



# **RADIO TEST REPORT**

## **ETSI EN 300 220-1 V3.1.1 (2017-02)**

## **ETSI EN 300 220-2 V3.2.1 (2018-06)**

**Product:** LoRa Module

**Trade Mark:**  , 

**Model Name:** Ra-01H

**Family Model:** N/A

**Report No.:** S20031100206001

### **Prepared for**

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### **Prepared by**

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## TEST RESULT CERTIFICATION

**Applicant's name** ..... : Shenzhen Ai-Thinker Technology Co., Ltd  
**Address** ..... : Room 701, Building B, Huafeng Industrial Park, Hangkong Road, Sanwei Community, Baoan District, Shenzhen, China  
**Manufacturer's Name** ..... : Shenzhen Ai-Thinker Technology Co., Ltd  
**Address** ..... : Room 701, Building B, Huafeng Industrial Park, Hangkong Road, Sanwei Community, Baoan District, Shenzhen, China

### Product description

**Product name** ..... : LoRa Module

**Trademark** ..... :  , 

**Model and/or type reference** : Ra-01H

**Family Model** ..... : N/A

**Rating(s)** ..... : DC 3.3V form Uart

**Standards** ..... : ETSI EN 300 220-1 V3.1.1 (2017-02)  
 ETSI EN 300 220-2 V3.2.1 (2018-06)

This device described above has been tested by Shenzhen NTEK, and the test results show that the equipment under test (EUT) is in compliance with the article 3.2 of 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** ..... : 11 Mar. 2020 ~26 Apr. 2020

**Date of Issue** ..... : 26 Apr. 2020


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

**Testing Engineer** :



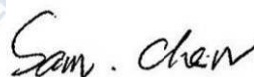
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(Jason Chen)

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(Sam Chen)



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## 1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:

ETSI EN 300 220-1 V3.1.1 (2017-02)

ETSI EN 300 220-2 V3.2.1 (2018-06)

Clause	Description of Test Item	Results(Pass/Fail)	N.T(Not Test)
Transmitter Parameters			
4.2.1	Operating frequency	Pass	
4.3.1	Effective Radiated Power	Pass	
4.3.2	Maximum Effective Radiated Power spectral density	Pass	
4.3.3	Duty Cycle	Pass	
4.3.4	Occupied Bandwidth	Pass	
4.3.5	Tx Out Of Band Emissions	Pass	
4.2.2	Unwanted emissions in the spurious domain	Pass	
4.3.6	Transient power	Pass	
4.3.7	Adjacent Channel Power		N.T
4.3.8	TX behaviour under Low Voltage Conditions	Pass	
4.3.9	Adaptive Power Control		N.T
4.4.1	RX sensitivity level	Pass	
4.4.2	Blocking	Pass	



### 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 518126 P.R. China

FCC Registered No.: 463705 IC Registered No.: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 %**.

No.	Item	Uncertainty
1	Conducted Emission Test	$\pm 1.38\text{dB}$
2	RF power,conducted	$\pm 0.16\text{dB}$
3	Spurious emissions,conducted	$\pm 0.21\text{dB}$
4	All emissions,radiated(<1G)	$\pm 4.68\text{dB}$
5	All emissions,radiated(>1G)	$\pm 4.89\text{dB}$
6	Temperature	$\pm 0.5^{\circ}\text{C}$
7	Humidity	$\pm 2\%$



### Revision History

Report No.	Version	Description	Issued Date
S20031100206001	Rev.01	Initial issue of report	26 Apr. 2020



## 2. GENERAL INFORMATION

### 2.1 GENERAL DESCRIPTION OF EUT

Equipment	LoRa Module	
Brand Name	 , 	
Model Name.	Ra-01H	
Family Model	N/A	
Model Difference	N/A	
Product Description	The EUT is LoRa Module	
	Operation Frequency Band:	Band AA: 863MHz-870MHz
	Channel number	LoRa/FSK/OOK
	Modulation Type:	3dB
	Antenna Gain(Peak)	Spring Antenna
	Antenna Designation:	DC 3.3V form Uart
	Power Rating	Band AA: 863MHz-870MHz
	Receiver Category	1
	Based on the application, features, or specification exhibited in User's Manual, the EUT is considered as an ITE/Computing Device. More details of EUT technical specification, please refer to the User's Manual.	
Channel List	Refer to below(Note 2)	
Adapter	N/A	
Battery	N/A	
Hardware Version	V3.2	
Firmware Version	N/A	
Software Version	V1.00	

Note:

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



## 2. Test Channel:

TX

Channel	Frequency (MHz)
01	864
02	865
03	866
04	867
05	868
06	869

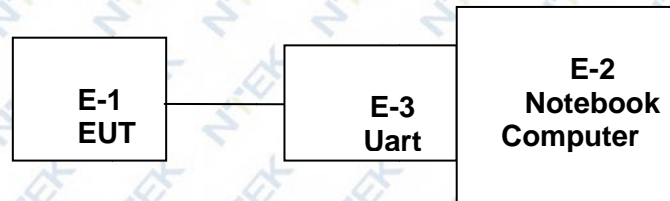
RX

Channel	Frequency (MHz)
01	864
02	865
03	866
04	867
05	868
06	869



## 2.2 DESCRIPTION OF TEST CONDITIONS



### 1. Test setup





## 2.3 DESCRIPTION OF SUPPORT UNITS

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-01	N/A	EUT
E-2	Notebook Computer	NTEK	N/A	N/A	
E-3	Uart	NTEK	N/A	N/A	

Item	Shielded Type	Ferrite Core	Length	Note

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.



## 2.4 TEST CONDITIONS

	Normal Test Conditions	Extreme Test Conditions
Temperature	15°C - 35°C	-10°C ~ 70°C Note: (1)
Relative Humidity	20% - 75%	N/A
Supply Voltage	DC 3.3V	DC 3.0-3.5V

Note:

- (1) Tests at extreme temperatures shall be made in accordance with the procedures specified in EN 300220-1 V3.1.1 clause 4.3.4.1.1 at the upper and lower temperatures of the operational profile declared by the manufacturer;
- (2) The extreme test voltages for equipment to be connected to an DC mains source shall be the nominal mains voltage  $\pm 10\%$ .



## 2.5 EQUIPMENTS LIST FOR ALL TEST ITEMS

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Spectrum Analyzer	Agilent	E4407B	MY45108040	2019.05.13	2020.05.12	1 year
2	Test Receiver	R&S	ESPI7	101318	2019.05.13	2020.05.12	1 year
3	Bilog Antenna	TESEQ	CBL6111D	31216	2019.05.13	2020.05.12	1 year
4	50Ω Coaxial Switch	Anritsu	MP59B	6200983705	2018.05.19	2020.05.18	2 year
5	Spectrum Analyzer	Agilent	N9020A	MY49100060	2019.08.28	2020.08.27	1 year
6	Horn Antenna	EM	EM-AH-10180	2011071402	2019.05.13	2020.05.12	1 year
7	Horn Ant	Schwarzbeck	BBHA 9170	9170-181	2018.12.11	2019.12.10	1 year
8	Amplifier	EMC	EMC051835SE	980246	2019.08.06	2020.08.05	1 year
9	Loop Antenna	ARA	PLA-2030/B	1029	2019.05.13	2020.05.12	1 year
10	Power Meter	Agilent	E4419B	MY45102538	2019.08.06	2020.08.05	1 year
11	ESG VETCTOR SIGNAL GENERATOR	Agilent	E4438C	MY45093347	2019.05.13	2020.05.12	1 year
12	Temperature & Humidity Chamber	GIANT FORCE	GTH-056P	GF-94454-1	2019.05.13	2020.05.12	1 year
13	Power Sensor	Agilent	E9301A.	MY41495644	2019.08.06	2020.08.05	1 year



### 3. OPERATING FREQUENCY

#### 3.1 LIMITS OF OPERATING FREQUENCY

Refer to chapter 4.2.1.2 of ETSI EN 300 220-2 V3.2.1 (2018-06)

The manufacturer may declare either one or more operating frequencies and operating channels. Operating channel(s) shall be entirely within operational frequency bands allowed by annex B or any NRI.

#### 3.2 TEST PROCEDURE

Refer to chapter 5.1.1 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

#### 3.3 CONFORMANCE

The information shown in Table 6 shall be recorded in the test report.

**Table 6: Information Recorded in the Test Report for Operating Frequency test**

Value	Notes
Operational Frequency band or bands	Band AA: 863MHz-870MHz
Nominal Operating Frequency or Frequencies	Refer to Channel list
Operating Channel width(s) - OCW	125KHz <sub>Note</sub>

Note: The manufacturer declared the OCW=125kHz.



#### 4. EFFECTIVE RADIATED POWER

##### 4.1 LIMITS OF EFFECTIVE RADIATED POWER

Refer to chapter 4.3.1.2 of ETSI EN 300 220-2 V3.2.1 (2018-06)

The effective radiated power shall not be greater than the value allowed in annex B or in any NR for the chosen operational frequency band(s).

The limits please refer to ETSI EN 300 220-2 V3.2.1 Annex B:

Operational Frequency Band	Maximum Effective Radiated Power	Channel access and occupation rules	Additional spectrum access parameters	Maximum occupied bandwidth	Other usage restriction	Band number in CEPT/ERC/REC 70-03 [i.1]
AA 863 MHz to 870 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle or polite spectrum access		300 kHz except for voice limited to 25 kHz	Sub-bands [868,6 MHz to 868,7 MHz], [869,250 MHz to 869,4 MHz], [869,650 MHz to 869,700 MHz] for alarms are excluded	Annex 1; h.1.3 (Notes 1, 3, 4)

##### 4.2 TEST PROCEDURE

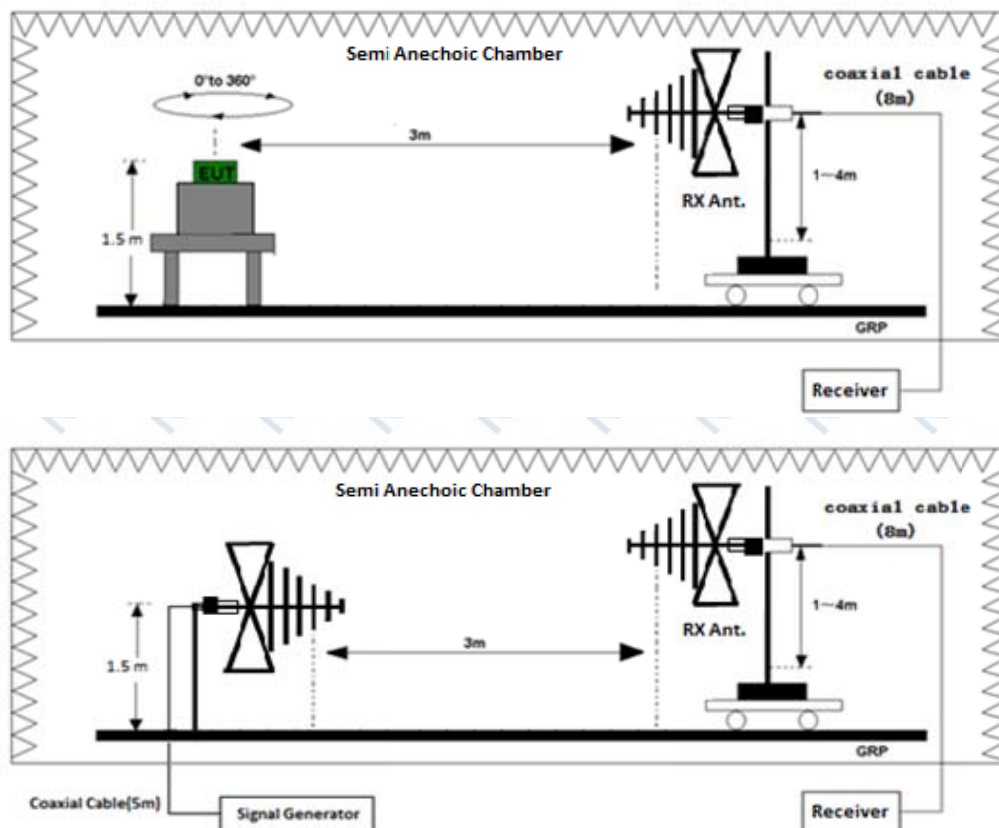
Refer to chapter 5.2.2.2 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input type="checkbox"/> Conducted measurement	<input checked="" type="checkbox"/> Radiated measurement

##### 4.3 DEVIATION FROM TEST STANDARD

No deviation

##### 4.4 TEST SETUP





#### 4.5 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	60 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX Mode		

Frequency	Ant	SG Level	Pcl	Ga	Correction	(ERP)	ERP	Limits	RESULT
(MHz)	H / V	(dBm)	(dB)	(dB)	(dBi)	(dBm)	(mW)	(mW)	
864	H	3.83	2.39	12.35	2.15	11.64	14.59	25	PASS
864	V	3.8	2.39	12.35	2.15	11.61	14.49	25	PASS
866	H	3.86	2.39	12.35	2.15	11.67	14.69	25	PASS
866	V	3.84	2.39	12.35	2.15	11.65	14.62	25	PASS
869	H	3.85	2.39	12.35	2.15	11.66	14.66	25	PASS
869	V	3.81	2.39	12.35	2.15	11.62	14.52	25	PASS

Note: Pcl= cable loss

Ga= Antenna Gain

Peak EIRP(dBm)= SGLevel -Pcl +Ga

ERP(dBm)=EIRP-2.15



## 5. MAXIMUM EFFECTIVE RADIATED POWER SPECTRAL DENSITY

### 5.1 APPLICABILITY

Maximum e.r.p. power spectral density applies to transmitters using annex B bands I.  
Maximum e.r.p. power spectral density applies to transmitters using DSSS or wideband techniques other than FHSS modulation, in annex C band W, AA or AC.

### 5.2 LIMITS OF MAXIMUM EFFECTIVE RADIATED POWER SPECTRAL DENSITY

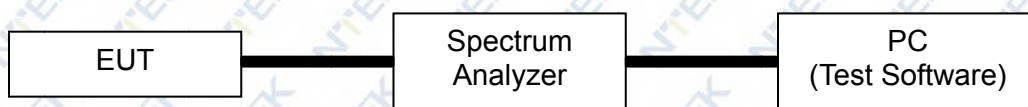
The Maximum e.r.p. power spectral density shall not be greater than the value allowed in annex B or any NRI for the chosen operational frequency band(s).

### 5.3 TEST PROCEDURES

Refer to chapter 5.3.4 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 5.4 TEST SETUP





## 5.5 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	60 %
Pressure:	1012 hPa	Test Voltage:	N/A
Test Mode:	N/A		

The Maximum e.r.p. spectral density shall not be required for EUT operating.



## 6. DUTY CYCLE

### 6.1 APPLICABILITY

Duty cycle applies to all transmitters except EUT with polite spectrum access (described in EN 300220-2 V3.2.1 clause 4.5) where permitted in annex B, table B.1 or annex C, table C.1 or any NRI.

### 6.2 LIMITS OF DUTY CYCLE

The limits please refer to ETSI EN 300 220-2 V3.2.1 Annex B:

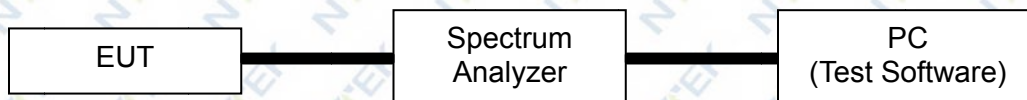
Operational Frequency Band	Maximum Effective Radiated Power	Channel access and occupation rules	Additional spectrum access parameters	Maximum occupied bandwidth	Other usage restriction	Band number in CEPT/ERC/REC 70-03 [i.1]
AA 863 MHz to 870 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle or polite spectrum access		300 kHz except for voice limited to 25 kHz	Sub-bands [868,6 MHz to 868,7 MHz], [869,250 MHz to 869,4 MHz], [869,650 MHz to 869,700 MHz] for alarms are excluded	Annex 1: h1.3 (Notes 1, 3, 4)

### 6.3 TEST PROCEDURE

Refer to chapter 5.4 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 6.4 TEST SETUP





## 6.5 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX-864		

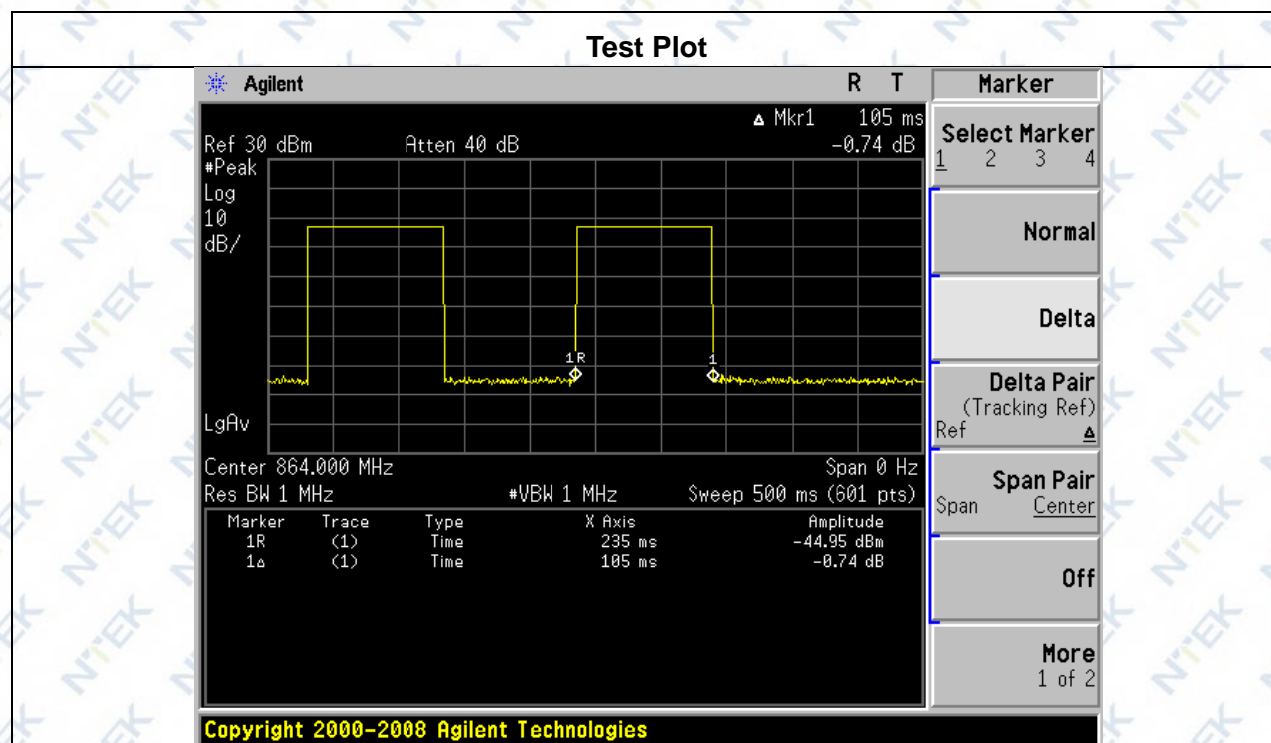
Duty Cycle	Limit	Result
0.291%	1%	Complies

$T_{on}=105ms$

$DC=(T_{on} \times N)/1hour$

$DC=(105 \times 100)/3600000=0.00291=0.291\%$

Note: N represents the number of times the EUT is transmitter within 1 hour, The customer claims that the maximum number of launches in the 1 hour is 100.



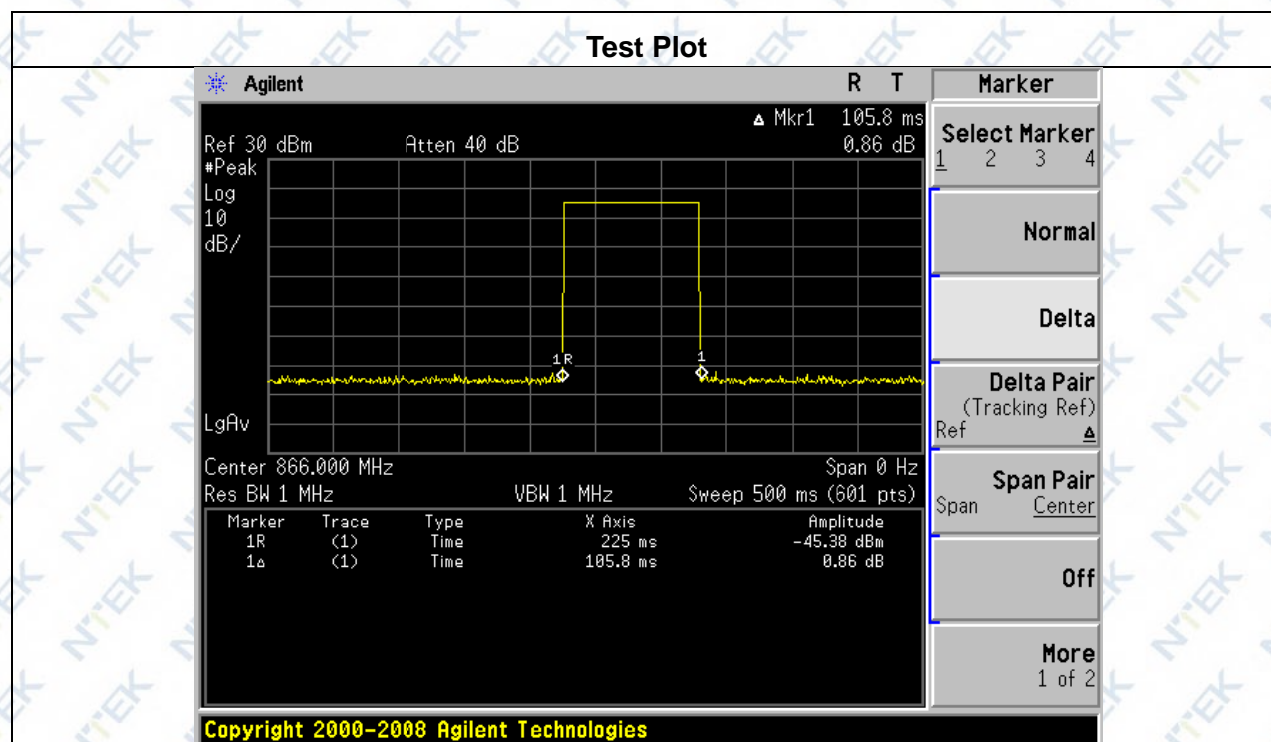


EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX-866		

Duty Cycle	Limit	Result
0.294%	1%	Complies

 $T_{on} = 105.8 \text{ ms}$ 
 $DC = (T_{on} \times N) / 1 \text{ hour}$ 
 $DC = (105.8 \times 100) / 3600000 = 0.00294 = 0.294\%$ 

Note: N represents the number of times the EUT is transmitter within 1 hour, The customer claims that the maximum number of launches in the 1 hour is 100.



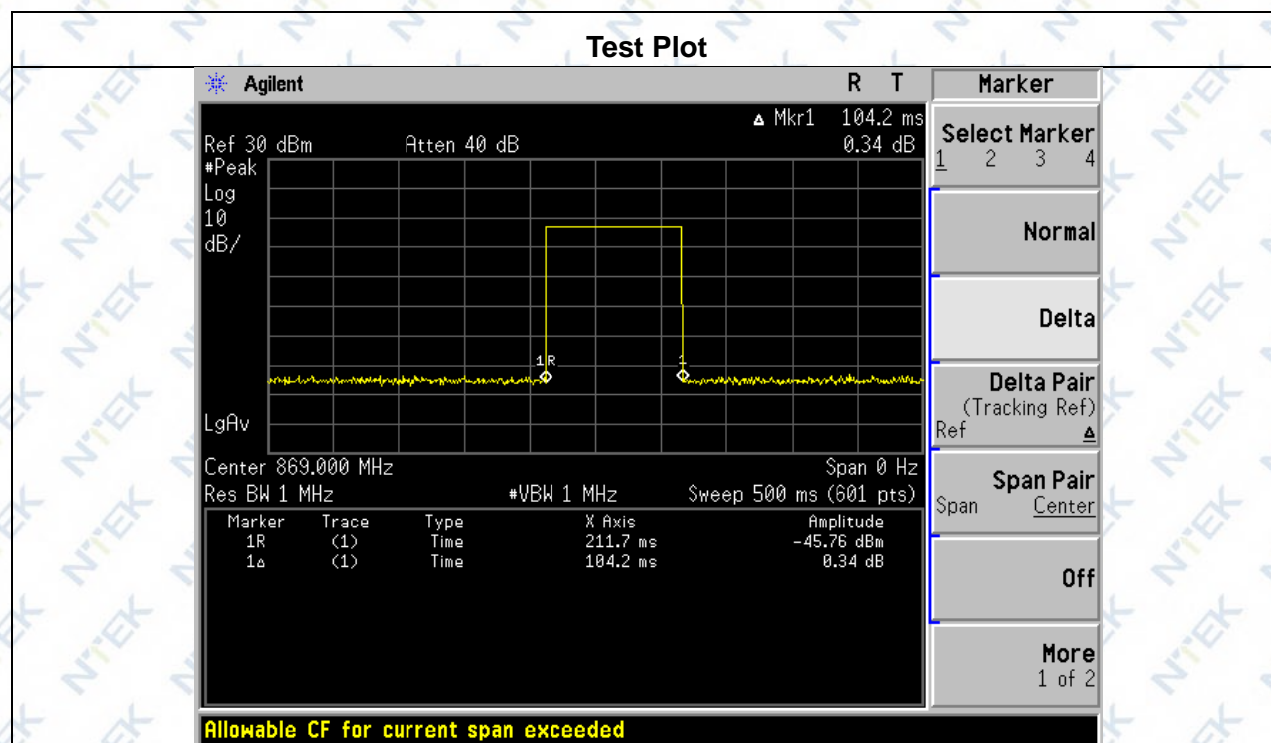


EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX-869		

Duty Cycle	Limit	Result
0.289%	1%	Complies

 $T_{on}=104.2\text{ms}$ 
 $DC=(T_{on} \times N)/1\text{hour}$ 
 $DC=(104.2 \times 100)/3600000=0.00289=0.289\%$ 

Note: N represents the number of times the EUT is transmitter within 1 hour, The customer claims that the maximum number of launches in the 1 hour is 100.





## 7. OCCUPIED BANDWIDTH

### 7.1 APPLICABILITY

Maximum occupied bandwidth applies to all transmitters.

### 7.2 LIMITS OF OCCUPIED BANDWIDTH

The occupied bandwidth of the EUT according to ETSI EN 300 220-1 [1], clause 5.6.2 shall comply with the limits in annex B or any NRI for the chosen operational frequency band(s).

The limits please refer to ETSI EN 300 220-2 V3.2.1 Annex B:

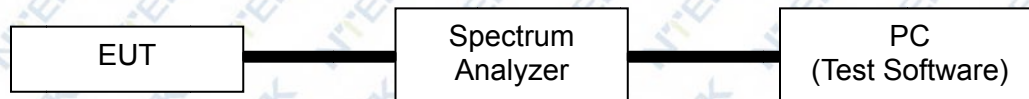
Operational Frequency Band	Maximum Effective Radiated Power	Channel access and occupation rules	Additional spectrum access parameters	Maximum occupied bandwidth	Other usage restriction	Band number in CEPT/ERC/REC 70-03 [i.1]
AA 863 MHz to 870 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle or polite spectrum access		300 kHz except for voice limited to 25 kHz	Sub-bands [868,6 MHz to 868,7 MHz], [869,250 MHz to 869,4 MHz], [869,650 MHz to 869,700 MHz] for alarms are excluded	Annex 1; h1.3 (Notes 1, 3, 4)

### 7.3 TEST PROCEDURE

Refer to chapter 5.3.5 of ETSI EN 300 220 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 7.4 TEST SETUP





## 7.5 TEST RESULTS

EUT :	LoRa Module	Model Name:	Ra-01H
Temperature :	26°C	Relative Humidity:	60 %
Pressure :	1012 hPa	Test Voltage :	DC 3.3V
Test Mode :	TX		

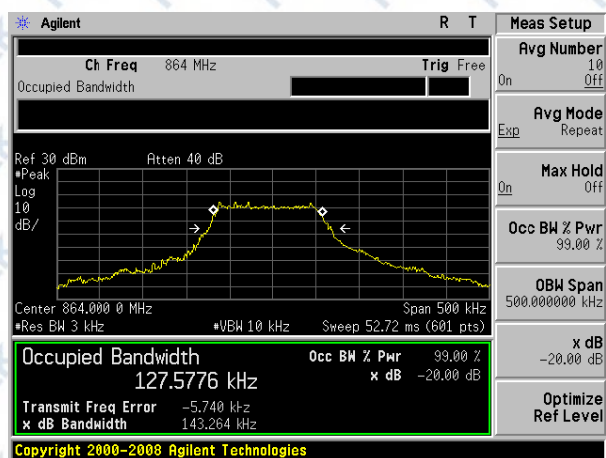
CHANNEL	CHANNEL FREQUENCY (MHz)	99%OCCUPIED BANDWIDTH (KHz)	Measured frequencies		Limit	PASS /FAIL
			FL (MHz)	FH (MHz)		
01	864	127.5776	863.9375	864.0625	F <sub>Low</sub> >863MHz and F <sub>High</sub> <870MHz	PASS
02	866	125.7994	865.9375	866.0625		
03	869	124.9833	868.9375	869.0625		

Note:  $F_L(f_{LOW}) = F_c(\text{Center Frequency}) - OCW/2$ ;  $F_H(f_{HIGH}) = F_c(\text{Center Frequency}) + OCW/2$



### Test Plot

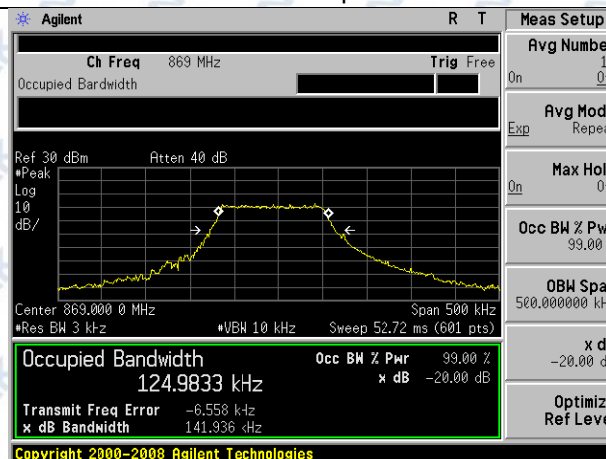
99% Power Bandwidth plot on channel 1



99% Power Bandwidth plot on channel 2



99% Power Bandwidth plot on channel 3





## 8. TX OUT OF BAND EMISSIONS

### 8.1 APPLICABILITY

TX Out of Band Emissions applies to all transmitters with OCW > 25 kHz.

### 8.2 LIMITS OF TX OUT OF BAND EMISSIONS

The EUT shall comply with reference limits defined in ETSI EN 300 220-1 [1], clause 5.8.2.

The EUT emissions level in OOB domains for the Operating Channel and the Operational Frequency Band shall be less or equal to Table 15 spectrum mask.

**Table 15: Emission limits in the Out Of Band domains**

Domain	Frequency Range	RBW <sub>REF</sub>	Max power limit
OOB limits applicable to Operational Frequency Band (See Figure 6)	$f \leq f_{\text{low\_OFB}} - 400 \text{ kHz}$	10 kHz	-36 dBm
	$F_{\text{low\_OFB}} - 400 \text{ kHz} \leq f \leq f_{\text{low\_OFB}} - 200 \text{ kHz}$	1 kHz	-36 dBm
	$f_{\text{low}} - 200 \text{ kHz} \leq f < f_{\text{low\_OFB}}$	1 kHz	See Figure 6
	$f = f_{\text{low\_OFB}}$	1 kHz	0 dBm
	$f = f_{\text{high\_OFB}}$	1 kHz	0 dBm
	$F_{\text{high\_OFB}} < f \leq f_{\text{high\_OFB}} + 200 \text{ kHz}$	1 kHz	See Figure 6
	$F_{\text{high\_OFB}} + 200 \text{ kHz} \leq f \leq f_{\text{high\_OFB}} + 400 \text{ kHz}$	1 kHz	-36 dBm
	$F_{\text{high\_OFB}} + 400 \text{ kHz} \leq f$	10 kHz	-36 dBm
OOB limits applicable to Operating Channel (See Figure 5)	$f = f_c - 2.5 \times \text{OCW}$	1 kHz	-36 dBm
	$f_c - 2.5 \times \text{OCW} \leq f \leq f_c - 0.5 \times \text{OCW}$	1 kHz	See Figure 5
	$f = f_c - 0.5 \times \text{OCW}$	1 kHz	0 dBm
	$f = f_c + 0.5 \times \text{OCW}$	1 kHz	0 dBm
	$f_c + 0.5 \times \text{OCW} \leq f \leq f_c + 2.5 \times \text{OCW}$	1 kHz	See Figure 5
	$f = f_c + 2.5 \times \text{OCW}$	1 kHz	-36 dBm

NOTE:  $f$  is the measurement frequency.  
 $f_c$  is the Operating Frequency.  
 $F_{\text{low\_OFB}}$  is the lower edge of the Operational Frequency Band.  
 $F_{\text{high\_OFB}}$  is the upper edge of the Operational Frequency Band.  
OCW is the operating channel bandwidth.

### 8.3 TEST PROCEDURES

Refer to chapter 5.8 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 8.4 TEST SETUP



These measurements only were performed at normal test conditions. The measurement shall be performed only on the lowest and the highest frequency within the ststed frequency range. In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator. Controlling software has been activated to set the EUT on specific status.

## 8.5 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX		

864MHz OCW=125KHz

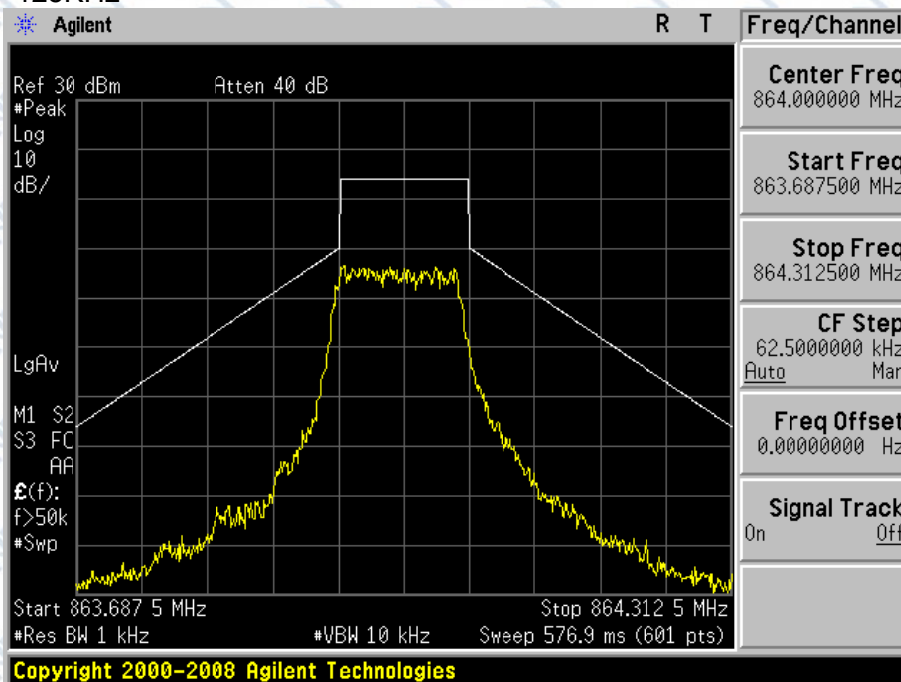


Figure 5 Out Of Band Domain for Operating Channel with reference BW

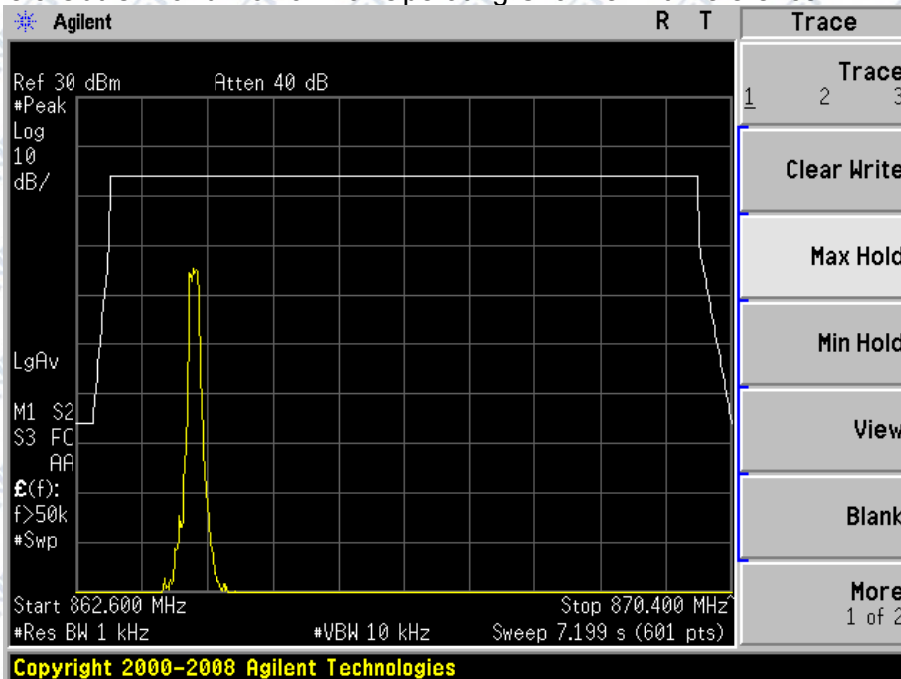


Figure 6 Out Of Band Domain for Operational Frequency Band with reference BW



866MHz OCW=125KHz

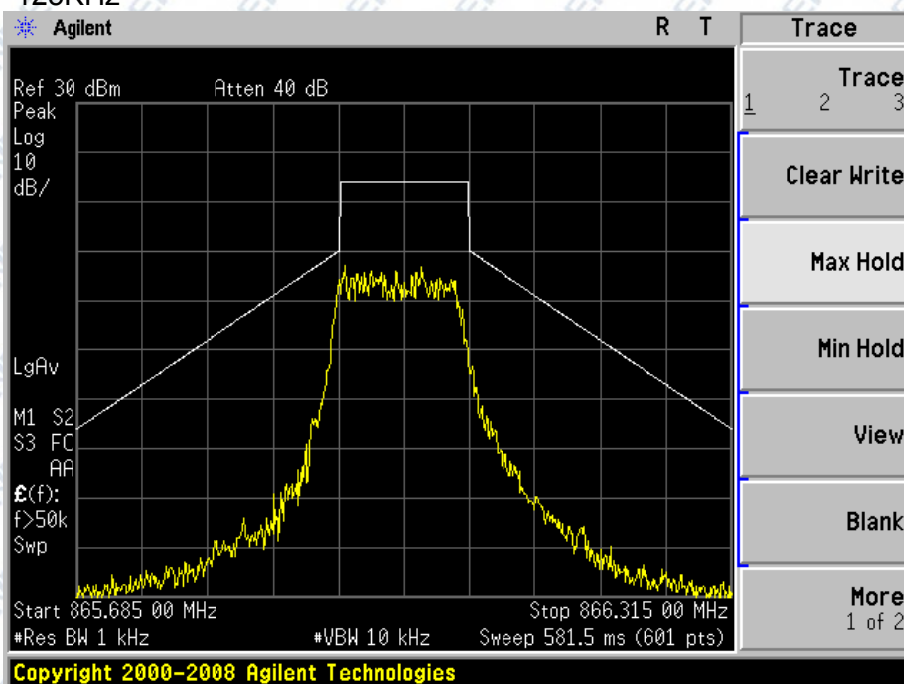


Figure 5 Out Of Band Domain for Operating Channel with reference BW

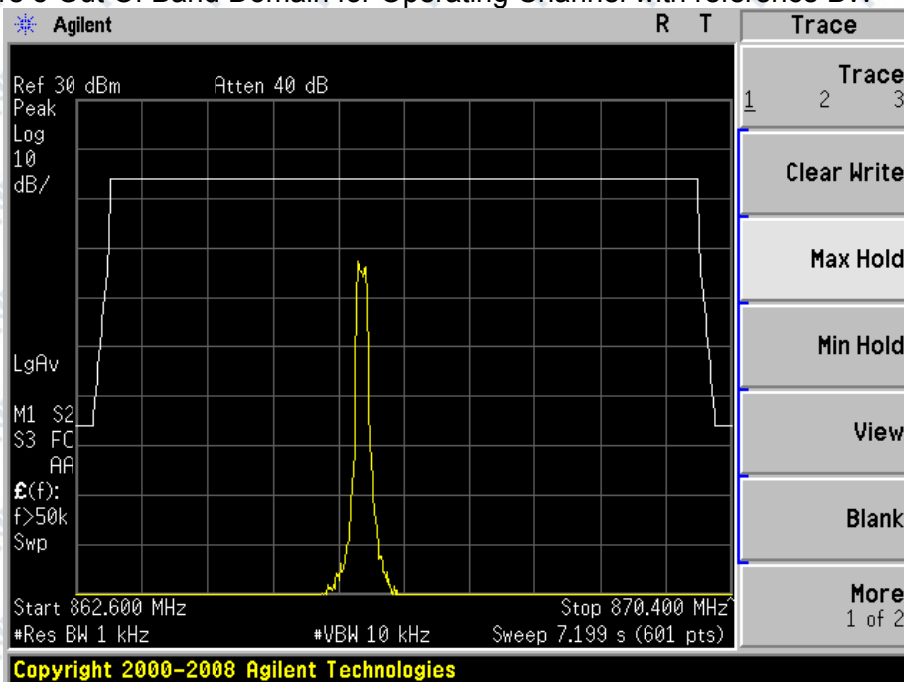


Figure 6 Out Of Band Domain for Operational Frequency Band with reference BW

869MHz OCW=125KHz

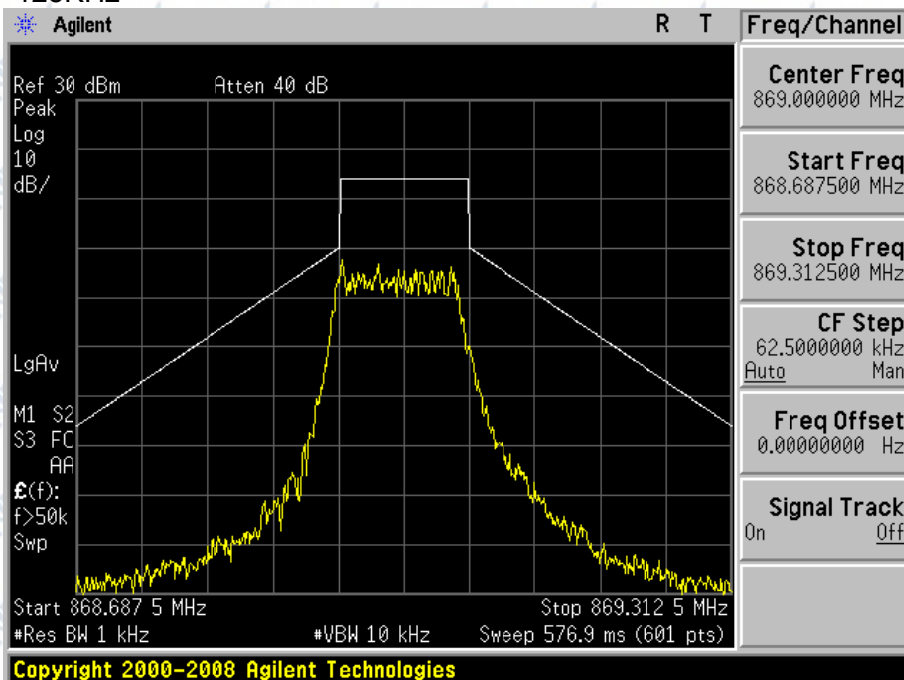


Figure 5 Out Of Band Domain for Operating Channel with reference BW

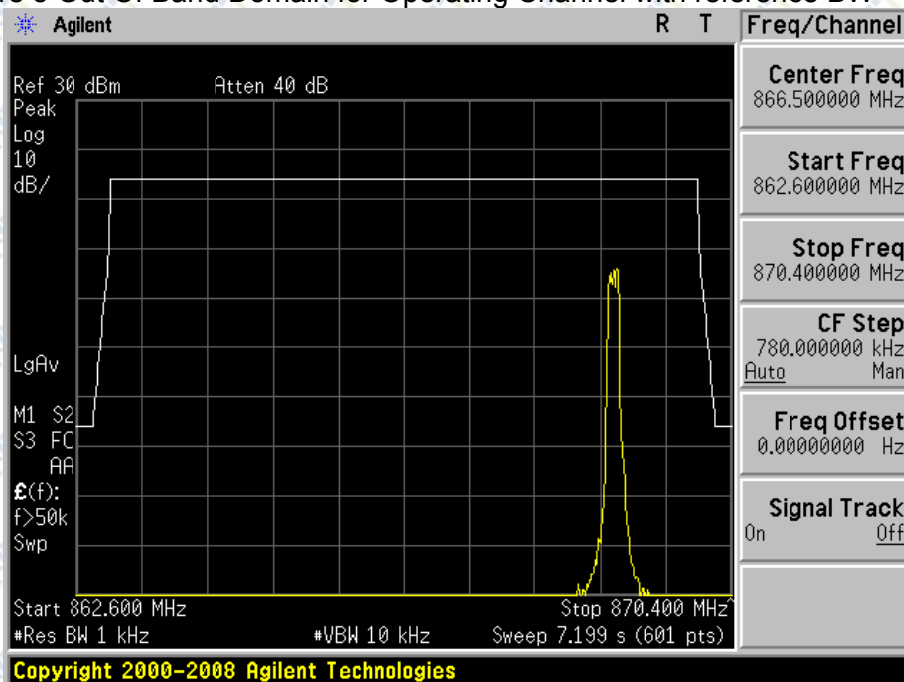


Figure 6 Out Of Band Domain for Operational Frequency Band with reference BW



## 9. UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

### 9.1 APPLICABILITY

This items applies to all equipment.

### 9.2 LIMITS OF UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

Refer to chapter 5.9.2 of ETSI EN 300 220-1 V3.1.1

The power of any unwanted emission in the spurious domain shall not exceed the values given in Table 19.

**Table 19: Spurious domain emission limits**

Frequency State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 790 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
TX mode	-54 dBm	-36 dBm	-30 dBm
RX and all other modes	-57 dBm	-57 dBm	-47 dBm

### 9.3 MEASURING INSTRUMENTS AND SETTING

Operating Mode	Frequency Range	RBW <sub>REF</sub> (see note 2)
Transmit mode	$9 \text{ kHz} \leq f < 150 \text{ kHz}$	1 kHz
	$150 \text{ kHz} \leq f < 30 \text{ MHz}$	10 kHz
	$30 \text{ MHz} \leq f < f_c - m$	100 kHz
	$f_c - m \leq f < f_c - n$	10 kHz
	$f_c - n \leq f < f_c - p$	1 kHz
	$f_c + p < f \leq f_c + n$	1 kHz
	$f_c + n < f \leq f_c + m$	10 kHz
	$f_c + m < f \leq 1 \text{ GHz}$	100 kHz
	$1 \text{ GHz} < f \leq 6 \text{ GHz}$	1 MHz

NOTE 1: f is the measurement frequency.  
 $f_c$  is the Operating Frequency.  
m is 10 x OCW or 500 kHz, whichever is the greater.  
n is 4 x OCW or 100 kHz, whichever is the greater.  
p is 2,5 x OCW.

NOTE 2: If the value of RBW used for measurement is different from RBW<sub>REF</sub>, use bandwidth correction from clause 4.3.10.1.

**Table 22: Spurious Radiations radiated Measurement Frequency Range**

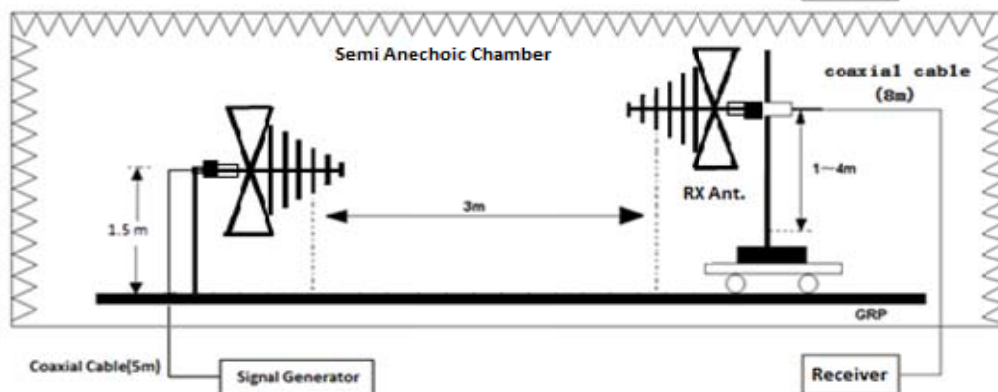
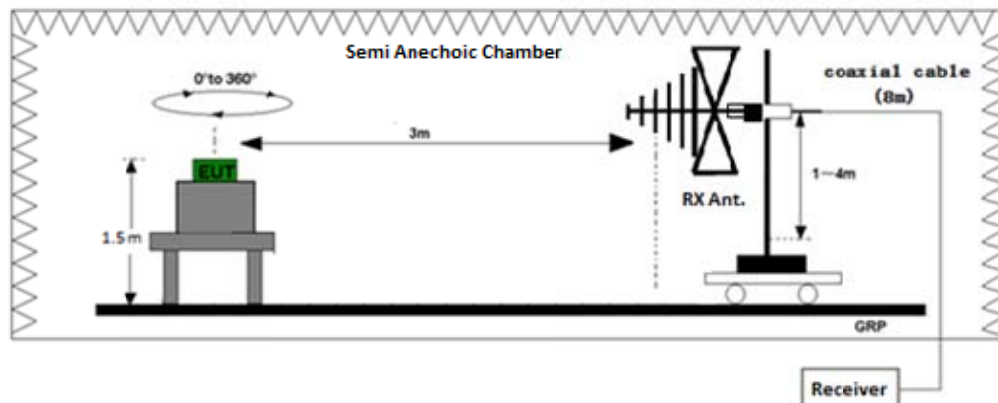
Frequency Range
25 MHz to 6 GHz
NOTE: The measurements need only to be performed over the frequency range 4 GHz to 6 GHz if emissions are detected within 10 dB of the specified limit between 1,5 GHz and 4 GHz.

### 9.4 TEST PROCEDURES

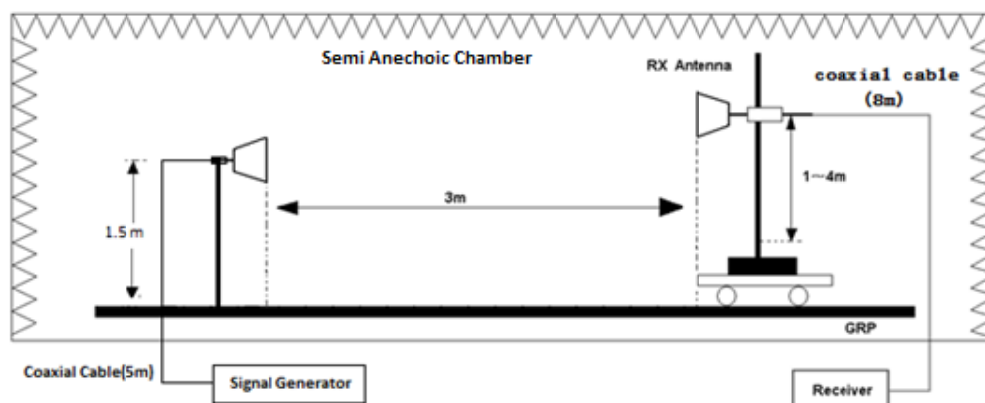
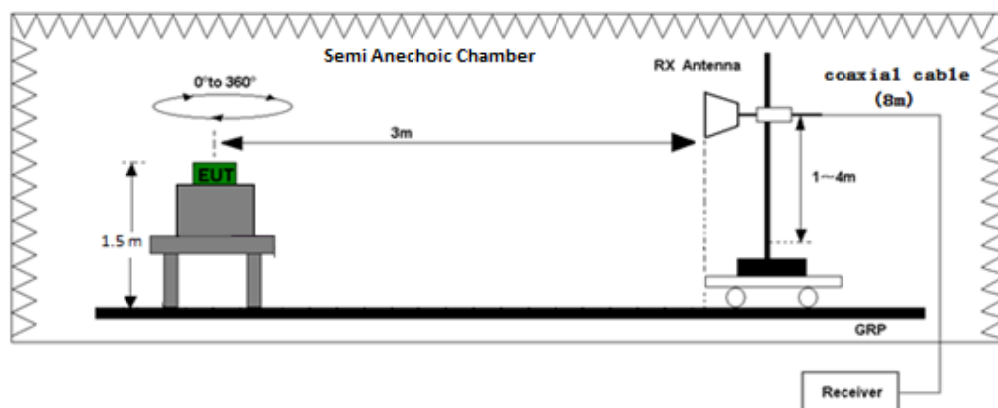
Refer to chapter 5.9.3.3.2 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input type="checkbox"/> Conducted measurement	<input checked="" type="checkbox"/> Radiated measurement

## 9.5 TEST SETUP LAYOUT



Test set-up of radiated disturbance (30MHz-1GHz)



Test set-up of radiated disturbance (above 1GHz)



## 9.6 EUT OPERATION DURING TEST

The EUT was programmed to be in continuously transmitting mode.



## 9.7 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	24 °C	Relative Humidity:	54%
Pressure:	1010 hPa	Test Power:	DC 3.3V
Test Mode:	TX for 864MHz		

## BELOW 1 GHz WORST- CASE DATA (30 MHz ~ 1GHz)

Polar (H/V)	Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
	(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dB)	
V	35.2051	-96.12	17.03	-79.09	-36	-43.09	peak
V	53.1986	-92.19	9.38	-82.81	-54	-28.81	peak
V	102.9169	-93.36	10.26	-83.10	-54	-29.10	peak
V	137.0084	-95.85	11.00	-84.85	-36	-48.85	peak
V	647.1393	-98.50	20.32	-78.18	-54	-24.18	peak
V	771.3442	-94.39	22.80	-71.59	-54	-17.59	peak
H	36.7822	-94.73	16.17	-78.56	-36	-42.56	peak
H	49.1240	-90.39	9.80	-80.59	-54	-26.59	peak
H	79.2587	-92.98	9.39	-83.59	-36	-47.59	peak
H	107.1019	-98.30	10.28	-88.02	-54	-34.02	peak
H	206.5574	-89.36	11.49	-77.87	-54	-23.87	peak
H	774.3421	-96.12	19.93	-76.19	-54	-22.19	peak

**Remark:**

Absolute Level= ReadingLevel+ Factor, Margin= Absolute Level - Limit

## ABOVE 1 GHz WORST- CASE DATA (1GHz ~ 6GHz)

Polar (H/V)	Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
	(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dB)	
V	1730.642	-68.68	3.72	-64.96	-30	-34.96	peak
V	2595.467	-67.45	3.15	-64.30	-30	-34.30	peak
V	3460.605	-63.29	8.13	-55.16	-30	-25.16	peak
V	4325.197	-68.18	9.27	-58.91	-30	-28.91	peak
V	5201.407	-70.34	8.97	-61.37	-30	-31.37	peak
H	1730.642	-64.85	3.43	-61.42	-30	-31.42	peak
H	2595.467	-66.71	3.47	-63.24	-30	-33.24	peak
H	3460.605	-65.12	8.44	-56.68	-30	-26.68	peak
H	4325.197	-67.06	9.48	-57.58	-30	-27.58	peak
H	5201.407	-67.35	8.48	-58.87	-30	-28.87	peak

**Remark:**

Absolute Level= ReadingLevel+ Factor, Margin= Absolute Level - Limit

Note: All modes had been tested, but only the worst data recorded in the report.



EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	24 °C	Relative Humidity:	54%
Pressure:	1010 hPa	Test Power:	DC 3.3V
Test Mode:	RX for 864MHz		

## BELOW 1 GHz WORST- CASE DATA (30 MHz ~ 1GHz)

Polar (H/V)	Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Remark
	(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dB)	
V	33.6073	-101.93	19.34	-82.59	-57	-25.59	peak
V	45.4699	-95.38	12.92	-82.46	-57	-25.46	peak
V	75.8009	-95.47	9.74	-85.73	-57	-28.73	peak
V	153.2586	-96.09	11.75	-84.34	-57	-27.34	peak
V	285.5592	-95.33	11.86	-83.47	-57	-26.47	peak
V	857.2321	-91.24	19.49	-71.75	-57	-14.75	peak
H	33.2877	-99.37	19.30	-80.07	-57	-23.07	peak
H	45.2198	-94.89	11.73	-83.16	-57	-26.16	peak
H	71.5628	-97.62	9.72	-87.90	-57	-30.90	peak
H	157.6225	-95.36	11.74	-83.62	-57	-26.62	peak
H	288.5328	-95.53	12.18	-83.35	-57	-26.35	peak
H	869.6724	-91.42	19.69	-71.73	-57	-14.73	peak

**Remark:**

Absolute Level= ReadingLevel+ Factor, Margin= Absolute Level - Limit

## ABOVE 1 GHz WORST- CASE DATA (1GHz ~ 12.75GHz)

Polar (H/V)	Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Remark
	(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dB)	
V	1731.500	-72.89	7.27	-65.62	-47	-18.62	peak
V	2520.000	-69.75	8.78	-60.97	-47	-13.97	peak
V	3465.000	-70.16	8.67	-61.49	-47	-14.49	peak
V	4345.000	-69.96	6.70	-63.26	-47	-16.26	peak
V	5223.500	-67.22	8.54	-58.68	-47	-11.68	peak
V	6182.500	-72.57	13.18	-59.39	-47	-12.39	peak
H	1728.000	-67.34	7.27	-60.07	-47	-13.07	peak
H	2538.000	-71.35	8.15	-63.20	-47	-16.20	peak
H	3406.000	-72.08	8.78	-63.30	-47	-16.30	peak
H	4315.000	-68.65	6.10	-62.55	-47	-15.55	peak
H	5243.000	-72.60	10.09	-62.51	-47	-15.51	peak
H	6209.000	-73.82	13.59	-60.23	-47	-13.23	peak

**Remark:**

Absolute Level= ReadingLevel+ Factor, Margin= Absolute Level - Limit

Note: All modes had been tested, but only the worst data recorded in the report.



## 10 TRANSIENT POWER

### 10.1 APPLICABILITY

Transient power applies to all transmitters.

### 10.2 LIMITS OF TRANSIENT POWER

The EUT shall comply with reference limits defined in ETSI EN 300 220-1 [1], clause 5.10.2.

The transient power shall not exceed the values given in Table 23.

**Table 23: Transmitter Transient Power limits**

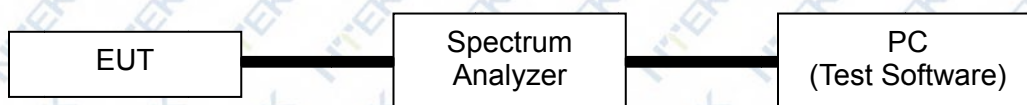
Absolute offset from centre frequency	RBW <sub>REF</sub>	Peak power limit applicable at measurement points
≤ 400 kHz	1 kHz	0 dBm
> 400 kHz	1 kHz	-27 dBm

### 10.3 TEST PROCEDURES

Refer to chapter 5.10.3.2 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 10.4 TEST SETUP





## 10.5 TEST RESULT

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX		

864MHz OCW=125KHz

Frequency	Center Frequency	RBW	Max Vaule	Limit	Results
MHz	MHz	(kHz)	(dBm)	(dBm)	(P/F)
-0,5 x OCW - 3 kHz	863.934	1kHz	-10.40	0 dBm	PASS
0,5 x OCW + 3 kHz	864.066	1kHz	-25.16	0 dBm	PASS
-OCW	863.875	3kHz	-39.15	0 dBm	PASS
+OCW	864.125	3kHz	-40.98	0 dBm	PASS
-0,5 x OCW - 400 kHz	863.537	100kHz	-58.12	-27 dBm	PASS
0,5 x OCW + 400 kHz	864.463	100kHz	-58.03	-27 dBm	PASS
-0,5 x OCW -1200 kHz	862.737	300kHz	-57.29	-27 dBm	PASS
0,5 x OCW +1200 kHz	865.263	300kHz	-57.29	-27 dBm	PASS

866MHz OCW=125KHz

Frequency	Center Frequency	RBW	Max Vaule	Limit	Results
MHz	MHz	(kHz)	(dBm)	(dBm)	(P/F)
-0,5 x OCW - 3 kHz	865.934	1kHz	-10.75	0 dBm	PASS
0,5 x OCW + 3 kHz	866.066	1kHz	-25.67	0 dBm	PASS
-OCW	865.875	3kHz	-42.19	0 dBm	PASS
+OCW	866.125	3kHz	-42.91	0 dBm	PASS
-0,5 x OCW - 400 kHz	865.537	100kHz	-58.05	-27 dBm	PASS
0,5 x OCW + 400 kHz	866.463	100kHz	-58.34	-27 dBm	PASS
-0,5 x OCW -1200 kHz	864.737	300kHz	-57.40	-27 dBm	PASS
0,5 x OCW +1200 kHz	867.263	300kHz	-57.51	-27 dBm	PASS



869MHzOCW=125KHz

Frequency	Center Frequency	RBW	Max Vaule	Limit	Results
MHz	MHz	(kHz)	(dBm)	(dBm)	(P/F)
-0,5 x OCW - 3 kHz	868.934	1kHz	-9.51	0 dBm	PASS
0,5 x OCW + 3 kHz	869.066	1kHz	-25.98	0 dBm	PASS
-OCW	868.875	3kHz	-41.75	0 dBm	PASS
+OCW	869.125	3kHz	-42.57	0 dBm	PASS
-0,5 x OCW - 400 kHz	868.537	100kHz	-57.95	-27 dBm	PASS
0,5 x OCW + 400 kHz	869.463	100kHz	-57.95	-27 dBm	PASS
-0,5 x OCW -1200 kHz	867.737	300kHz	-57.32	-27 dBm	PASS
0,5 x OCW +1200 kHz	870.263	300kHz	-57.46	-27 dBm	PASS



## 11. ADJACENT CHANNEL POWER

### 11.1 APPLICABILITY

Adjacent channel power applies to all transmitters with  $OCW \leq 25$  kHz.

### 11.2 LIMITS OF ADJACENT CHANNEL POWER

Where the Operating Channel Width is less than or equal to 25 kHz, the power in the adjacent channels shall not exceed the reference limits defined in ETSI EN 300 220-1 [1], clause 5.11.2.

**Table 26: Adjacent channel power limits for transmitters with  $OCW \leq 25$  kHz**

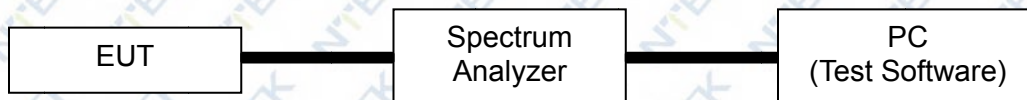
		Adjacent Channel power integrated over 0,7 x OCW	Alternate Adjacent Channel power integrated over 0,7 x OCW
OCW < 20 kHz	Normal test conditions	-20 dBm	-20 dBm
	Extreme test conditions	-15 dBm	-20 dBm
OCW ≥ 20 kHz	Normal test conditions	-37 dBm	-40 dBm
	Extreme test conditions	-32 dBm	-37 dBm

### 11.3 TEST PROCEDURES

Refer to chapter 5.11.3.3 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 11.4 TEST SETUP



## 11.5 TEST RESULT

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	N/A
Test Mode:	N/A		

Note: Not applicable.



## 12. TX BEHAVIOUR UNDER LOW VOLTAGE CONDITIONS

### 12.1 APPLICABILITY

TX behaviour under low voltage condition applies to battery powered EUT.

### 12.2 LIMITS OF TX BEHAVIOUR UNDER LOW VOLTAGE CONDITIONS

The EUT shall comply with reference limits defined in ETSI EN 300 220-1 [1], clause 5.12.2.

The equipment shall either:

- a) remain in the Operating Channel OC without exceeding any applicable limits (e.g. Duty Cycle);
- or
- b) reduce its effective radiated power below the Spurious Emission limits without exceeding any applicable limits(e.g. Duty Cycle); or
- c) shut down, (ceasing function);

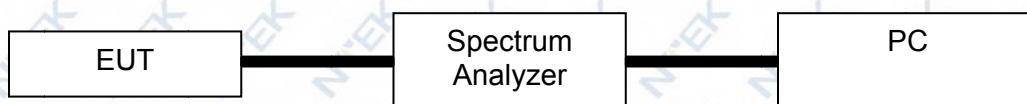
as the voltage falls below the manufacturers declared operating voltage.

### 12.3 TEST PROCEDURES

Refer to chapter 5.12.3.2 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 12.4 TEST SETUP





## 12.5 TEST RESULT

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26 °C	Relative Humidity:	60 %
Pressure:	1010 hPa	Test Power:	DC 3.3V
Test Mode:	TX		

### 864MHz

DC power Supplied (V) DC	Conducted Power	Limits
3.3	0.38	a) Remain on channel, for channelized equipment within the limits stated in clause 7.1.3, or within the assigned operating frequency band, for non-channelized equipment, whilst the radiated or conducted power is greater than the spurious emission limits; or b) The equipment cease to function below the providers declared operating voltage.
3.2	0.27	
3.1	-0.32	
3.0	-38.56	
< 3.0	No function	

Test Conditions	Stop Function Voltage (V)
T nom(°C) 20	3.0
Result	PASS

### 866MHz

DC power Supplied (V) DC	Conducted Power	Limits
3.3	0.09	a) Remain on channel, for channelized equipment within the limits stated in clause 7.1.3, or within the assigned operating frequency band, for non-channelized equipment, whilst the radiated or conducted power is greater than the spurious emission limits; or b) The equipment cease to function below the providers declared operating voltage.
3.2	0.07	
3.1	-0.32	
3.0	-37.56	
< 3.0	No function	

Test Conditions	Stop Function Voltage (V)
T nom(°C) 20	3.0
Result	PASS



## 869MHz

DC power Supplied (V) DC	Conducted Power	Limits
3.3	-0.48	a) remain in the Operating Channel OC without exceeding any applicable limits (e.g. Duty Cycle); or b) reduce its effective radiated power below the Spurious Emission limits without exceeding any applicable limits (e.g. Duty Cycle); or c) shut down, (ceasing function); as the voltage falls below the manufacturers declared operating voltage.
3.2	-0.38	
3.1	-1.85	
3.0	-37.34	
< 3.0	No function	

Test Conditions	Stop Function Voltage (V)
T nom(°C) 20	3.0
Result	PASS

### 13. ADAPTIVE POWER CONTROL

#### 13.1 APPLICABILITY

Adaptive power control applies to all EUT with adaptive power control using annex C band AF.

#### 13.2 LIMITS OF ADAPTIVE POWER CONTROL

The EUT shall comply with reference limits defined in ETSI EN 300 220-1 [1], clause 5.13.2.

The peak power measured when active APC function at its minimum setting shall not exceed the value shown in Table 29.

**Table 29: APC power limit**

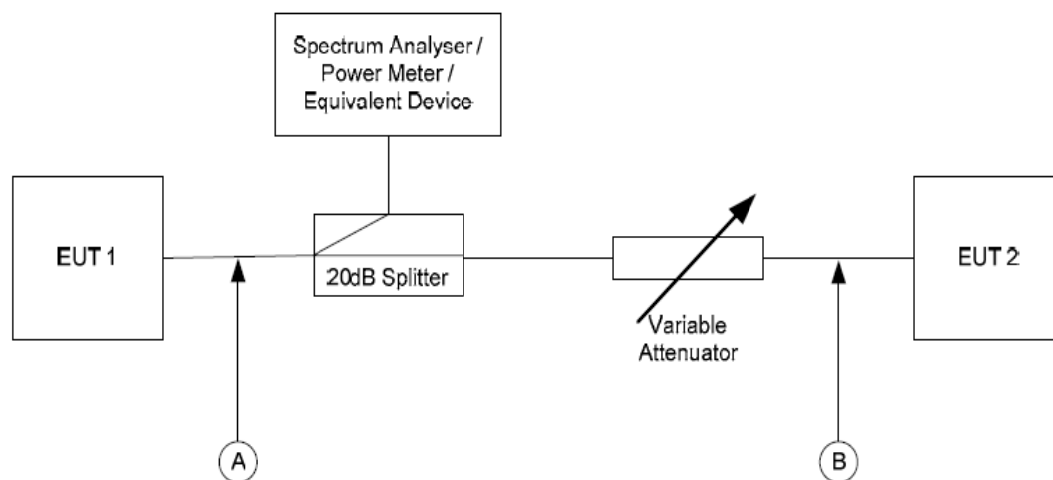
Parameter	Limit
Transmitted e.r.p.	+7 dBm

#### 13.3 TEST PROCEDURES

Refer to chapter 5.12.3.2 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

#### 13.4 TEST SETUP



**Figure 8: APC Measurement Setup**

The EUTs shall be set to communicate with each other for at least the APC settling time.

The test equipment shall then be used to measure power for at least 60 seconds.

NOTE: The power measuring interval should be sufficiently long to capture transmissions from the EUT.



## 13.5 TEST RESULT

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26 °C	Relative Humidity:	60 %
Pressure:	1010 hPa	Test Power:	N/A
Test Mode:	N/A		

Note: The equipment is not applicable for adaptive power control.

## 14. RX SENSITIVITY LEVEL

### 14.1 APPLICABILITY

Rx sensitivity requirement is applicable to all EUT employing polite spectrum access as set out in clause 4.5.1.

### 14.2 LIMITS OF RX SENSITIVITY LEVEL

Refer to chapter 4.4.1.2 of ETSI EN 300 220-2 V3.2.1& EN 300 220-1 V3.1.1, clause 5.14.2.

The sensitivity for receivers shall be below or equal to Table 32 level.

**Table 32: Limits for Receiver sensitivity**

$$S = 10 \log RB_{kHz} - 4 \text{ dB}\mu V \text{ emf}; \text{ or}$$

$$S_p = 10 \log RB_{kHz} - 117 \text{ dBm}$$

where:

- $S_p$  is the sensitivity in dBm.
- RB is the declared receiver bandwidth in kHz.

The receiver bandwidth RB shall be declared by the manufacturer. RB is the usually 3 dB receiver bandwidth selectivity.

For example, the sensitivity for a 25 kHz Operating Channel equipment with a 16 kHz bandwidth shall be better than +8 dBμV emf for a 50 Ω receiver input impedance. This corresponds to a receiver sensitivity of -105 dBm.

### 14.3 TEST PROCEDURES

Refer to chapter 5.14.3.3 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 14.4 TEST SETUP





## 14.5 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	N/A
Test Mode:	N/A		

Note: The EUT has no function of polite spectrum access. So this test is not applicable.



## 15. BLOCKING

### 15.1 APPLICABILITY

Blocking applies to all receivers.

### 15.2 LIMITS OF BLOCKING

The blocking level shall be better or equal to category 2 reference limits level defined in ETSI EN 300 220-1 [1], clause 5.18.3.

**Table 41: Blocking level parameters for RX category 2**

Requirement	Limits
	Receiver category 2
Blocking at $\pm 2$ MHz from OC edge f <sub>high</sub> and f <sub>low</sub>	$\geq -69$ dBm
Blocking at $\pm 10$ MHz from OC edge f <sub>high</sub> and f <sub>low</sub>	$\geq -44$ dBm
Blocking at $\pm 5$ % of Centre Frequency or 15 MHz, whichever is the greater	$\geq -44$ dBm

The blocking levels at the specified frequency offsets shall be equal to or greater than the limits Table 42, except at frequencies where spurious responses are found.

**Table 42: Blocking level parameters for RX category 1.5**

Requirement	Limits
	Receiver category 1.5
Blocking at $\pm 2$ MHz from OC edge f <sub>high</sub> and f <sub>low</sub>	$\geq -43$ dBm
Blocking at $\pm 10$ MHz from OC edge f <sub>high</sub> and f <sub>low</sub>	$\geq -33$ dBm
Blocking at $\pm 5$ % of Centre Frequency or 15 MHz, whichever is the greater	$\geq -33$ dBm

The blocking levels at the specified frequency offsets shall be equal to or greater than the limits Table 43, except at frequencies where spurious responses are found.

**Table 43: Blocking level parameters for RX category 1**

Requirement	Limits
	Receiver category 1
Blocking at $\pm 2$ MHz from Centre Frequency	$\geq -20$ dBm
Blocking at $\pm 10$ MHz from Centre Frequency	$\geq -20$ dBm
Blocking at $\pm 5$ % of Centre Frequency or 15 MHz, whichever is the greater	$\geq -20$ dBm

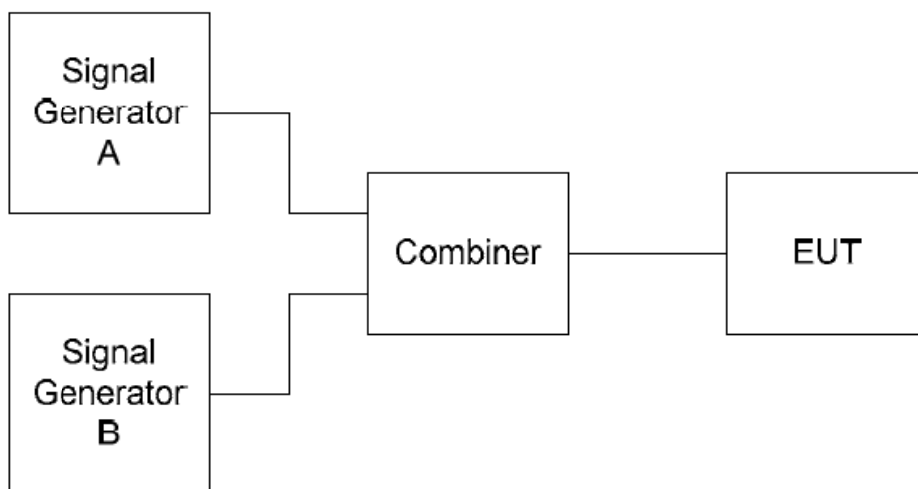


### 15.3 TEST PROCEDURES

Refer to chapter 5.18.6.3&5.18.6.4 of ETSI EN 300 220-1 V3.1.1 (2017-02)

Measurement	
<input checked="" type="checkbox"/> Conducted measurement	<input type="checkbox"/> Radiated measurement

### 15.4 TEST SETUP



**Figure 10: Blocking measurement arrangement**



## 15.5 TEST RESULTS

EUT:	LoRa Module	Model Name:	Ra-01H
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	RX		

## 864MHz

Flow=863.9375MHz; Fhigh=864.0625MHz

Receiver category	Frequency offset	Test Frequency (MHz)	Receiver BW(kHz)	Measurement Vause(dB)	≧ Limit(dB)
2	+2 MHz of Flow	865.9375	125	-37	-69
	-2 MHz of Flow	861.9375	125	-35	-69
	+2 MHz of Fhigh	866.0625	125	-36	-69
	-2 MHz of Fhigh	862.0625	125	-33	-69
	+10 MHz of Fhigh	874.0625	125	-27	-44
	-10 MHz of Fhigh	854.0625	125	-27	-44
	+10 MHz of Flow	873.9375	125	-26	-44
	-10 MHz of Flow	853.9375	125	-20	-44
	-43.2 MHz	820.6375	125	-27	-44
	+43.2 MHz	907.36	125	-25	-44

## 866MHz

Flow=865.9375MHz; Fhigh=866.0625MHz

Receiver category	Frequency offset	Test Frequency (MHz)	Receiver BW(kHz)	Measurement Vause(dB)	≧ Limit(dB)
2	+2 MHz of F <sub>low</sub>	867.9375	125	-33	-69
	-2 MHz of F <sub>low</sub>	863.9375	125	-35	-69
	+2 MHz of F <sub>high</sub>	868.0625	125	-31	-69
	-2 MHz of F <sub>high</sub>	864.0625	125	-32	-69
	+10 MHz of F <sub>high</sub>	876.0625	125	-31	-44
	-10 MHz of F <sub>high</sub>	856.0625	125	-23	-44
	+10 MHz of F <sub>low</sub>	875.9375	125	-24	-44
	-10 MHz of F <sub>low</sub>	855.9375	125	-21	-44
	-43.2 MHz	822.6375	125	-27	-44
	+43.2 MHz	909.36	125	-24	-44

## 869MHz

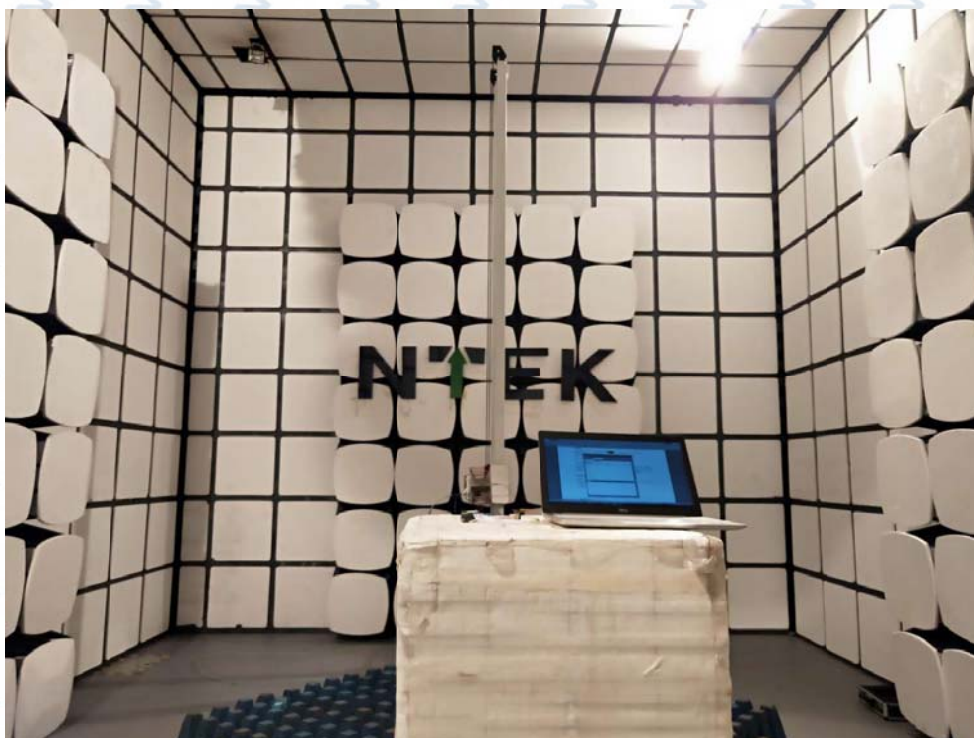
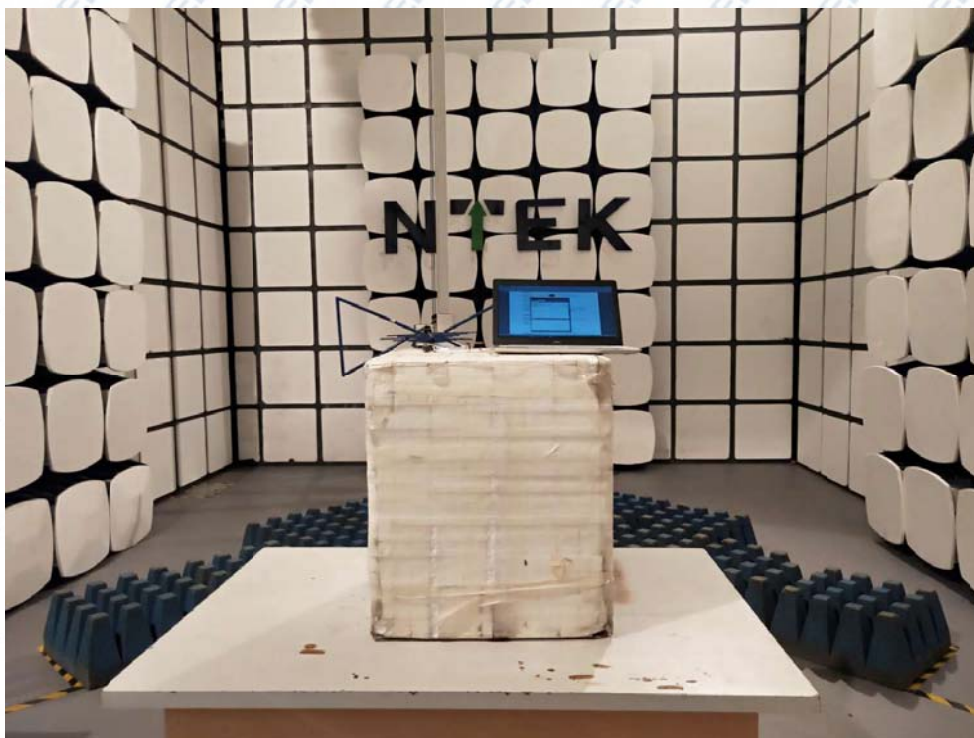
Flow=868.9375 MHz; Fhigh=869.0625MHz

Receiver category	Frequency offset	Test Frequency (MHz)	Receiver BW(kHz)	Measurement Vause(dB)	≧ Limit(dB)
2	+2 MHz of F <sub>low</sub>	870.9375	125	-34	-69
	-2 MHz of F <sub>low</sub>	866.9375	125	-36	-69
	+2 MHz of F <sub>high</sub>	871.0625	125	-32	-69
	-2 MHz of F <sub>high</sub>	867.0625	125	-33	-69
	+10 MHz of F <sub>high</sub>	879.0625	125	-23	-44
	-10 MHz of F <sub>high</sub>	859.0625	125	-21	-44
	+10 MHz of F <sub>low</sub>	878.9375	125	-24	-44
	-10 MHz of F <sub>low</sub>	858.9375	125	-24	-44
	-43.2 MHz	825.4875	125	-29	-44
	+43.2 MHz	912.51	125	-27	-44



## APPENDIX-PHOTOGRAPHS OF EUT CONSTRUCTIONAL DETAILS

### Radiated Measurement Photos



END OF REPORT