



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-01SH

Family Model: N/A

Report No.: S20110203403001

Prepared for

Shenzhen Ai-Thinker Technology Co., Ltd

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Prepared by

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TEST RESULT CERTIFICATION

Applicant's name : Shenzhen Ai-Thinker Technology Co., Ltd

Address : 410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road,
Gushu Community, Xixiang Street, Baoan District, Shenzhen,
China

Manufacturer's Name : Shenzhen Ai-Thinker Technology Co., Ltd

Address : 410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road,
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

Rating(s) : DC 3.3V

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 : 02 Nov. 2020 ~04 Dec. 2020

Date of Issue : 04 Dec. 2020

Test Result : **Pass**

Testing Engineer :

(Mary Hu)

Technical Manager :

(Jason Chen)

Authorized Signatory :

(Alex Li)

Table of Contents

Page

1 . SUMMARY OF TEST RESULTS	6
1.1 TEST FACILITY	7
1.2 MEASUREMENT UNCERTAINTY	7
2 . GENERAL INFORMATION	9
2.1 GENERAL DESCRIPTION OF EUT	9
2.2 DESCRIPTION OF TEST CONDITIONS	11
2.3 DESCRIPTION OF SUPPORT UNITS	12
2.4 TEST CONDITIONS	13
2.5 EQUIPMENTS LIST FOR ALL TEST ITEMS	14
3 . OPERATING FREQUENCY	15
3.1 LIMITS OF OPERATING FREQUENCY	15
3.2 TEST PROCEDURE	15
3.3 CONFORMANCE	15
4 . EFFECTIVE RADIATED POWER	16
4.1LIMITS OF EFFECTIVE RADIATED POWER	16
4.2 TEST PROCEDURE	16
4.3 DEVIATION FROM TEST STANDARD	16
4.4 TEST SETUP	16
4.5 TEST RESULTS	17
5 . MAXIMUM EFFECTIVE RADIATED POWER SPECTRAL DENSITY	18
5.1 APPLICABILITY	18
5.2 LIMITS OF MAXIMUM EFFECTIVE RADIATED POWER SPECTRAL DENSITY	18
5.3 TEST PROCEDURES	18
5.4 TEST SETUP	18
5.5 TEST RESULTS	19
6. DUTY CYCLE	20
6.1 APPLICABILITY	20
6.2 LIMITS OF DUTY CYCLE	20
6.3 TEST PROCEDURE	20
6.4 TEST SETUP	20
6.5 TEST RESULTS	21
7.1 APPLICABILITY	24

Table of Contents

Page

7.2 LIMITS OF OCCUPIED BANDWIDTH	24
7.3 TEST PROCEDURE	24
7.4 TEST SETUP	24
7.5 TEST RESULTS	25
8. TX OUT OF BAND EMISSIONS	27
8.1 APPLICABILITY	27
8.2 LIMITS OF TX OUT OF BAND EMISSIONS	27
8.3 TEST PROCEDURES	27
8.4 TEST SETUP	27
8.5 TEST RESULTS	28
9. UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN	31
9.1 APPLICABILITY	31
9.2 LIMITS OF UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN	31
9.3 MEASURING INSTRUMENTS AND SETTING	31
9.4 TEST PROCEDURES	31
9.5 TEST SETUP LAYOUT	32
9.6 EUT OPERATION DURING TEST	33
9.7 TEST RESULTS	34
10 TRANSIENT POWER	36
10.1 APPLICABILITY	36
10.2 LIMITS OF TRANSIENT POWER	36
10.3 TEST PROCEDURES	36
10.4 TEST SETUP	36
10.5 TEST RESULT	37
11. ADJACENT CHANNEL POWER	39
11.1 APPLICABILITY	39
11.2 LIMITS OF ADJACENT CHANNEL POWER	39
11.3 TEST PROCEDURES	39
11.4 TEST SETUP	39
11.5 TEST RESULT	40
12. TX BEHAVIOUR UNDER LOW VOLTAGE CONDITIONS	41
12.1 APPLICABILITY	41
12.2 LIMITS OF TX BEHAVIOUR UNDER LOW VOLTAGE CONDITIONS	41

Table of Contents	Page
12.3 TEST PROCEDURES	41
12.4 TEST SETUP	41
12.5 TEST RESULT	42
13. ADAPTIVE POWER CONTROL	43
13.1 APPLICABILITY	43
13.2 LIMITS OF ADAPTIVE POWER CONTROL	43
13.3 TEST PROCEDURES	43
13.4 TEST SETUP	43
13.5 TEST RESULT	44
14. RX SENSITIVITY LEVEL	45
14.1 APPLICABILITY	45
14.3 TEST PROCEDURES	45
14.4 TEST SETUP	45
14.5 TEST RESULTS	46
15. BLOCKING	47
15.1 APPLICABILITY	47
15.2 LIMITS OF BLOCKING	47
15.3 TEST PROCEDURES	48
15.4 TEST SETUP	48
15.5 TEST RESULTS	49
APPENDIX-PHOTOGRAPHS OF EUT CONSTRUCTIONAL DETAILS	50

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 expended 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
S20110203403001	Rev.01	Initial issue of report	04 Dec. 2020

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

Equipment	LoRa Module	
Brand Name	 	
Model Name.	Ra-01SH	
Family Model	N/A	
Model Difference	N/A	
Product Description	The EUT is LoRa Module	
	Operation Frequency Band:	Band AA: 863MHz-870MHz
	Channel number	6CH
	Modulation Type:	FSK/OOK
	Antenna Gain(Peak)	3dBi
	Antenna Designation:	Spring Antenna
	Power Rating	Band AA: 863MHz-870MHz
	Receiver Category	2
	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	N/A	
Firmware 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. Test Channel:

TX

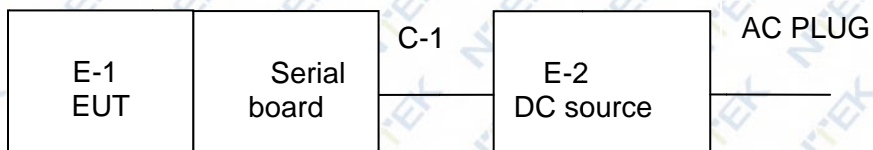
Channel	Frequency (MHz)
01	864
02	865
03	866
04	867
05	868
06	869

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-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.

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 3.0-3.6V

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	2020.05.11	2021.05.10	1 year
2	Test Receiver	R&S	ESPI7	101318	2020.05.11	2021.05.10	1 year
3	Bilog Antenna	TESEQ	CBL6111D	31216	2020.04.11	2021.04.10	1 year
4	50Ω Coaxial Switch	Anritsu	MP59B	6200983705	2020.05.11	2023.05.10	3 year
5	Spectrum Analyzer	Agilent	N9020A	MY49100060	2020.05.11	2021.05.10	1 year
6	Horn Antenna	EM	EM-AH-10180	2011071402	2020.05.11	2021.05.10	1 year
7	Horn Ant	Schwarzbeck	BBHA 9170	9170-181	2020.05.11	2021.05.10	1 year
8	Amplifier	EMC	EMC051835SE	980246	2020.7.13	2021.7.12	1 year
9	Loop Antenna	ARA	PLA-2030/B	1029	2020.05.11	2021.05.10	1 year
10	Power Meter	Agilent	E4419B	MY45102538	2020.7.13	2021.7.12	1 year
11	ESG VETCTOR SIGNAL GENERATOR	Agilent	E4438C	MY45093347	2020.7.13	2021.7.12	1 year
12	Temperature & Humidity Chamber	GIANT FORCE	GTH-056P	GF-94454-1	2020.05.11	2021.05.10	1 year
13	Power Sensor	Agilent	E9301A.	MY41495644	2020.05.11	2021.05.10	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	300KHz _{Note}

Note: The manufacturer declared the OCW=300kHz.

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

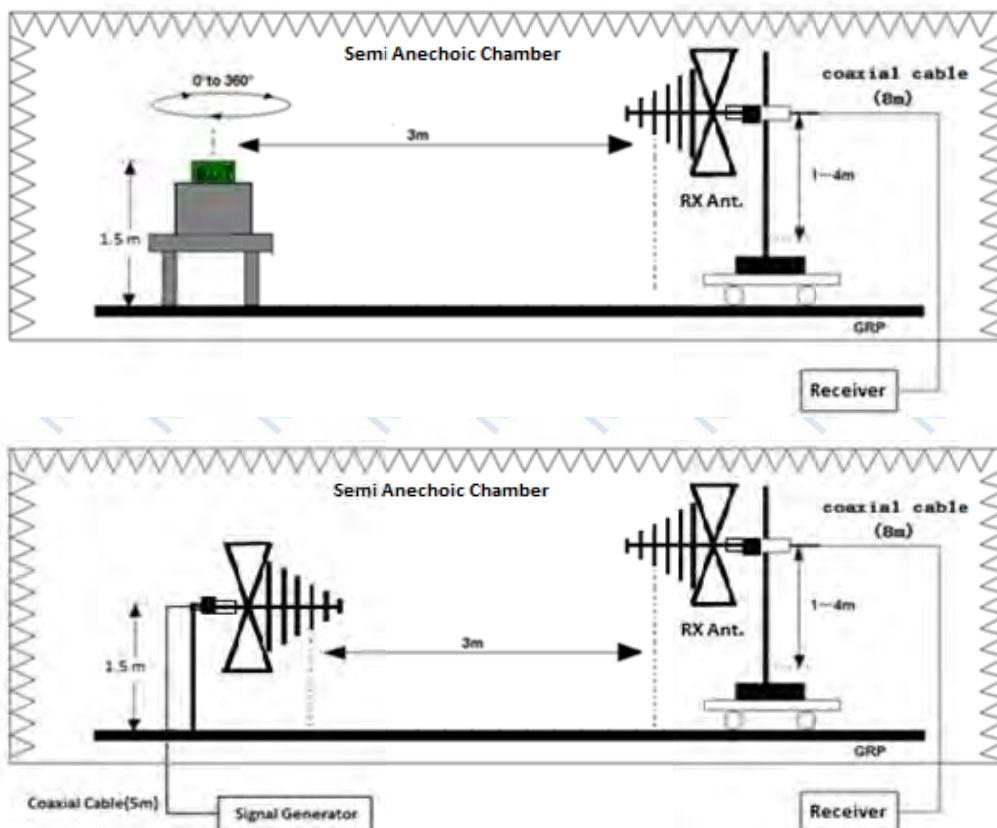
Refer to chapter 5.2.2.2 of ETSI EN 300 220-1 V3.1.1 (2017-02)

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-01SH
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	5.73	2.38	12.34	2.15	13.54	22.59	25	PASS
864	V	5.11	2.38	12.34	2.15	12.92	19.59	25	PASS
866	H	5.51	2.38	12.34	2.15	13.32	21.48	25	PASS
866	V	5.1	2.38	12.34	2.15	12.91	19.54	25	PASS
869	H	5.44	2.38	12.35	2.15	13.26	21.18	25	PASS
869	V	5.06	2.38	12.35	2.15	12.88	19.41	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

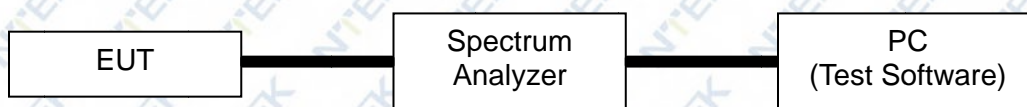
The Maximum e.r.p. power spectral density shall not be greater than the value allowed in annex B or any NRI for the chosen operational frequency band(s).

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-01SH
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:

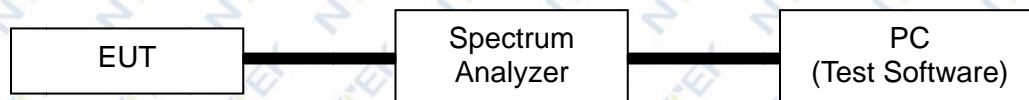
Operational Frequency Band	Maximum Effective Radiated Power	Channel access and occupation rules	Additional spectrum access parameters	Maximum occupied bandwidth	Other usage restriction	Band number in CEPT/ERC/REC 70-03 [i.1]
AA 863 MHz to 870 MHz	25 mW e.r.p.	≤ 0.1 % duty cycle or polite spectrum access		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: h.1.3 (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-01SH
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX-864		

Duty Cycle	Limit	Result
0.242%	1%	Complies

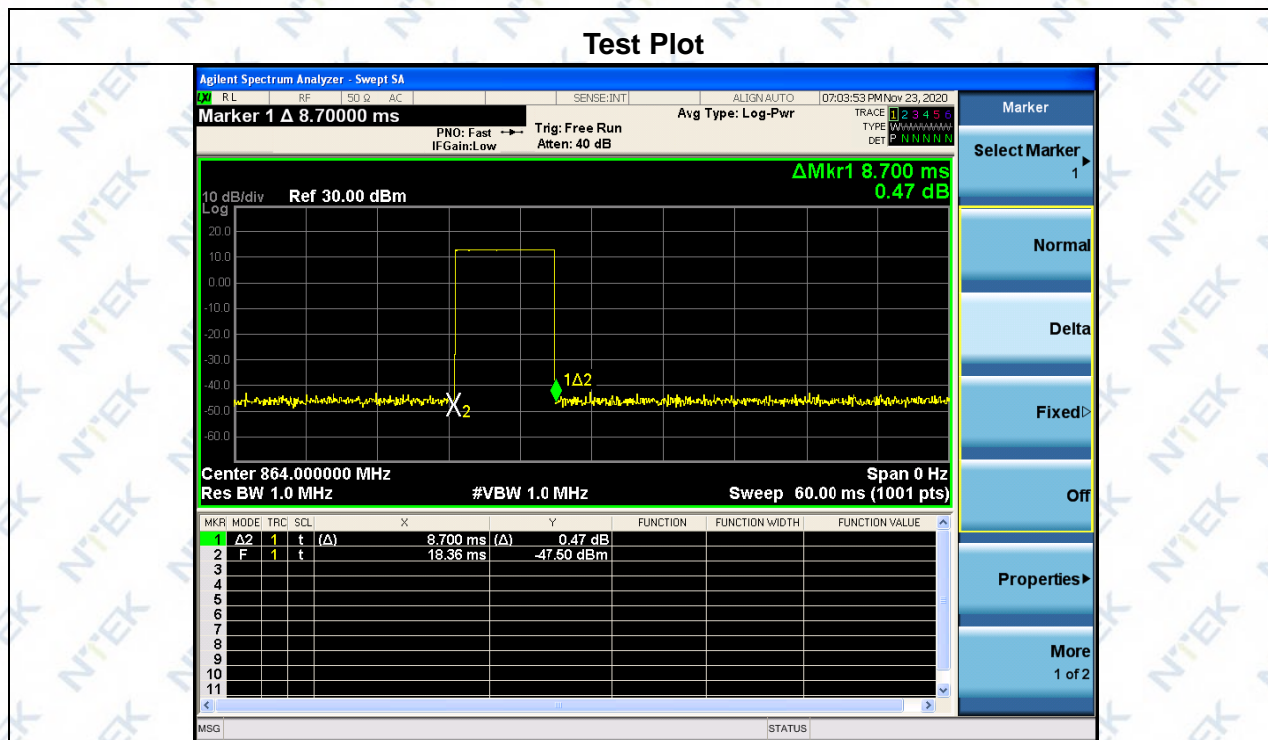
$T_{on}=8.7ms$

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

$DC=(8.7 \times 100)/3600000=0.00242=0.242\%$

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.

Test Plot



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

Duty Cycle	Limit	Result
0.237%	1%	Complies

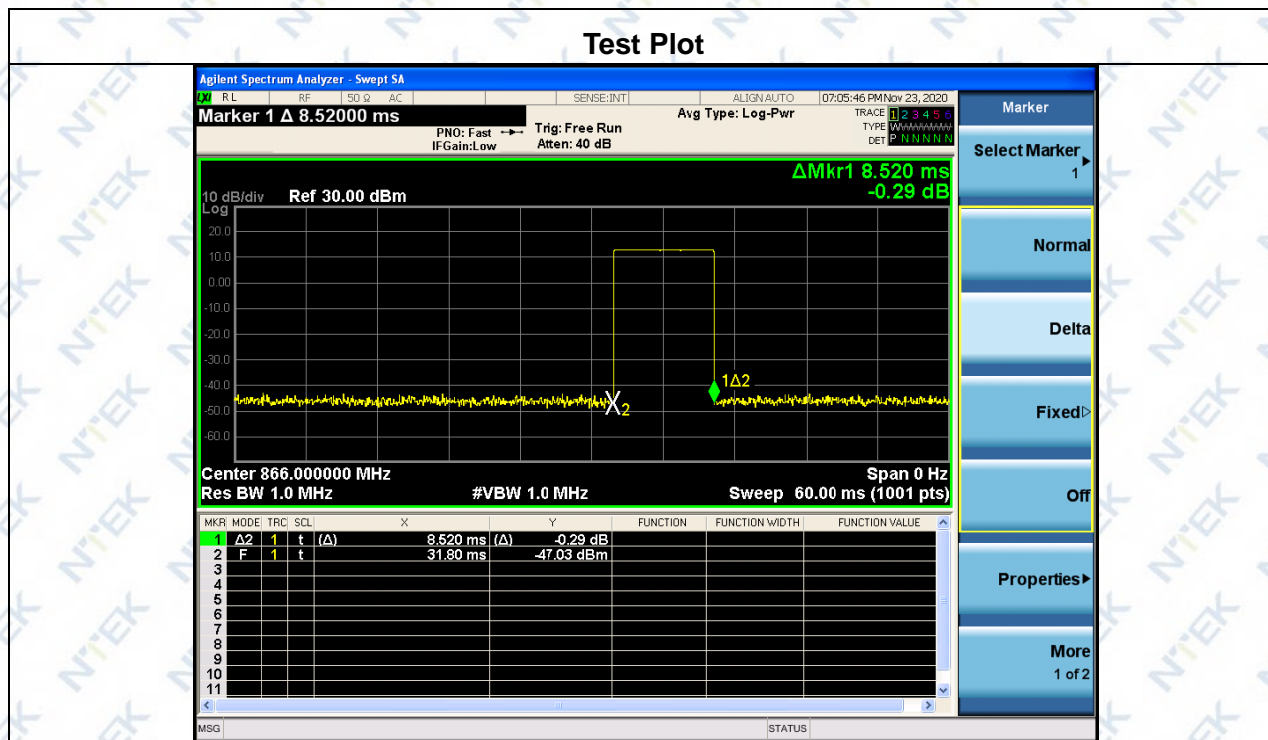
$T_{on}=8.52\text{ms}$

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

$DC=(8.52 \times 1000) / 3600000=0.00237=0.237\%$

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.

Test Plot



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

Duty Cycle	Limit	Result
0.240%	1%	Complies

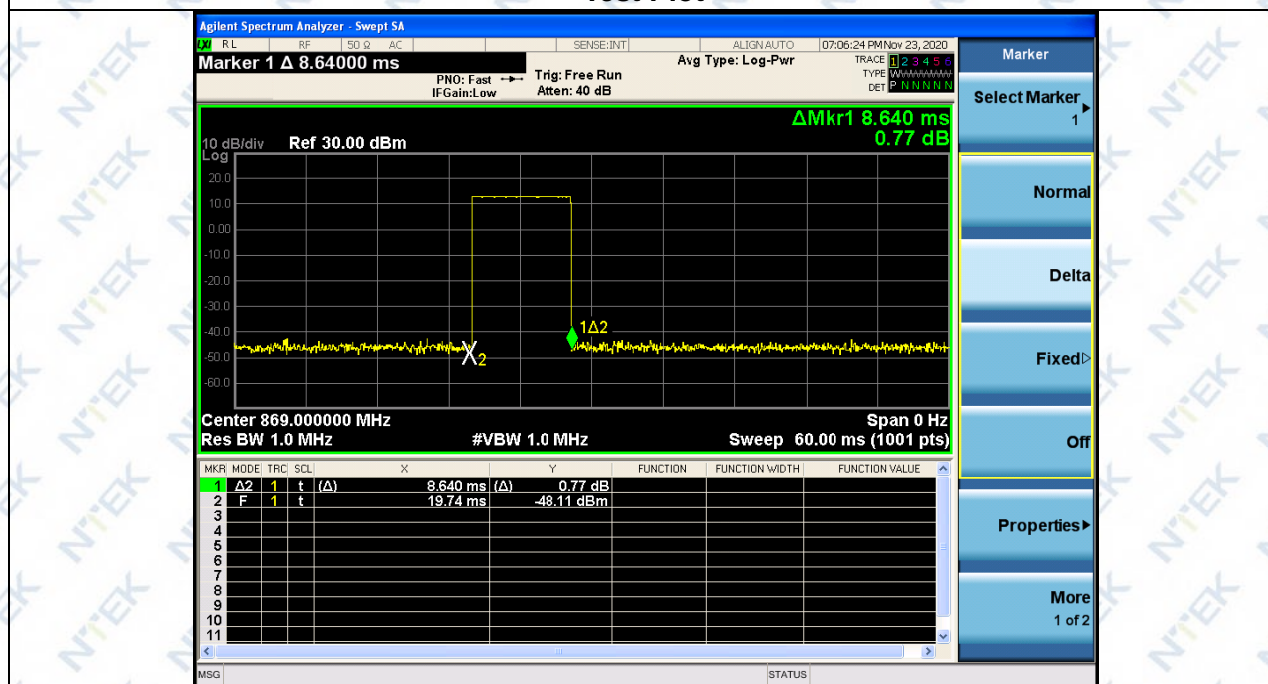
$T_{on}=8.64\text{ms}$

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

$DC=(8.64 \times 100) / 3600000 = 0.00240 = 0.240\%$

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.

Test Plot



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:

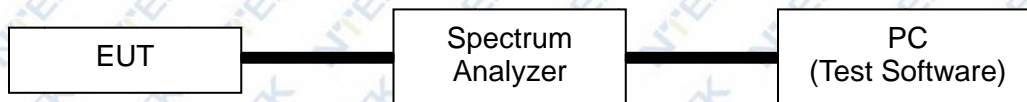
	Operational Frequency Band	Maximum Effective Radiated Power	Channel access and occupation rules	Additional spectrum access parameters	Maximum occupied bandwidth	Other usage restriction	Band number in CEPT/ERC/REC 70-03 [i.1]
AA	863 MHz to 870 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle or polite spectrum access		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: h.1.3 (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-01SH
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	265.37	863.85	864.15	300 kHz except for voice limited to 25 kHz	PASS
03	866	265.96	865.85	866.15		
06	869	264.52	868.85	869.15		

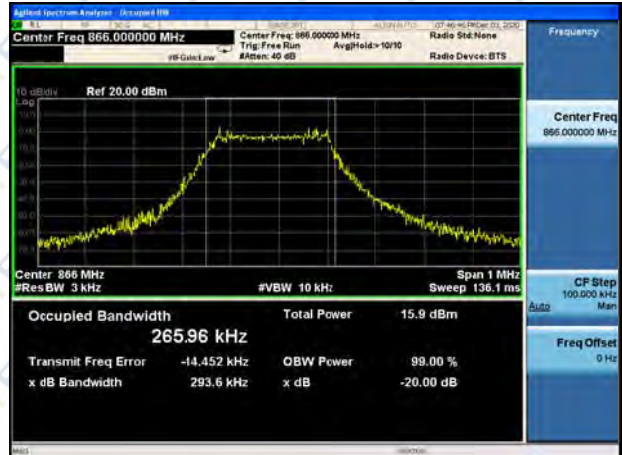
Note: $F_L(f_{LOW}) = F_c(\text{Center Frequency}) - OCW/2$; $F_H(f_{HIGH}) = F_c(\text{Center Frequency}) + OCW/2$

Test Plot

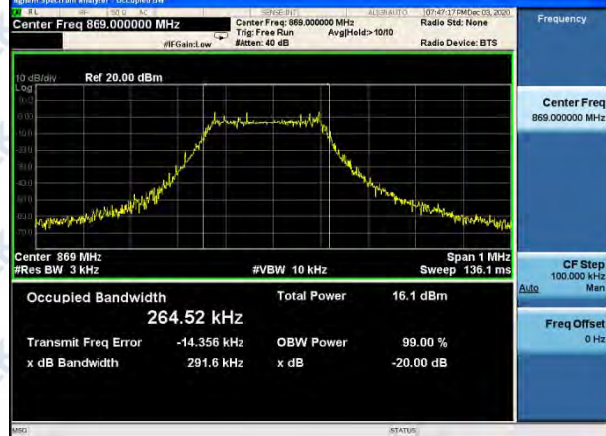
99% Power Bandwidth plot on channel 01



99% Power Bandwidth plot on channel 03



99% Power Bandwidth on plot channel 06



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 _{REF}	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-01SH
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX		

864MHz OCW=300KHz

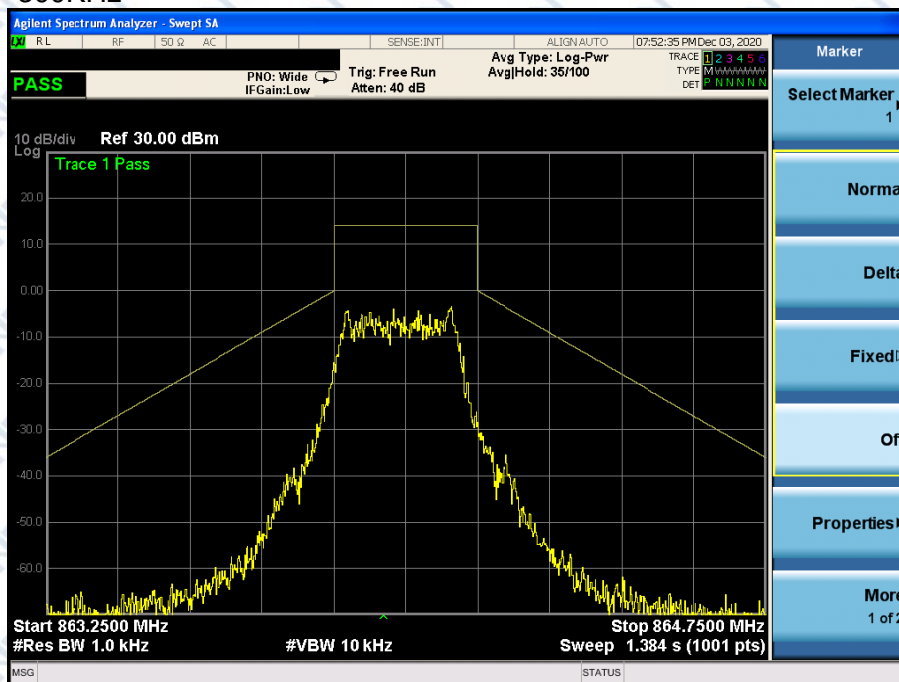


Figure 5 Out Of Band Domain for Operating Channel with reference BW

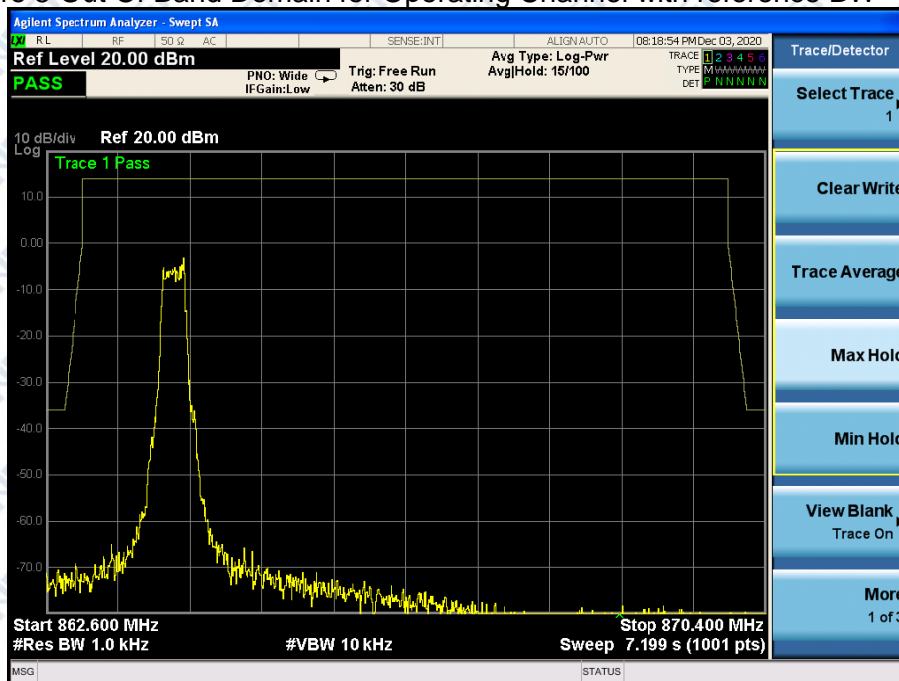


Figure 6 Out Of Band Domain for Operational Frequency Band with reference BW

866MHz OCW=300KHz

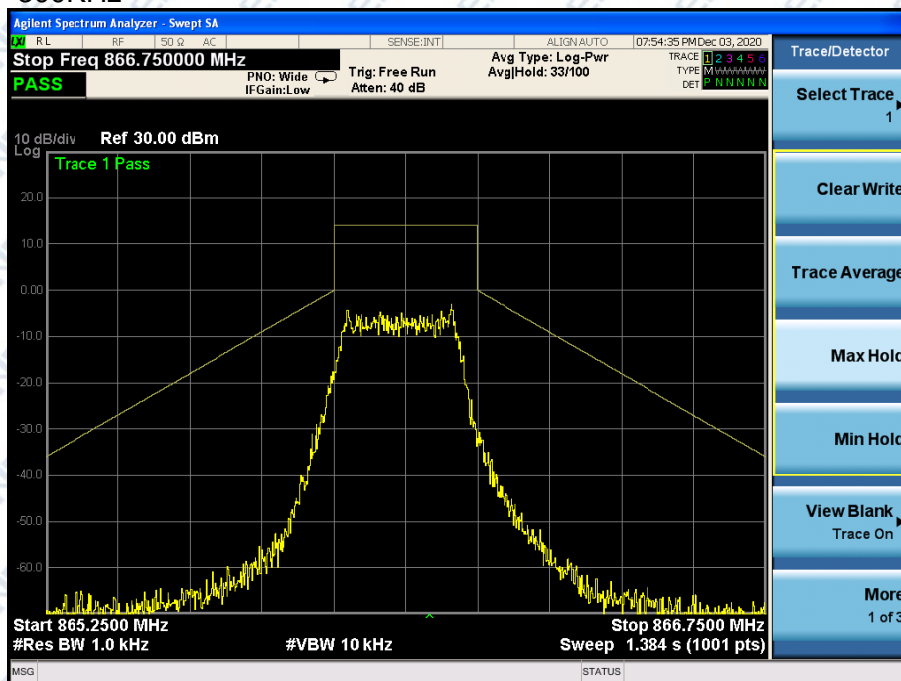


Figure 5 Out Of Band Domain for Operating Channel with reference BW

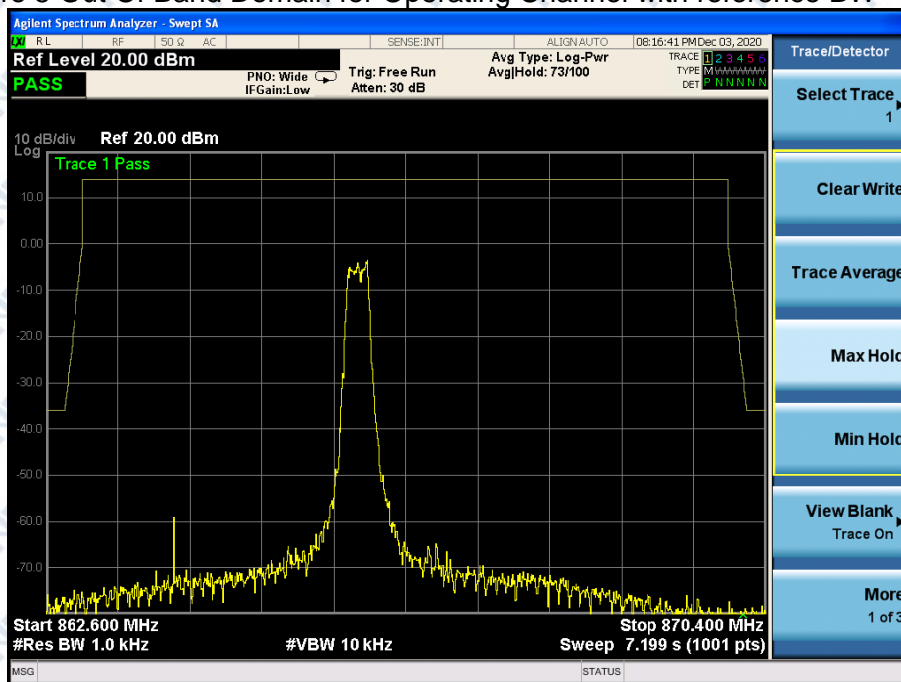


Figure 6 Out Of Band Domain for Operational Frequency Band with reference BW

869MHz OCW=300KHz

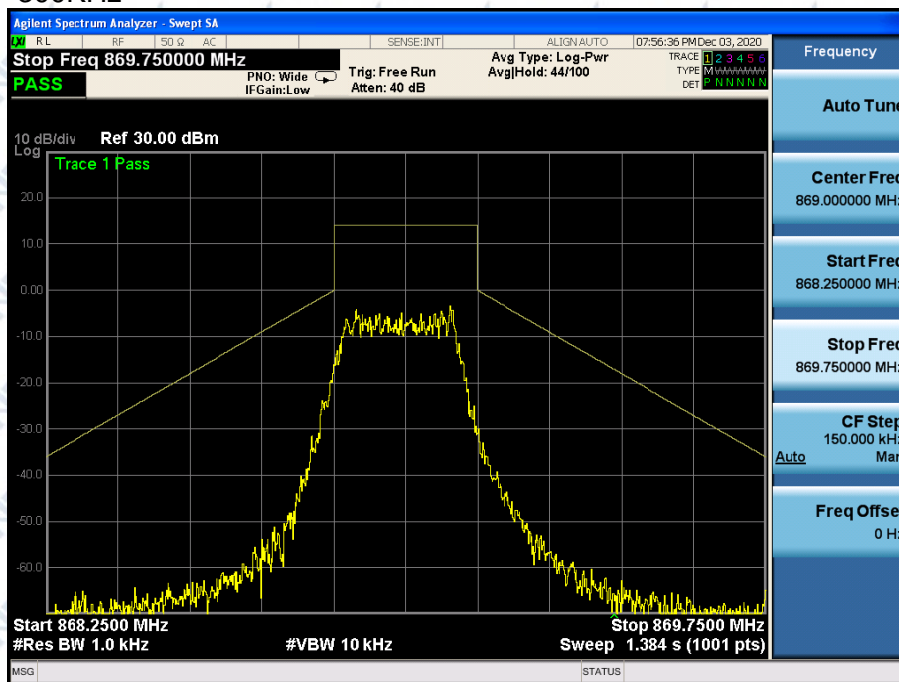


Figure 5 Out Of Band Domain for Operating Channel with reference BW

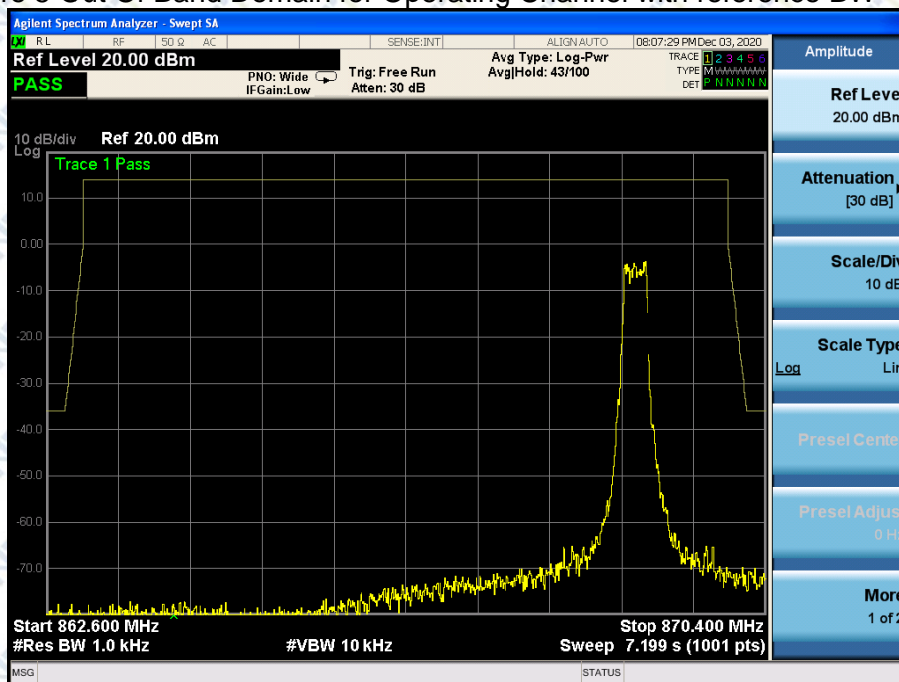


Figure 6 Out Of Band Domain for Operational Frequency Band with reference BW

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 _{REF} (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_{REF}, use bandwidth correction from clause 4.3.10.1.

Table 22: Spurious Radiations radiated Measurement Frequency Range

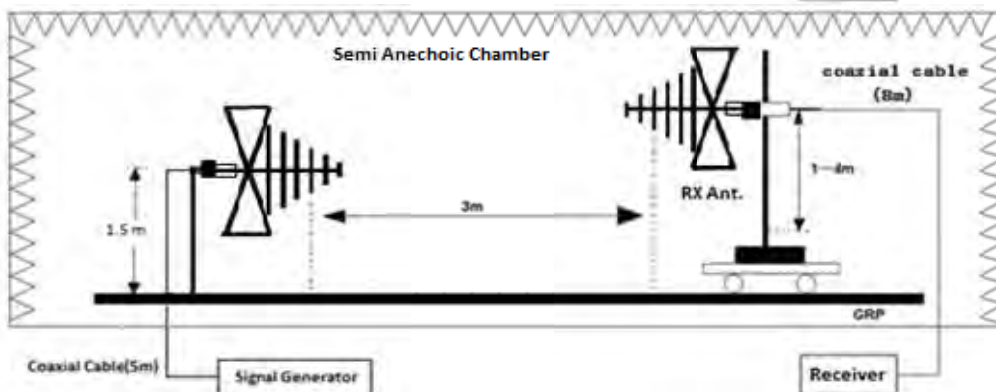
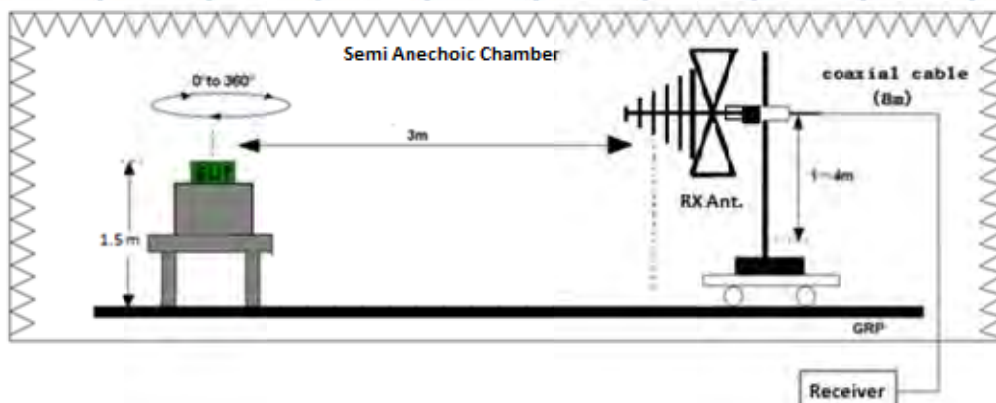
Frequency Range
25 MHz to 6 GHz
NOTE: The measurements need only to be performed over the frequency range 4 GHz to 6 GHz if emissions are detected within 10 dB of the specified limit between 1,5 GHz and 4 GHz.

9.4 TEST PROCEDURES

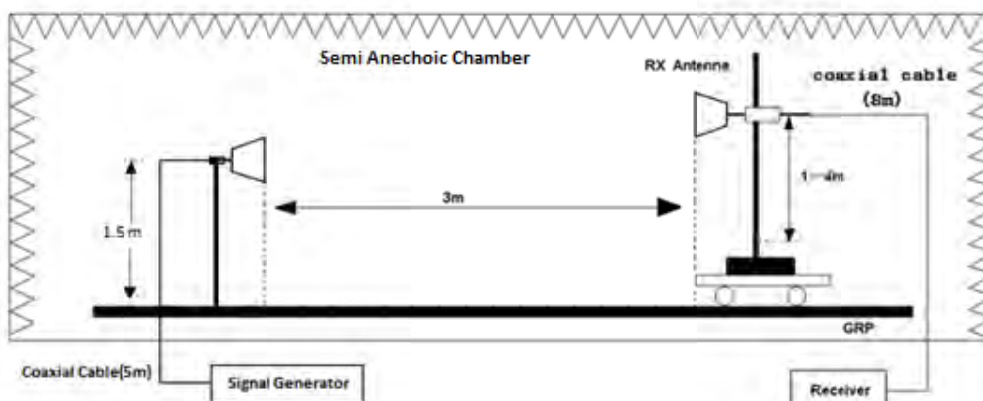
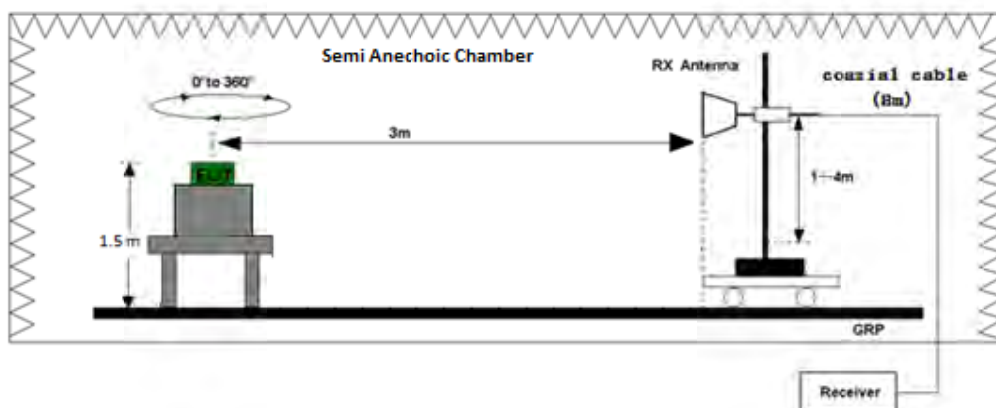
Refer to chapter 5.9.3.3.2 of ETSI EN 300 220-1 V3.1.1 (2017-02)

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-01SH
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	44.5867	-75.05	11.80	-63.25	-36.00	-27.25	peak
V	51.3004	-76.43	8.39	-68.04	-54.00	-14.04	peak
V	56.5929	-75.55	6.86	-68.69	-54.00	-14.69	peak
V	114.1136	-83.40	13.07	-70.33	-54.00	-16.33	peak
V	143.8291	-85.12	13.18	-71.94	-36.00	-35.94	peak
V	383.9318	-90.22	18.78	-71.44	-36.00	-35.44	peak
H	43.2017	-79.23	12.45	-66.78	-36.00	-30.78	peak
H	96.0986	-79.60	11.08	-68.52	-54.00	-14.52	peak
H	125.8863	-83.05	13.35	-69.70	-36.00	-33.70	peak
H	167.8240	-80.41	11.38	-69.03	-36.00	-33.03	peak
H	383.9318	-89.17	18.78	-70.39	-36.00	-34.39	peak
H	432.5457	-87.83	20.14	-67.69	-36.00	-31.69	peak

Remark:

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

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

Polar (H/V)	Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
	(MHz)	(dBm)	(dB)	(dBm)	(dBm)	(dB)	
V	1793.125	-59.40	3.69	-55.71	-30.00	-25.71	peak
V	2703.750	-66.20	9.46	-56.74	-30.00	-26.74	peak
V	2968.125	-66.19	8.96	-57.23	-30.00	-27.23	peak
V	3203.125	-67.02	8.14	-58.88	-30.00	-28.88	peak
V	7168.750	-72.46	13.97	-58.49	-30.00	-28.49	peak
V	10458.750	-74.77	17.05	-57.72	-30.00	-27.72	peak
H	2086.875	-67.57	9.38	-58.19	-30.00	-28.19	peak
H	2527.500	-66.78	9.00	-57.78	-30.00	-27.78	peak
H	4113.750	-69.51	8.27	-61.24	-30.00	-31.24	peak
H	7110.000	-73.11	14.44	-58.67	-30.00	-28.67	peak
H	8343.750	-72.81	15.14	-57.67	-30.00	-27.67	peak
H	10693.750	-74.77	23.18	-51.59	-30.00	-21.59	peak

Remark:

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

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

EUT:	LoRa Module	Model Name:	Ra-01SH
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	167.8240	-92.09	11.38	-80.71	-57.00	-23.71	peak
V	212.2692	-87.65	10.94	-76.71	-57.00	-19.71	peak
V	324.4560	-94.36	16.63	-77.73	-57.00	-20.73	peak
V	601.4265	-93.26	23.95	-69.31	-57.00	-12.31	peak
V	744.8659	-99.84	27.55	-72.29	-57.00	-15.29	peak
V	979.1802	-99.93	31.02	-68.91	-57.00	-11.91	peak
H	130.3788	-88.14	13.45	-74.69	-57.00	-17.69	peak
H	167.8240	-89.57	11.38	-78.19	-57.00	-21.19	peak
H	222.9499	-87.55	12.02	-75.53	-57.00	-18.53	peak
H	625.0778	-98.41	24.77	-73.64	-57.00	-16.64	peak
H	744.8659	-100.01	27.55	-72.46	-57.00	-15.46	peak
H	912.8618	-99.46	29.67	-69.79	-57.00	-12.79	peak

Remark:

Emission Level= Meter Reading+ Factor, Margin= Emission 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	1793.125	-63.71	3.69	-60.02	-47.00	-13.02	peak
V	2204.375	-65.76	8.06	-57.70	-47.00	-10.70	peak
V	2703.750	-67.28	9.46	-57.82	-47.00	-10.82	peak
V	2968.125	-67.76	8.96	-58.80	-47.00	-11.80	peak
V	8490.625	-73.38	15.58	-57.80	-47.00	-10.80	peak
V	10458.750	-74.98	17.05	-57.93	-47.00	-10.93	peak
H	1558.125	-61.79	2.91	-58.88	-47.00	-11.88	peak
H	2086.875	-65.74	9.38	-56.36	-47.00	-9.36	peak
H	2703.750	-67.56	9.81	-57.75	-47.00	-10.75	peak
H	3996.250	-69.63	9.04	-60.59	-47.00	-13.59	peak
H	8285.000	-73.05	15.35	-57.70	-47.00	-10.70	peak
H	10693.750	-75.28	23.18	-52.10	-47.00	-5.10	peak

Remark:

Emission Level= Meter Reading+ Factor, Margin= Emission 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

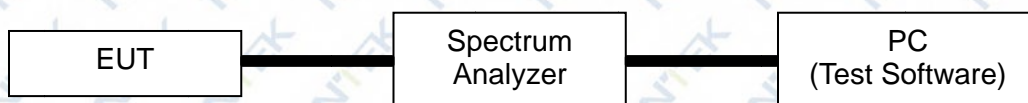
Absolute offset from centre frequency	RBW _{REF}	Peak power limit applicable at measurement points
≤ 400 kHz	1 kHz	0 dBm
> 400 kHz	1 kHz	-27 dBm

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-01SH
Temperature:	26°C	Relative Humidity:	53 %
Pressure:	1012 hPa	Test Voltage:	DC 3.3V
Test Mode:	TX		

864MHz OCW=300KHz

Frequency	Center Frequency	RBW	Max Vaule	Limit	Results
MHz	MHz	(kHz)	(dBm)	(dBm)	(P/F)
-0,5 x OCW - 3 kHz	863.847	1kHz	-19.851	0 dBm	PASS
0,5 x OCW + 3 kHz	864.153	1kHz	-31.136	0 dBm	PASS
-OCW	863.7	3kHz	-49.079	0 dBm	PASS
+OCW	864.3	3kHz	-52.679	0 dBm	PASS
-0,5 x OCW - 400 kHz	863.45	100kHz	-52.93	-27 dBm	PASS
0,5 x OCW + 400 kHz	864.55	100kHz	-52.644	-27 dBm	PASS
-0,5 x OCW -1200 kHz	862.65	300kHz	-53.208	-27 dBm	PASS
0,5 x OCW +1200 kHz	865.35	300kHz	-53.124	-27 dBm	PASS

866MHz OCW=300KHz

Frequency	Center Frequency	RBW	Max Vaule	Limit	Results
MHz	MHz	(kHz)	(dBm)	(dBm)	(P/F)
-0,5 x OCW - 3 kHz	865.847	1kHz	-20.73	0 dBm	PASS
0,5 x OCW + 3 kHz	866.153	1kHz	-33.849	0 dBm	PASS
-OCW	865.7	3kHz	-43.417	0 dBm	PASS
+OCW	866.3	3kHz	-53.657	0 dBm	PASS
-0,5 x OCW - 400 kHz	865.45	100kHz	-52.949	-27 dBm	PASS
0,5 x OCW + 400 kHz	866.55	100kHz	-53.468	-27 dBm	PASS
-0,5 x OCW -1200 kHz	864.65	300kHz	-53.231	-27 dBm	PASS
0,5 x OCW +1200 kHz	867.35	300kHz	-53.170	-27 dBm	PASS

869MHzOCW=300KHz

Frequency	Center Frequency	RBW	Max Vaule	Limit	Results
MHz	MHz	(kHz)	(dBm)	(dBm)	(P/F)
-0,5 x OCW - 3 kHz	868.847	1kHz	-20.046	0 dBm	PASS
0,5 x OCW + 3 kHz	869.153	1kHz	-34.065	0 dBm	PASS
-OCW	868.7	3kHz	-51.53	0 dBm	PASS
+OCW	869.3	3kHz	-53.987	0 dBm	PASS
-0,5 x OCW - 400 kHz	868.45	100kHz	-53.091	-27 dBm	PASS
0,5 x OCW + 400 kHz	869.55	100kHz	-53.3	-27 dBm	PASS
-0,5 x OCW -1200 kHz	867.65	300kHz	-53.095	-27 dBm	PASS
0,5 x OCW +1200 kHz	870.35	300kHz	-53.081	-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

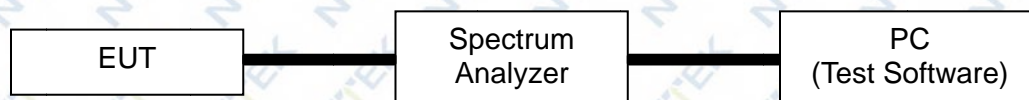
		Adjacent Channel power integrated over 0,7 x OCW	Alternate Adjacent Channel power integrated over 0,7 x OCW
OCW < 20 kHz	Normal test conditions	-20 dBm	-20 dBm
	Extreme test conditions	-15 dBm	-20 dBm
OCW \geq 20 kHz	Normal test conditions	-37 dBm	-40 dBm
	Extreme test conditions	-32 dBm	-37 dBm

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-01SH
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);

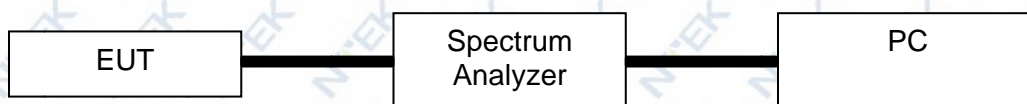
as the voltage falls below the manufacturers declared operating voltage.

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-01SH
Temperature:	26 °C	Relative Humidity:	60 %
Pressure:	1010 hPa	Test Power:	DC 3.3V
Test Mode:	TX		

Note: This item applies to battery powered EUT

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

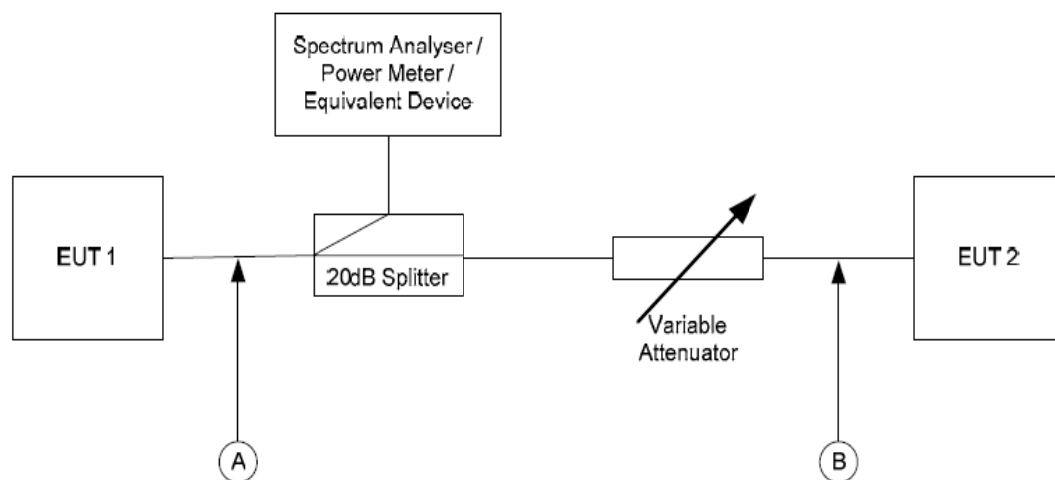


Figure 8: APC Measurement Setup

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-01SH
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-01SH
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 ± 2 MHz from OC edge fhigh and flow	≥ -69 dBm
Blocking at ± 10 MHz from OC edge fhigh and flow	≥ -44 dBm
Blocking at ± 5 % of Centre Frequency or 15 MHz, whichever is the greater	≥ -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 ± 2 MHz from OC edge fhigh and flow	≥ -43 dBm
Blocking at ± 10 MHz from OC edge fhigh and flow	≥ -33 dBm
Blocking at ± 5 % of Centre Frequency or 15 MHz, whichever is the greater	≥ -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 ± 2 MHz from Centre Frequency	≥ -20 dBm
Blocking at ± 10 MHz from Centre Frequency	≥ -20 dBm
Blocking at ± 5 % of Centre Frequency or 15 MHz, whichever is the greater	≥ -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

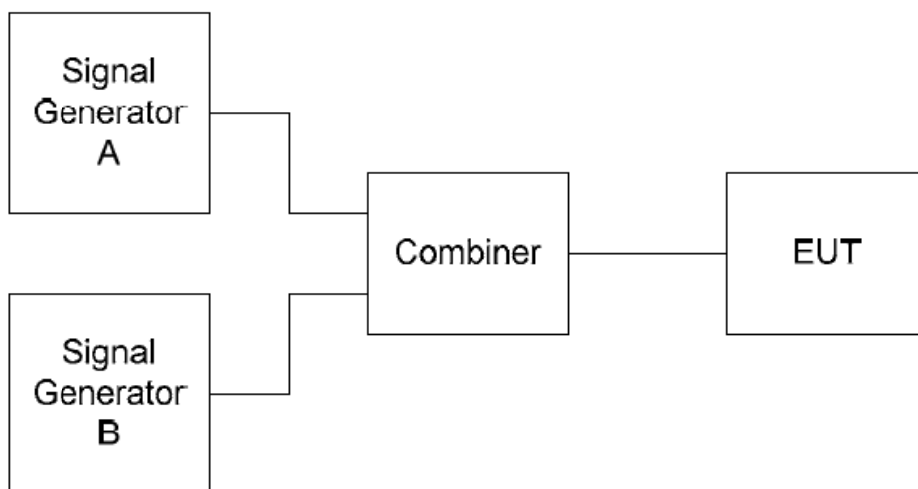


Figure 10: Blocking measurement arrangement

15.5 TEST RESULTS

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

864MHz

Flow=863.85MHz; Fhigh=864.15MHz

Receiver category	Frequency offset	Test Frequency (MHz)	Receiver BW(kHz)	Measurement Vause(dB)	≥ Limit(dB)
2	+2 MHz of Flow	865.9375	300	-26	-69
	-2 MHz of Flow	861.9375	300	-28	-69
	+2 MHz of Fhigh	866.0625	300	-29	-69
	-2 MHz of Fhigh	862.0625	300	-26	-69
	+10 MHz of Fhigh	874.0625	300	-20	-44
	-10 MHz of Fhigh	854.0625	300	-20	-44
	+10 MHz of Flow	873.9375	300	-19	-44
	-10 MHz of Flow	853.9375	300	-22	-44
	-43.2 MHz	820.8000	300	-20	-44
	+43.2 MHz	907.2000	300	-18	-44

866MHz

Flow=865.85MHz; Fhigh=866.15MHz

Receiver category	Frequency offset	Test Frequency (MHz)	Receiver BW(kHz)	Measurement Vause(dB)	≥ Limit(dB)
2	+2 MHz of F_{low}	867.9472	300	-26	-69
	-2 MHz of F_{low}	863.9472	300	-28	-69
	+2 MHz of F_{high}	868.0528	300	-24	-69
	-2 MHz of F_{high}	864.0528	300	-25	-69
	+10 MHz of F_{high}	876.0528	300	-24	-44
	-10 MHz of F_{high}	856.0528	300	-16	-44
	+10 MHz of F_{low}	875.9472	300	-14	-44
	-10 MHz of F_{low}	855.9472	300	-21	-44
	-43.3 MHz	822.7000	300	-20	-44
	+43.3 MHz	909.3000	300	-17	-44

869MHz

Flow=868.85 MHz; Fhigh=869.15 MHz

Receiver category	Frequency offset	Test Frequency (MHz)	Receiver BW(kHz)	Measurement Vause(dB)	≥ Limit(dB)
2	+2 MHz of F_{low}	870.9375	300	-27	-69
	-2 MHz of F_{low}	866.9375	300	-29	-69
	+2 MHz of F_{high}	871.0625	300	-25	-69
	-2 MHz of F_{high}	867.0625	300	-26	-69
	+10 MHz of F_{high}	879.0625	300	-16	-44
	-10 MHz of F_{high}	859.0625	300	-24	-44
	+10 MHz of F_{low}	878.9375	300	-17	-44
	-10 MHz of F_{low}	858.9375	300	-27	-44
	-43.45 MHz	825.5500	300	-22	-44
	+43.45 MHz	912.4500	300	-20	-44

APPENDIX-PHOTOGRAPHS OF EUT CONSTRUCTIONAL DETAILS

Radiated Measurement Photos



END OF REPORT