ports	Perform. Criteria
1. ESD IEC/EN 61000-4-2	8KV air discharge 4KV contact discharge	Direct Mode	B
	4KV HCP discharge 4KV VCP discharge	Indirect Mode	B
2. RS IEC/EN 61000-4-3	80 MHz to 6000 MHz, 1000Hz, 80%, AM modulated	Enclosure	A
3. EFT/Burst IEC/EN 61000-4-4	5/50ns Tr/Th 5KHz Repetition Freq.	Power Supply Port	B
	5/50ns Tr/Th 5KHz Repetition Freq.	CTL/Signal Data Line Port	B
4. Surges IEC/EN 61000-4-5	1.2/50(8/20) Tr/Th us	L-N	B
	1.2/50(8/20) Tr/Th us	L-PE N-PE	B
5 Injected Current IEC/EN 61000-4-6	0.15 MHz to 80 MHz, 1000Hz 80% , AM Modulated 150Ω source impedance	CTL/Signal Port	A
	0.15 MHz to 80 MHz, 1000Hz 80% , AM Modulated 150Ω source impedance	AC Power Port	A
	0.15 MHz to 80 MHz, 1000Hz 80% , AM Modulated 150Ω source impedance	DC Power Port	A
6. Volt. Interruptions Volt. Dips IEC/EN 61000-4-11	Voltage dip 100%	AC Power Port	B
	Voltage dip 30%		C
	Interruption 100%		C

#### 4.2 GENERAL PERFORMANCE CRITERIA

According to **EN 301 489-3** standard, the general performance criteria as following:

SRD equipment		
Criteria	During the test	After the test
<b>A</b>	Operate as intended No loss of function No unintentional responses	Operate as intended No loss of function No degradation of performance No loss of stored data or user programmable functions
<b>B</b>	May show loss of function No unintentional responses	Operate as intended Lost function(s) shall be self-recoverable No degradation of performance No loss of stored data or user programmable functions

#### 4.3 GENERAL PERFORMANCE CRITERIA TEST SETUP

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.



#### 4.4 ESD TESTING

##### 4.4.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-2
Discharge Impedance:	330 ohm / 150 pF
Required Performance	B
Discharge Voltage:	Air Discharge:2kV/4kV/8kV (Direct) Contact Discharge:2kV/4kV (Direct/Indirect)
Polarity:	Positive & Negative
Number of Discharge:	Air Discharge: min. 20 times at each test point Contact Discharge: min. 200 times in total
Discharge Mode:	Single Discharge
Discharge Period:	1 second minimum

##### 4.4.2 TEST PROCEDURE

The test generator necessary to perform direct and indirect application of discharges to the EUT in the following manner:

- a. Contact discharge was applied to conductive surfaces and coupling planes of the EUT. During the test, it was performed with single discharges. For the single discharge time between successive single discharges was at least 1 second.

Vertical Coupling Plane (VCP):

The coupling plane, of dimensions 0.5m x 0.5m, is placed parallel to, and positioned at a distance 0.1m from, the EUT, with the Discharge Electrode touching the coupling plane.

The four faces of the EUT will be performed with electrostatic discharge.

Horizontal Coupling Plane (HCP):

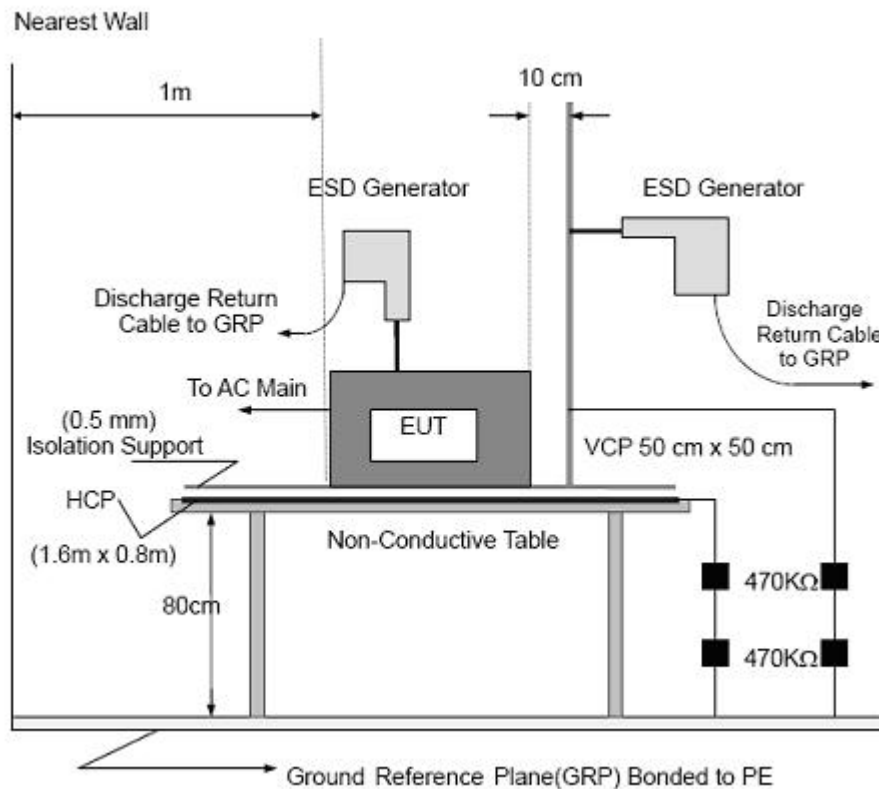
The coupling plane is placed under to the EUT. The generator shall be positioned vertically at a distance of 0.1m from the EUT, with the Discharge Electrode touching the coupling plane.

The four faces of the EUT will be performed with electrostatic discharge.

- b. Air discharges at insulation surfaces of the EUT.

It was at least ten single discharges with positive and negative at the same selected point.

#### 4.4.3 TEST SETUP



Note:

##### TABLE-TOP EQUIPMENT

The configuration consisted of a wooden table 0.8 meters high standing on the Ground Reference Plane. The GRP consisted of a sheet of aluminum at least 0.25mm thick, and 2.5 meters square connected to the protective grounding system. A Horizontal Coupling Plane (1.6m x 0.8m) was placed on the table and attached to the GRP by means of a cable with 940k total impedance. The equipment under test, was installed in a representative system as described in section 7 of IEC /EN 61000-4-2, and its cables were placed on the HCP and isolated by an insulating support of 0.5mm thickness. A distance of 1-meter minimum was provided between the EUT and the walls of the laboratory and any other metallic structure.

##### FLOOR-STANDING EQUIPMENT

The equipment under test was installed in a representative system as described in section 7 of IEC/EN 61000-4-2, and its cables were isolated from the Ground Reference Plane by an insulating support of 0.1-meter thickness. The GRP consisted of a sheet of aluminum that is at least 0.25mm thick, and 2.5meters square connected to the protective grounding system and extended at least 0.5 meters from the EUT on all sides.

## 4.4.4 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	45%
Pressure:	1010 hPa	Test Mode:	Mode1
Test Power:	DC 3.3V		

Mode	Contact Discharge (Indirect)							Observation	Criteria	Result			
Test level (kV)	Test Point	2		4		6							
Test Location		+	-	+	-	+	-						
HCP	Front	P	P	P	P			TT,TR	B	Complies			
	Rear	P	P	P	P								
	Left	P	P	P	P								
	Right	P	P	P	P								
VCP	Front	P	P	P	P								
	Rear	P	P	P	P								
	Left	P	P	P	P								
	Right	P	P	P	P								

Note:

- 1) +/- denotes the Positive/Negative polarity of the output voltage.
- 2) In the table: 'P' represents 'PASS'; 'F' represents 'FAIL'.

#### 4.5 RS TESTING

##### 4.5.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-3
Required Performance	A
Frequency Range:	80 MHz - 6000 MHz
Field Strength:	3 V/m
Modulation:	1kHz Sine Wave, 80%, AM Modulation
Frequency Step:	1 % of fundamental
Polarity of Antenna:	Horizontal and Vertical
Test Distance:	3 m
Antenna Height:	1.5 m
Dwell Time:	at least 3 seconds

##### 4.5.2 TEST PROCEDURE

The EUT and support equipment, which are placed on a table that is 0.8 meter above ground and the testing was performed in a fully-anechoic chamber.

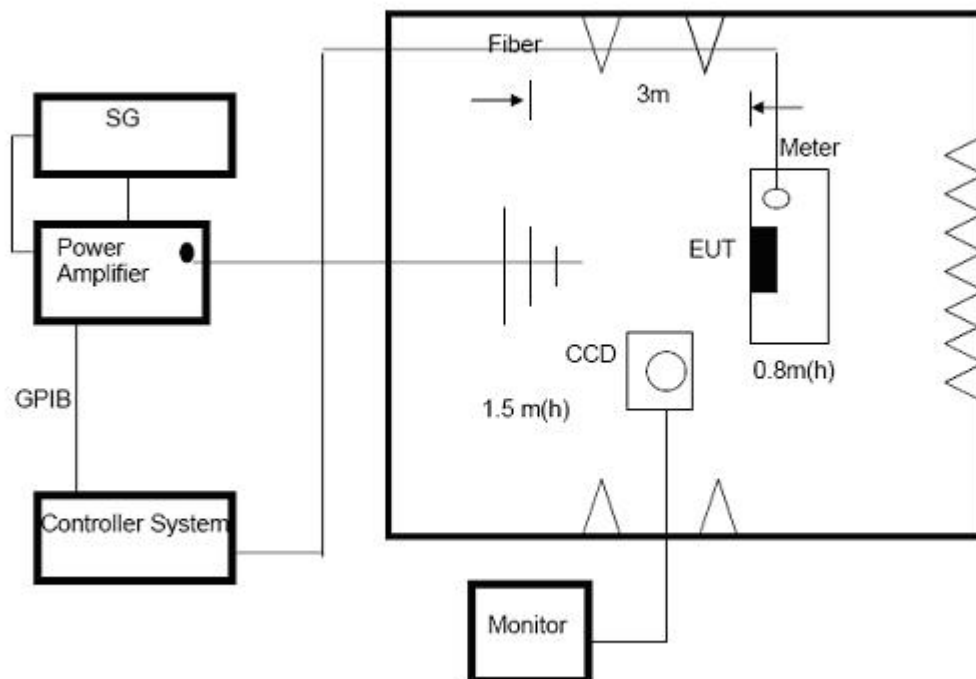
The testing distance from antenna to the EUT was 3 meters.

The other condition as following manner:

- The field strength level was 3V/m.
- The frequency range is swept from 80 MHz to 6000MHz with the signal 80%amplitude modulated with a 1kHz sine wave. The rate of sweep did not exceed  $1.5 \times 10^{-3}$  decade/s. Where the frequency range is swept incrementally, the step size was 1% of fundamental.
- Sweep Frequency 900 MHz, with the Duty Cycle:1/8 and Modulation: Pulse 217 Hz(if applicable)
- The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.



#### 4.5.3 TEST SETUP



Note:

##### TABLE-TOP EQUIPMENT

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-3 was placed on a non-conductive table 0.8 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

##### FLOOR-STANDING EQUIPMENT

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-3 was placed on a non-conductive wood support 0.1 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

#### 4.5.4 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	60%
Pressure:	1010 hPa	Test Mode:	Mode 1
Test Power:	DC 3.3V		

##### Mode1

Frequency Range (MHz)	RF Field Position	R.F. Field Strength	Azimuth	Observation	Perform. Criteria	Results
80~1000	H / V	3 V/m (rms) AM Modulated 1000Hz, 80%	Front	<b>CT,CR</b>	<b>A</b>	<b>P</b>
			Rear			
			Left			
			Right			

Frequency Range (MHz)	RF Field Position	R.F. Field Strength	Azimuth	Observation	Perform. Criteria	Results
1000~6000	H / V	3 V/m (rms) AM Modulated 1000Hz, 80%	Front	<b>CT,CR</b>	<b>A</b>	<b>P</b>
			Rear			
			Left			
			Right			

Note: "A" stand for, during test, operate as intended no loss of function, no degradation of performance, no unintentional transmissions and after test, no degradation of performance, no loss of function, no loss of stored data or user programmable functions.

Note: "A" stand for, during test, operate as intended no loss of function, no degradation of performance, no unintentional transmissions and after test, no degradation of performance, no loss of function, no loss of stored data or user programmable functions.

Note:

- 1) N/A - denotes test is not applicable in this test report.
- 2) There was not any unintentional transmission in standby mode
- 3) In the table: 'P' represents 'PASS'; 'F' represents 'FAIL'.

#### 4.6 EFT/BURST TESTING

##### 4.6.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-4
Required Performance	B
Test Voltage:	Power Line:1 kV Signal/Control Line:0.5 KV
Polarity:	Positive & Negative
Impulse Frequency:	5 kHz
Impulse Wave shape :	5/50 ns
Burst Duration:	15 ms
Burst Period:	300 ms
Test Duration:	Not less than 1 min.

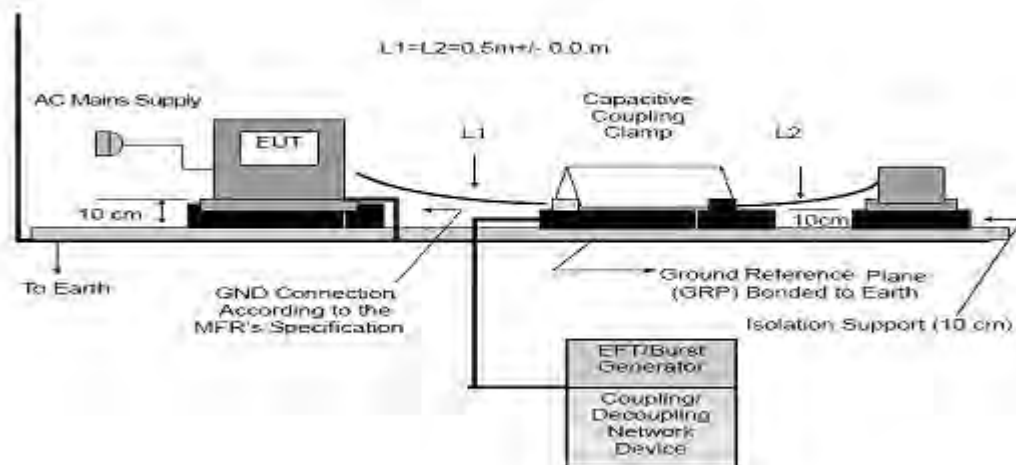
##### 4.6.2 TEST PROCEDURE

The EUT and support equipment, are placed on a table that is 0.8 meter above a metal ground plane measured 1m\*1m min. and 0.65mm thick min.

The other condition as following manner:

- The length of power cord between the coupling device and the EUT should not exceed 1 meter.
- Both positive and negative polarity discharges were applied.
- The duration time of each test sequential was 1 minute
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

The diagram illustrates a test setup for an EUT (Equipment Under Test) and an EFT/Burst Generator. The EUT is placed on a table, and the EFT/Burst Generator is placed on a separate stand. The distance between the EUT and the EFT/Burst Generator is labeled as  $L \leq 1 \text{ m}$ . The EFT/Burst Generator is connected to the AC Mains Supply and the Protective GND. The EUT is connected to the Protective GND According to the standard. The Ground Reference Plane (GRP) is bonded to Earth. The distance from the EUT to the nearest wall is labeled as  $>0.5 \text{ m}$ . The height of the EUT is labeled as 80 cm.



## TABLE-TOP EQUIPMENT

## FLOOR-STANDING EQUIPMENT

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-4 and its cables, were isolated from the Ground Reference Plane by an insulating support that is 0.1-meter thick. The GRP consisted of a sheet of aluminum (at least 0.25mm thick and 2.5m square) connected to the protective grounding system.



## 4.6.4 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	60%
Pressure :	1010 hPa	Test Power :	N/A
Test Mode	N/A		

Note: not applicable

## 4.7 SURGE TESTING

### 4.7.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-5
Required Performance	B
Wave-Shape:	Combination Wave 1.2/50 us Open Circuit Voltage 8 /20 us Short Circuit Current
Test Voltage:	Power Line:0.5 kV, 1 kV, 2 kV
Surge Input/Output:	L-N, L-PE, N-PE
Generator Source:	2 ohm between networks
Impedance:	12 ohm between network and ground
Polarity:	Positive/Negative
Phase Angle:	0 /90/180/270°
Pulse Repetition Rate:	1 time / min. (maximum)
Number of Tests:	5 positive and 5 negative at selected points

### 4.7.2 TEST PROCEDURE

a. For EUT power supply:

The surge is to be applied to the EUT power supply terminals via the capacitive coupling network. Decoupling networks are required in order to avoid possible adverse effects on equipment not under test that may be powered by the same lines, and to provide sufficient decoupling impedance to the surge wave. The power cord between the EUT and the coupling/decoupling networks shall be 2meters in length (or shorter).

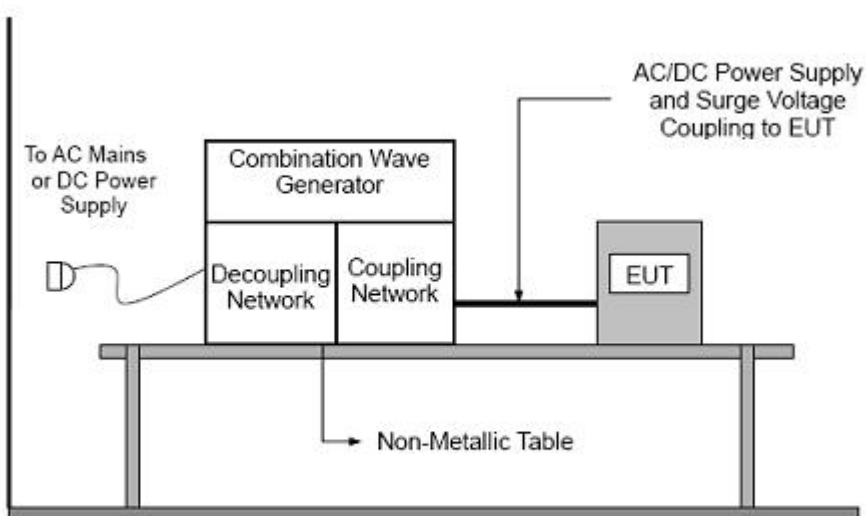
b. For test applied to unshielded unsymmetrically operated interconnection lines of EUT:

The surge is applied to the lines via the capacitive coupling. The coupling /decoupling networks shall not influence the specified functional conditions of the EUT. The interconnection line between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

c. For test applied to unshielded symmetrically operated interconnection /telecommunication lines of EUT:

d. The surge is applied to the lines via gas arrestors coupling. Test levels below the ignition point of the coupling arrestor cannot be specified. The interconnection line between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

## 4.7.3 TEST SETUP



#### 4.7.4 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	60%
Pressure :	1010 hPa	Test Power :	N/A
Test Mode	N/A		

#### TEST RESULT

Mode 1

Coupling Line			Test level								Observation	Criterion	Result
			0.5 kV		1 kV		2 kV		4 kV				
			+	-	+	-	+	-	+	-			
AC line	L-N	0°	P	P	P	P					TT,TR	B	Complies
		90°	P	P	P	P							
		180°	P	P	P	P							
		270°	P	P	P	P							
	L-PE	0°											
		90°											
		180°											
		270°											
	N-PE	0°											
		90°											
		180°											
		270°											
DC Line													
Signal Line													

Note:

- 1) There was not any unintentional transmission in standby mode
- 2) In the table: 'P' represents 'PASS'; 'F' represents 'FAIL'.



## 4.8 INJECTION CURRENT TESTING

### 4.8.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-6
Required Performance	A
Frequency Range:	0.15 MHz - 80 MHz
Field Strength:	3 Vr.m.s.
Modulation:	1kHz Sine Wave, 80%, AM Modulation
Frequency Step:	1 % of fundamental
Dwell Time:	at least 3 seconds

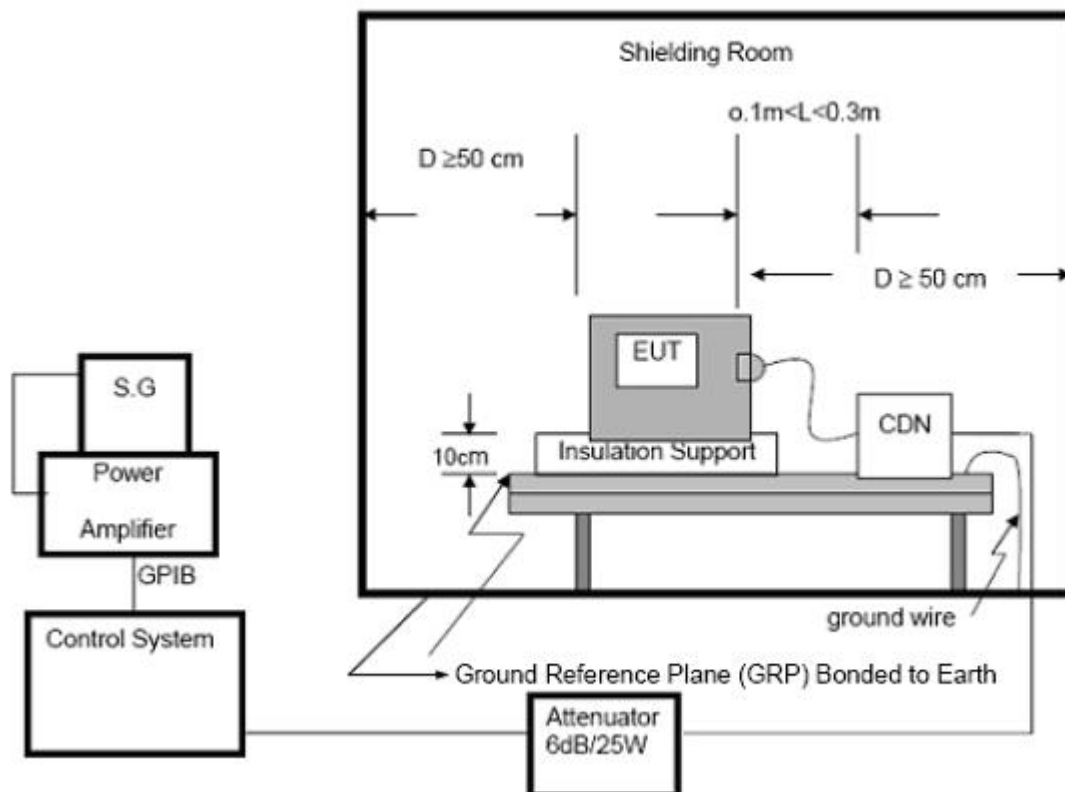
### 4.8.2 TEST PROCEDURE

The EUT and support equipment, are placed on a table that is 0.8 meter above a metal ground plane measured 1m\*1m min. and 0.65mm thick min.

The other condition as following manner:

- The frequency range is swept from 150 KHz to 80 MHz, with the signal 80%amplitude modulated with a 1kHz sine wave. The rate of sweep did not exceed  $1.5 \times 10^{-3}$  decade/s. Where the frequency range is swept incrementally, the step size was 1% of fundamental.
- The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.

#### 4.8.3 TEST SETUP



#### NOTE:

##### FLOOR-STANDING EQUIPMENT

The equipment to be tested is placed on an insulating support of 0.1 meters height above a ground reference plane. All relevant cables shall be provided with the appropriate coupling and decoupling devices at a distance between 0.1 meters and 0.3 meters from the projected geometry of the EUT on the ground reference plane.

## 4.8.4 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	60%
Pressure :	1010 hPa	Test Power :	DC 3.3V
Test Mode	Mode 1		

## TEST RESULT

Note: not applicable

## 4.9 VOLTAGE INTERRUPTION/DIPS TESTING

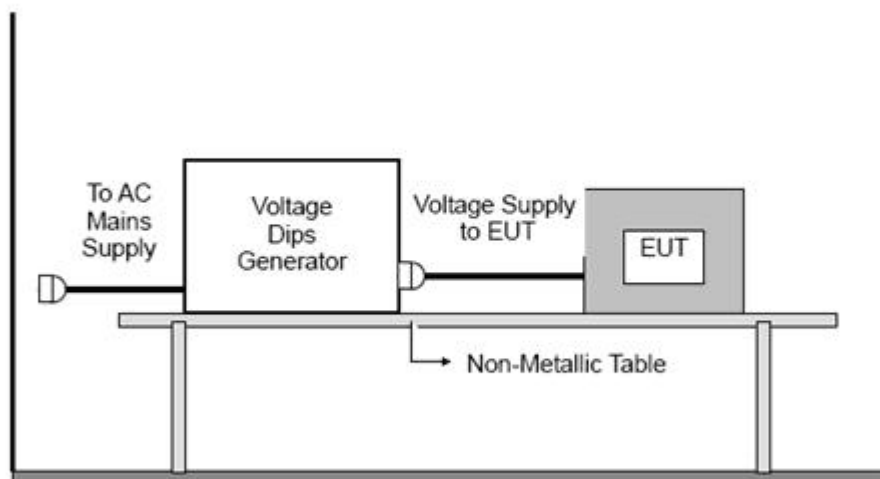
### 4.9.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-11
Required Performance	B (For 100% Voltage Dips) C (For 30% Voltage Dips) C (For 100% Voltage Interruptions)
Test Duration Time:	Minimum three test events in sequence
Interval between Event:	Minimum ten seconds
Phase Angle:	0°/45°/90°/135°/180°/225°/270°/315°/360°
Test Cycle:	3 times

### 4.9.2 TEST PROCEDURE

The EUT shall be tested for each selected combination of test levels and duration with a sequence of three dips/interruptions with intervals of 10 s minimum (between each test event). Each representative mode of operation shall be tested. Abrupt changes in supply voltage shall occur at zero crossings of the voltage waveform.

### 4.9.3 TEST SETUP





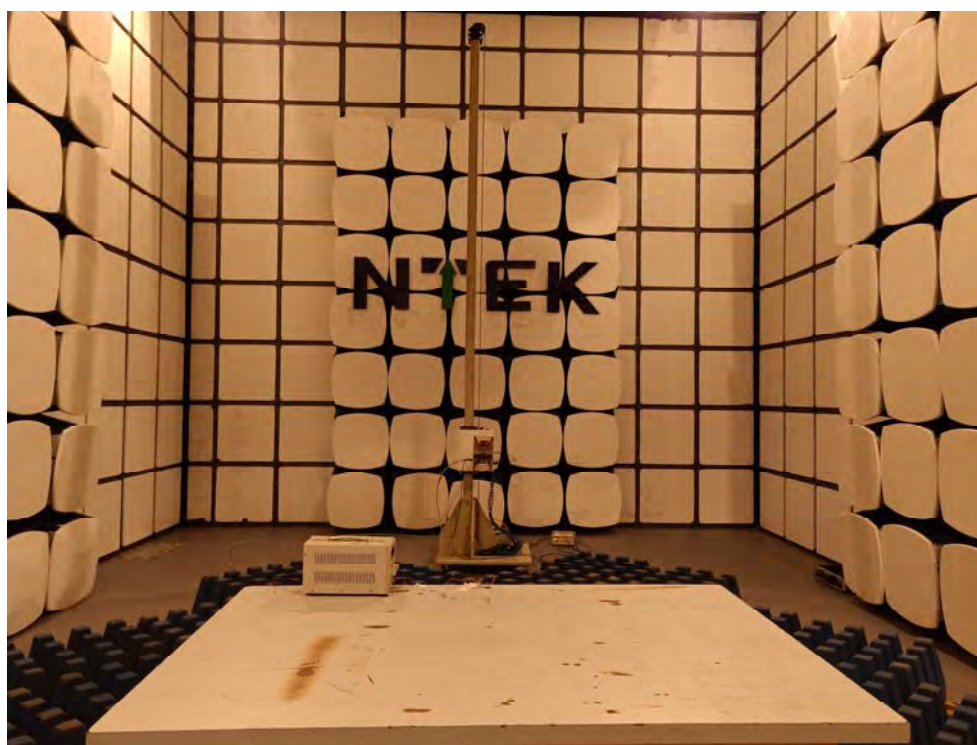
## 4.9.4 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01SH
Temperature:	25 °C	Relative Humidity:	60%
Pressure :	1010 hPa	Test Power :	N/A
Test Mode	N/A		

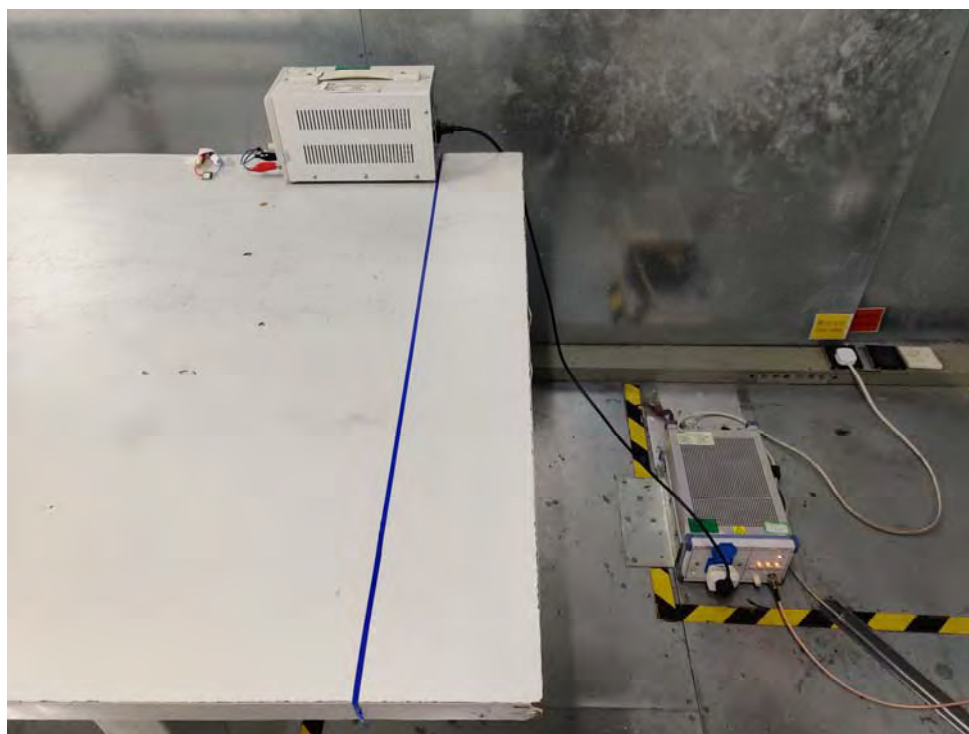
Note: not applicable

## 4.9.5. EUT TEST PHOTO

Radiated Measurement Photos



**Conducted Measurement Photo**



END OF REPORT