

AS/NZS 4268:2017

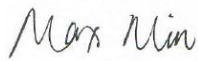

## TEST REPORT

For

**Pycom Ltd**

High Point 9 Sydenham Road, Guildford Surrey GU1 3RX, Surrey, United Kingdom

**Tested Model: LoPy4 1.0**

<b>Report Type:</b> Original Report	<b>Product Type:</b> LoPy4 Module
<b>Test Engineer:</b>	Max Min 
<b>Report Number:</b>	RSHA180625001-14D
<b>Report Date:</b>	2019-02-14
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## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

Applicant	Pycom Ltd
Tested Model	LoPy4 1.0
Product Type	LoPy4 Module
Dimension	55mm (L)* 20 mm (W)*10 mm(H)
Power Supply	DC 3.4-5.5V

*\*All measurement and test data in this report was gathered from production sample serial number: 20180625001.  
(Assigned by the BACL. The EUT supplied by the applicant was received on 2018-06-25)*

### Objective

The test report is prepared on behalf of the *Pycom Ltd* in accordance with ETSI EN 300 220-2 V3.1.1 (2017-02), Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 2: Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU for non specific radio equipment.

The objective is to determine the compliance of the EUT with ETSI EN 300 220-2 V3.1.1 (2017-02).

### Test Methodology

All measurements contained in this report were conducted with ETSI EN 300 220-1 V 3.1.1 (2017-02).

## Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB558074 D01 DTS Meas Guidance v04, and according to Figure 1, it was conform to the requirement of AS/NZS 4268:2017.

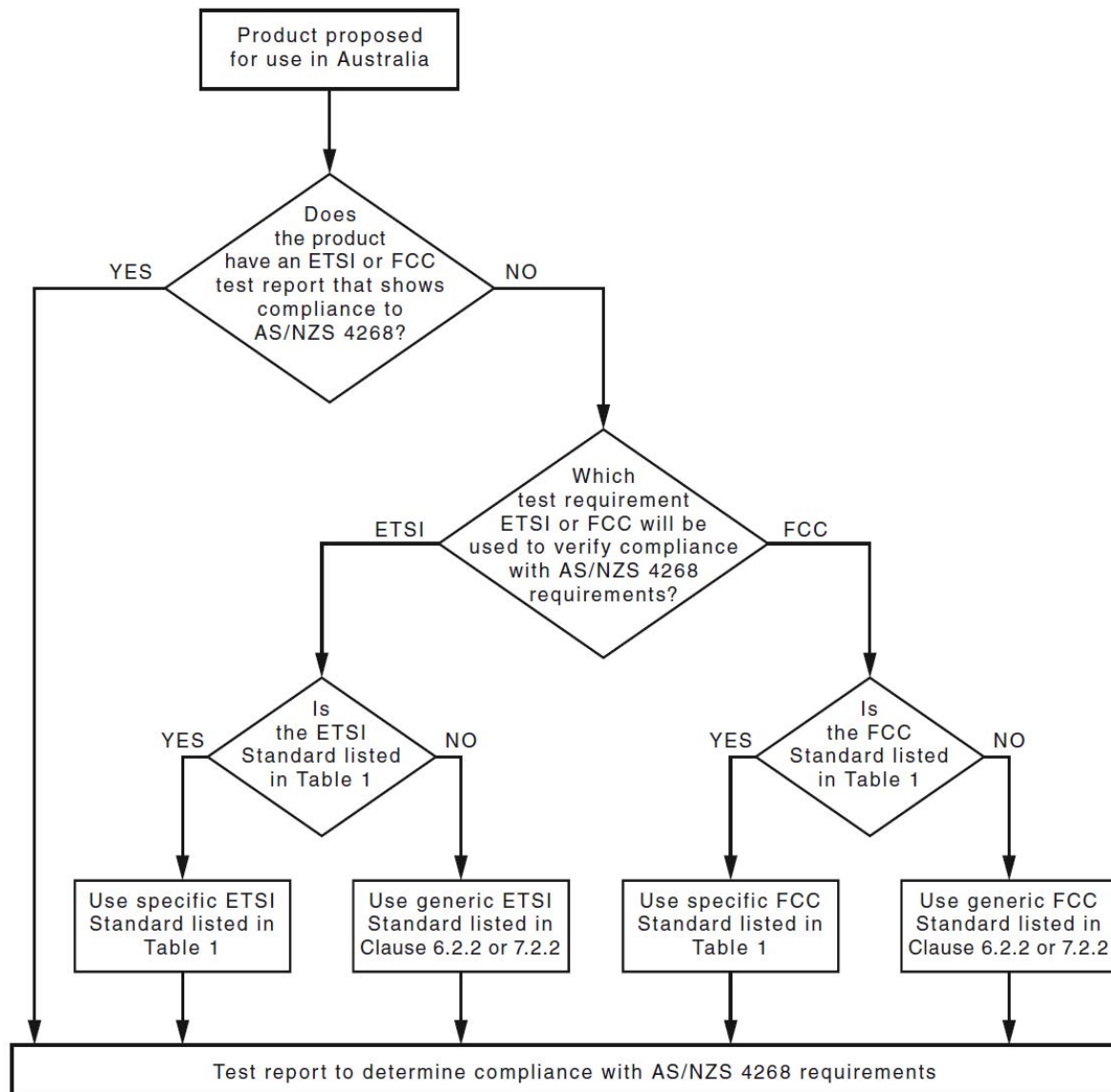


FIGURE 1 DETERMINING METHOD OF ASSESSMENT

**Measurement Uncertainty**

Item		Uncertainty
RF Output Power with Power meter		0.5dB
Power Spectral Density, conducted		0.5dB
Unwanted Emissions, conducted		2.34 dB
Radiated emission	30MHz~1GHz	5.91dB
	1GHz~6GHz	4.68dB
	6 GHz ~18 GHz	4.92dB
Occupied Bandwidth		0.5kHz
Temperature		1.0℃
Humidity		6%
Time		5 %
Supply voltages		0.04%

**Test Facility**

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

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

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

Channel list For LoRa:

Channel	Frequency (MHz)
1	868.10
2	868.30
3	868.50

### EUT Exercise Software

RF test tool: SecureCRT

Power Level: 12

### Special Accessories

No special accessories.

### Equipment Modifications

No modification was made to the EUT tested.

### Support Equipment List and Details

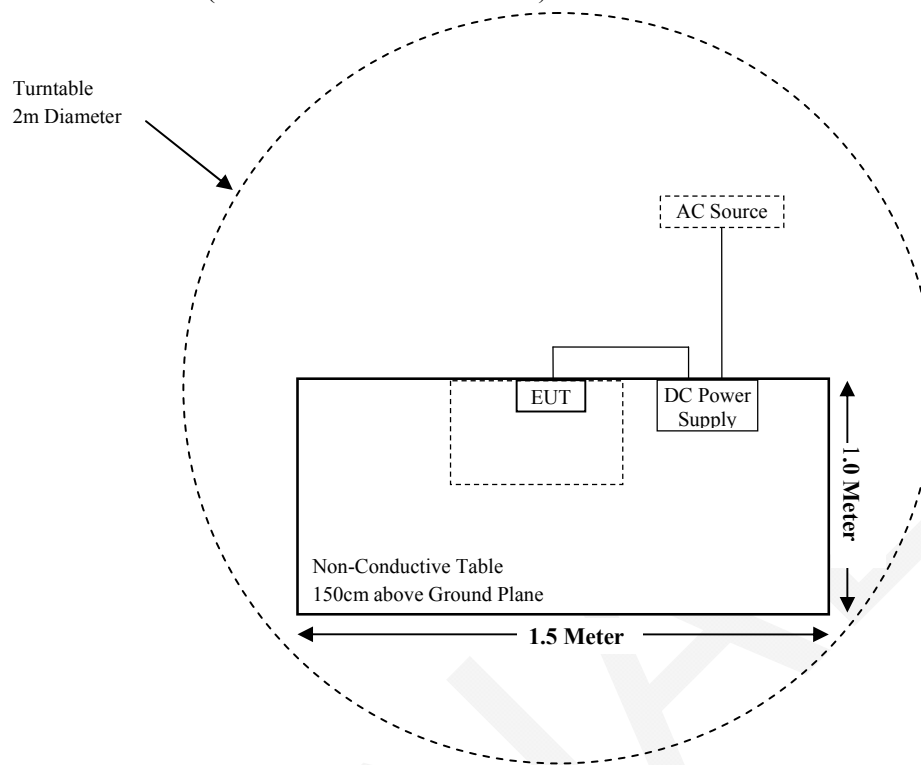
Manufacturer	Description	Model	Serial Number
BEST	DC Power Supply	PS-1502D+	/

### External I/O Cable

Cable Description	Length (m)	From Port	To
Power Cable	1.0	EUT	DC Power Supply

**Block Diagram of Test Setup**

For Radiated Emissions (Below 1GHz&Above 1GHz):





## SUMMARY OF TEST RESULTS

### ETSI EN 300 220-2 V3.1.1 (2017-02)

Rules	Description of Test	Result
CLAUSE 4.2.1	Operating Frequency	Compliance
CLAUSE 4.2.2	Unwanted Emissions in the Spurious Domain	Compliance
CLAUSE 4.3.1	Effective Radiated Power	Compliance
CLAUSE 4.3.2	Maximum e.r.p. Spectral Density	Not Applicable (See Note1)
CLAUSE 4.3.3	Duty Cycle	Compliance
CLAUSE 4.3.4	Occupied Bandwidth	Compliance
CLAUSE 4.3.5	TX Out of Band Emissions	Compliance
CLAUSE 4.3.6	Transient Power	Compliance
CLAUSE 4.3.7	Adjacent Channel Power	Not Applicable (See Note2)
CLAUSE 4.3.8	TX Behavior under Low Voltage Conditions	Compliance
CLAUSE 4.3.9	Adaptive power control	Not Applicable (See Note1)
CLAUSE 4.3.10	FHSS equipment	Not Applicable (See Note3)
CLAUSE 4.3.11	Short Term Behavior	Not Applicable (See Note1)
CLAUSE 4.4.1	RX Sensitivity	Not Applicable (See Note4)
CLAUSE 4.5.2	Clear Channel Assessment Threshold	Not Applicable (See Note4)
CLAUSE 4.5.3	Polite Spectrum Access Timing Parameters	Not Applicable (See Note4)
CLAUSE 4.4.2	Blocking	Compliance
CLAUSE 4.5.4	Adaptive Frequency Agility	Not Applicable (See Note5)

Note1: The EUT operated in Band M.

Note2: This item applies to EUT with  $OCW \leq 25$  kHz.

Note3: This item applies to FHSS EUT.

Note4: This item applies to EUT with polite spectrum access.

Note5: This item applies to EUT with AFA.

**TEST EQUIPMENT LIST**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
<b>Radiated Emission Test (Chamber 1#)</b>					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2017-11-12	2018-11-11
Sunol Sciences	Broadband Antenna	JB3	A090413-1	2016-12-26	2019-12-25
Sunol Sciences	Broadband Antenna	JB3	A090314-2	2016-01-09	2019-01-08
Sonoma Instrunent	Pre-amplifier	310N	171205	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-8	008	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-7	007	2017-08-15	2018-08-14
<b>Radiated Emission Test (Chamber 2#)</b>					
HP	Signal Generator	HP 8341B	2624A00116	2017-08-29	2018-08-28
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2017-08-27	2018-08-26
ETS-LINDGREN	Horn Antenna	3115	9311-4159	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3115	6229	2016-01-11	2019-01-10
Narda	Pre-amplifier	AFS42-00101800	2001270	2017-12-12	2018-12-11
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-16	016	2017-08-15	2018-08-14
<b>RF Conducted Test</b>					
Rohde & Schwarz	SMBV100A Vector Signal Generator	SMBV100A	261558	2018-07-22	2019-07-21
Rohde & Schwarz	SMB 100A Signal Generator	SMB100A	110390	2018-07-22	2019-07-21
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2018-11-30	2019-11-29
BACL	Temperature & Humidity Chamber	BTH-150	30023	2018-09-05	2019-09-04
EAST	Regulated DC Power Supply	MCH-303D-II	14070562	2018-09-05	2019-09-04
Pycom Ltd	RF Cable	C01Cable	001	Each Time	/

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

**ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.2.1 - OPERATING FREQUENCY****Description**

According to ETSI EN 300 220-1 V3.1.1 (2017-02), the nominal operating frequency is the centre of a channel of width OCW.

**Limits**

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 annexes B, C or any NRI in ETSI EN 300 220-2 V3.1.1 (2017-02).

**Method of measurement**

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	Declared by the manufacturer
Nominal Operating Frequency or Frequencies	Declared by the manufacturer
Operating Channel width(s) - OCW	Declared by the manufacturer

**The result**

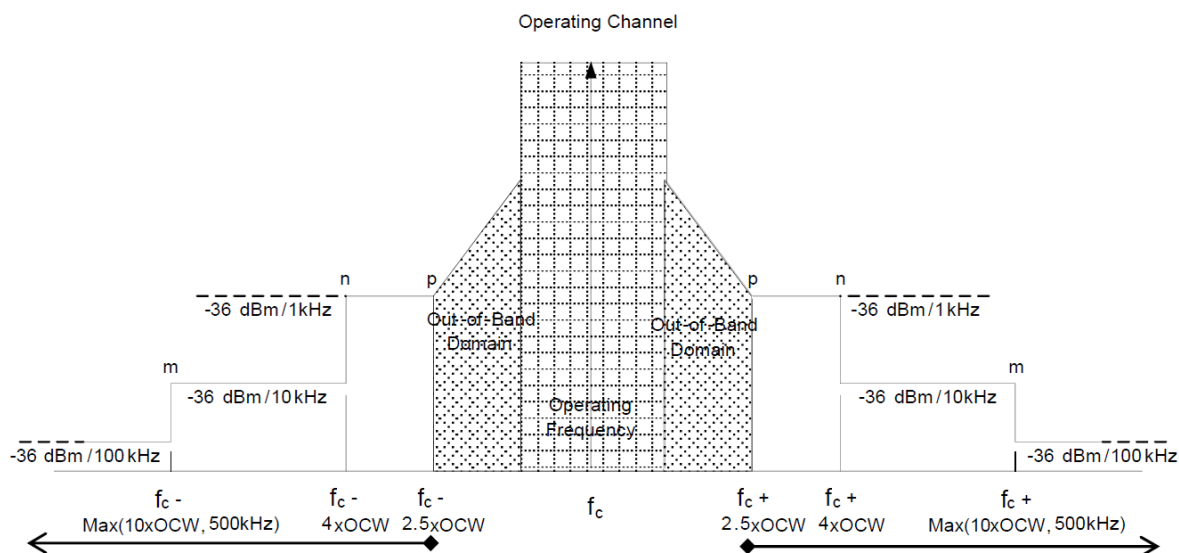
Note: Compliance, which is declared by the manufacturer.

Operating frequency (MHz)	Operating Frequency Band (MHz)	Operating Channel Width (kHz)
868.10	868.000 ~ 868.600	130
868.30	868.000 ~ 868.600	130
868.50	868.000 ~ 868.600	130

## ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.2.2 – UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

### Description

#### Unwanted emissions for a TX mode



**Figure 7: Spectrum Mask for Unwanted Emissions in the Spurious Domain with reference BW**

Spurious emissions are unwanted emissions in the spurious domain at frequencies other than those of the Operating Channel and its Out Of Band Domain. The relevant spurious domain is shown in Figure 7.

#### Unwanted emissions for all other modes

Spurious radiations from the EUT are components, at any frequency, radiated by the equipment and antenna.

### Limits

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	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
State			
<b>TX mode</b>	-54 dBm	-36 dBm	-30 dBm
<b>RX and all other modes</b>	-57 dBm	-57 dBm	-47 dBm

## Conformance

### Test conditions for TX mode

The EUT shall be operated in a mode representative of normal operation.

For EUT without an external conventional 50  $\Omega$  coaxial antenna connector, the spurious emissions levels shall be established by the radiated measurement procedure in CLAUSE 5.9.3.3.2.

For all other EUT the spurious emissions levels shall be established as both:

- the conducted measurement procedure in CLAUSE 5.9.3.3.1; and
- the radiated measurement procedure in CLAUSE 5.9.3.3.2, with the antenna port terminated in a dummy load.

- 1) The transmitter shall be performed on the lowest and the highest Operating Frequency declared by the manufacturer. Additional frequencies may be tested.
- 2) The measurement shall be performed with the EUT operating at its maximum operating power level, as declared by the manufacturer, and also with the EUT in powered-on stand-by mode.
- 3) The RBW of measuring receiver are shown in Table 20.

**Table 20: Parameters for TX Spurious Radiations Measurement**

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.		

### Test conditions for RX and all other modes

The EUT shall be operated in a mode representative of normal operation.

For EUT without an external conventional 50  $\Omega$  coaxial antenna connector, the spurious emissions levels shall be established by the radiated measurement procedure in CLAUSE 5.9.3.3.2.

For all other EUT the spurious emissions levels shall be established as both:

- the conducted measurement procedure in CLAUSE 5.9.3.3.1; and
- the radiated measurement procedure in CLAUSE 5.9.3.3.2, with the antenna port terminated in a dummy load.

### Method of measurement

According to ETSI EN 300 220-1 CLAUSE 5.9.3.3

**Test Data****Environmental Conditions**

<b>Temperature:</b>	24.5 °C
<b>Relative Humidity:</b>	50 %
<b>ATM Pressure:</b>	101.2 kPa

The testing was performed by Max Min on 2018-07-01.

**Test result:** Compliant.

Frequency (MHz)	Receiver Reading (dBμV)	Turntable Angle Degree	Rx Antenna		Substituted			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Height (cm)	Polar (H/V)	Submitted Level (dBm)	Cable Loss (dB)	Antenna Gain (dBd/dBi)			
868.10MHz Test mode: TX Mode										
180.54	51.58	27	217	H	-53.74	0.4	-4.73	-58.87	-54	4.87
180.54	47.83	11	253	V	-55.68	0.4	-4.73	-60.81	-54	6.81
1736.20	43.42	231	260	H	-59.59	0.84	8.58	-51.85	-30	21.85
1736.20	42.23	251	176	V	-61.25	0.84	8.58	-53.51	-30	23.51
868.10MHz Test mode: RX/Standby Mode										
300.23	44.08	28	271	H	-63.14	0.46	-2.15	-65.75	-57	8.75
300.23	44.77	205	264	V	-61.25	0.46	-2.15	-63.86	-57	6.86
1594.55	40.59	165	129	H	-63.28	0.83	8.35	-55.76	-47	8.76
1594.55	42.92	51	131	V	-61.48	0.83	8.35	-53.96	-47	6.96

Note 1: The unit of antenna gain is dBd for frequency below 1GHz and dBi for frequency above 1GHz.

Note 2:

Absolute Level = Submitted Level - Cable loss + Antenna Gain

Margin = Limit – Absolute Level

Note 3: RX and Standby Modes are the same.

Frequency (MHz)	Receiver Reading (dBμV)	Turntable Angle Degree	Rx Antenna		Substituted			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Height (cm)	Polar (H/V)	Submitted Level (dBm)	Cable Loss (dB)	Antenna Gain (dBd/dBi)			
868.50 MHz Test mode: TX Mode										
181.55	51.82	91	263	H	-53.53	0.4	-4.66	-58.59	-54	4.59
181.55	48.26	144	152	V	-55.40	0.4	-4.66	-60.46	-54	6.46
1736.60	43.61	219	196	H	-59.40	0.84	8.58	-51.66	-30	21.66
1736.60	42.12	163	238	V	-61.36	0.84	8.58	-53.62	-30	23.62
868.50 MHz Test mode: RX/Standby Mode										
298.50	44.31	308	130	H	-62.94	0.46	-2.14	-65.54	-57	8.54
298.50	45.17	62	190	V	-60.81	0.46	-2.14	-63.41	-57	6.41
1595.00	40.67	132	141	H	-63.20	0.83	8.35	-55.68	-47	8.68
1595.00	43.01	134	258	V	-61.39	0.83	8.35	-53.87	-47	6.87

Note 1: The unit of antenna gain is dBd for frequency below 1GHz and dBi for frequency above 1GHz.

Note 2:

Absolute Level = Submitted Level - Cable loss + Antenna Gain

Margin = Limit – Absolute Level

Note 3: RX and Standby Modes are the same.

## ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.3.1 – EFFECTIVE RADIATED POWER

### Description

The effective radiated power (e.r.p) is the power radiated in the direction of the maximum radiated power under specified conditions of measurements for any condition of modulation. For equipment with a permanent or temporary antenna connection it may be taken as the power delivered from that connector taking into account the antenna gain.

### Limits

The effective radiated power shall not be greater than the value allowed in annexes B or C for the chosen operational frequency band(s) in ETSI EN 300 220-2 V3.1.1 (2017-02).

**Table B.1: EU wide harmonised national radio interfaces from 25 MHz to 1 000 MHz**

Operational Frequency Band		Maximum effective radiated power, e.r.p.	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Maximum occupied bandwidth	Other usage restrictions	Band number from EC Decision 2013/752 /EU [i.3]	Class 1 sub-class number according Commission Decision 2000/299/EU [i.7]
M	868,000 MHz to 868,600 MHz	25 mW e.r.p.	$\leq 1$ % duty cycle or polite spectrum access	The whole band except for audio & video applications limited to 300 kHz	/	48	28

### Method of measurement

According to ETSI EN 300 220-1 CLAUSE 5.2.2

### Test Data

#### Environmental Conditions

Temperature:	24.5 °C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

*The testing was performed by Max Min on 2018-07-01.*



*Test Mode: Transmitting*

Test Frequency (MHz)	Test Condition					Result
868.10	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance
868.30	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance
868.50	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance

**Note:**L.V.: Low Voltage 2.7V<sub>DC</sub>

L.T.: Low Temperature -20°C

N.V.: Normal Voltage 3.3 V<sub>DC</sub>

N.T.: Normal Temperature +25°C

H.V.: High Voltage 3.6V<sub>DC</sub>

H.T.: High Temperature +85°C

**Normal Condition Test Data as below:**

Frequency (MHz)	Reading (dBm)	Antenna Gain (dBd)	ERP (dBm)	Limit (dBm)
868.10	13.70	0.05	13.75	13.98
868.30	13.70	0.05	13.75	13.98
868.50	13.70	0.05	13.75	13.98

Note: 0dBd=2.15dBi

## ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.3.3 – DUTY CYCLE

### Definition

Duty cycle is the ratio expressed as a percentage, of the cumulative duration of transmissions  $T_{on\_cum}$  within an observation interval  $T_{obs}$ .  $DC = \left( \frac{T_{on\_cum}}{T_{obs}} \right)_{F_{obs}}$  on an observation bandwidth  $F_{obs}$ .

Unless otherwise specified,  $T_{obs}$  is 1 hour and the observation bandwidth  $F_{obs}$  is the operational frequency band. Each transmission consists of an RF emission, or sequence of RF emissions separated by intervals  $< T_{Dis}$ .

An equipment may operate on several bands simultaneously (i.e. multi transmissions), Duty Cycle limit of each individual band applies to each transmission within that band.

In case of a multicarrier modulation in a band, the duty cycle applies to the whole signal used for a transmission (e.g. OFDM).

It has to be noted that on some bands Duty Cycle value may depend on the presence of a primary radio service. Equipment may be triggered manually, by internal timing or by external stimulus. Depending on the method of triggering the timing may be predictable or random.

### Limit

The Duty Cycle at the operating frequency shall not be greater than values in annex B or C for the chosen operational frequency band(s).

**Table B.1: EU wide harmonised national radio interfaces from 25 MHz to 1 000 MHz**

Operational Frequency Band		Maximum effective radiated power, e.r.p.	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Maximum occupied bandwidth	Other usage restrictions	Band number from EC Decision 2013/752 /EU [i.3]	Class 1 sub-class number according Commission Decision 2000/299/EU [i.7]
M	868,000 MHz to 868,600 MHz	25 mW e.r.p.	$\leq 1\%$ duty cycle or polite spectrum access	The whole band except for audio & video applications limited to 300 kHz	/	48	28

## Method of measurement

An assessment of the overall Duty Cycle shall be made for a representative period of  $T_{\text{obs}}$  over the observation bandwidth  $F_{\text{obs}}$ . Unless otherwise specified,  $T_{\text{obs}}$  is 1 hour and the observation bandwidth  $F_{\text{obs}}$  is the operational frequency band.

The representative period shall be the most active one in normal use of the device. As a guide "Normal use" is considered as representing the behaviour of the device during transmission of 99 % of transmissions generated during its operational lifetime.

Procedures such as setup, commissioning and maintenance are not considered part of normal operation.

Where an acknowledgement is used, the additional transmitter on-time from a message responder shall be declared only once whether included in the message initiator Duty Cycle or in the message responder Duty Cycle.

NOTE: The intention of this rule is not to allow EUT to exceed the maximum duty cycle value.

## Test Data

### Environmental Conditions

Temperature:	24.5 °C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

*The testing was performed by Max Min on 2018-07-01.*

**Test result:** Compliant.

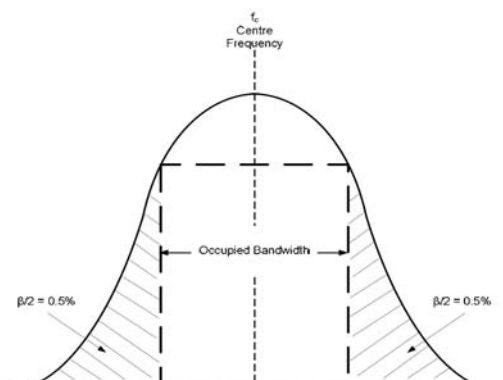
The duty cycle was not exceeded 0.05% in a period of 1 hour, which was declared by the manufacturer.

## ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.3.4 - OCCUPIED BANDWIDTH

### Definition

The occupied bandwidth (OBW) is the Frequency Range in which 99 % of the total mean power of a given emission falls. The residual part of the total power being denoted as  $\beta$ , which, in cases of symmetrical spectra, splits up into  $\beta/2$  on each side of the spectrum. Unless otherwise specified,  $\beta/2$  is taken as 0,5 % as described in Figure 3.

*Occupied Bandwidth (OBW)*: width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0,5 % of the total mean power of a given emission



**Figure 3: Signal occupied bandwidth**

The maximum occupied bandwidth includes all associated side bands above the appropriate emissions level and the frequency error or drift under extreme test conditions.

### Limits

The Operating Channel shall be declared and shall reside entirely within the Operational Frequency Band. The Maximum Occupied Bandwidth at 99 % shall reside entirely within the Operating Channel defined by  $F_{low}$  and  $F_{high}$ .

### Method of measurement

The spectrum analyser shall be configured as appropriate for the parameters shown in Table 12.

**Table 12: Test Parameters for Max Occupied Bandwidth Measurement**

Setting	Value	Notes
Centre frequency	The nominal Operating Frequency	The highest or lowest Operating Frequency as declared by the manufacturer
RBW	1 % to 3 % of OCW without being below 100 Hz	
VBW	3 x RBW	Nearest available analyser setting to 3 x RBW
Span	At least 2 x Operating Channel width	Span should be large enough to include all major components of the signal and its side bands
Detector Mode	RMS	
Trace	Max hold	

All other steps according to ETSI EN 300 220-1 CLAUSE 5.6.3

**Test Data****Environmental Conditions**

<b>Temperature:</b>	24.5 °C
<b>Relative Humidity:</b>	50 %
<b>ATM Pressure:</b>	101.2 kPa

The testing was performed by Max Min on 2018-12-02.

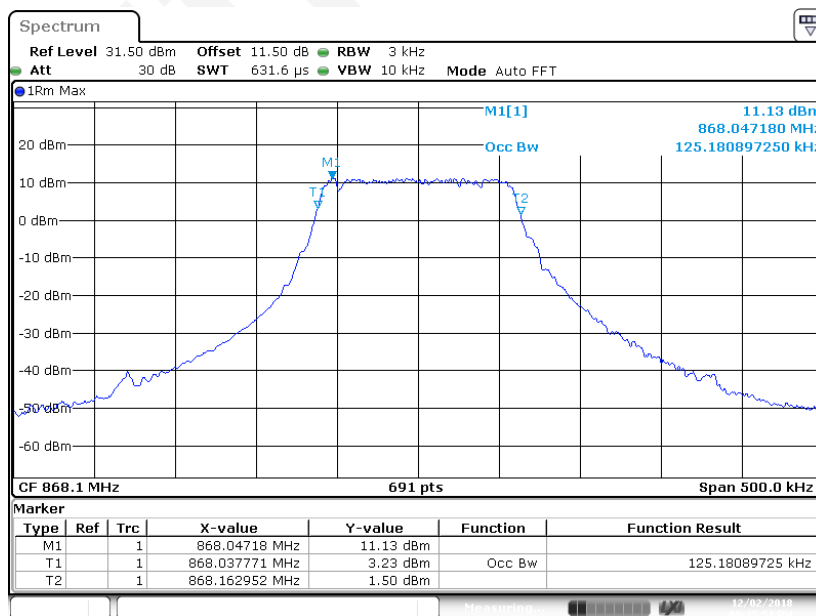
Test Mode: Transmitting

Test Frequency (MHz)	Test Condition					Result
868.10	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance
868.30	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance
868.50	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance

**Normal Condition Test Data as below:**

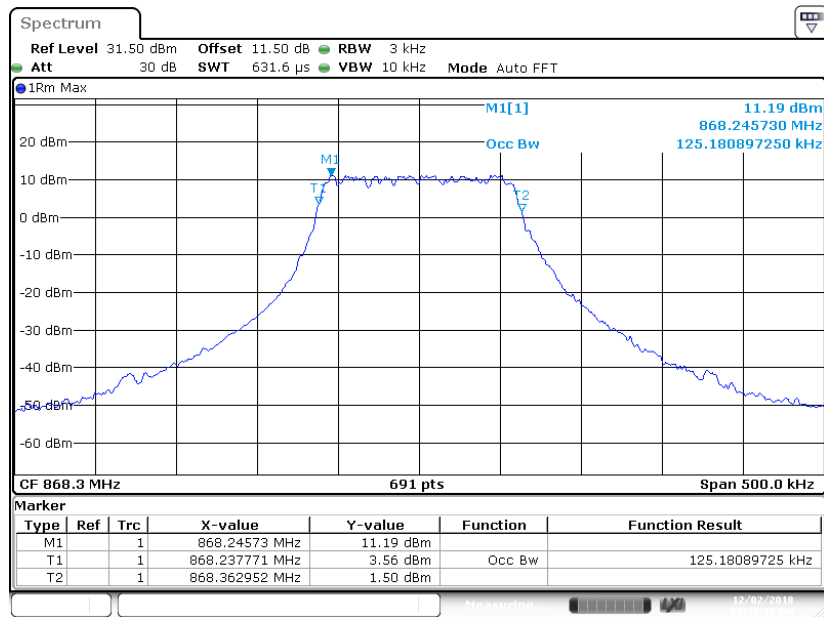
Test Frequency (MHz)	Occupied Bandwidth (kHz)
868.10	125.181
868.30	125.181
868.50	125.181

868.10MHz



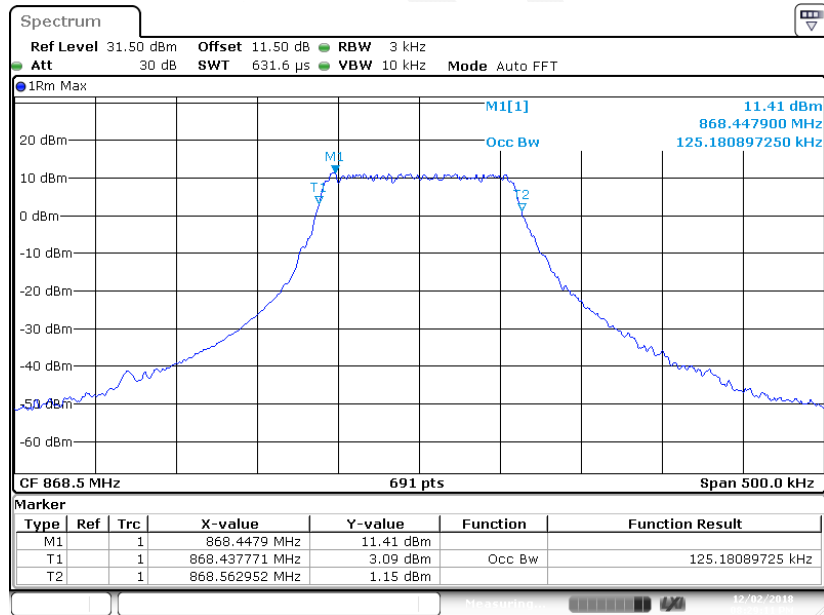
Date: 2 DEC 2018 20:35:52

## 868.30MHz



Date: 2 DEC 2018 20:32:11

## 868.50MHz

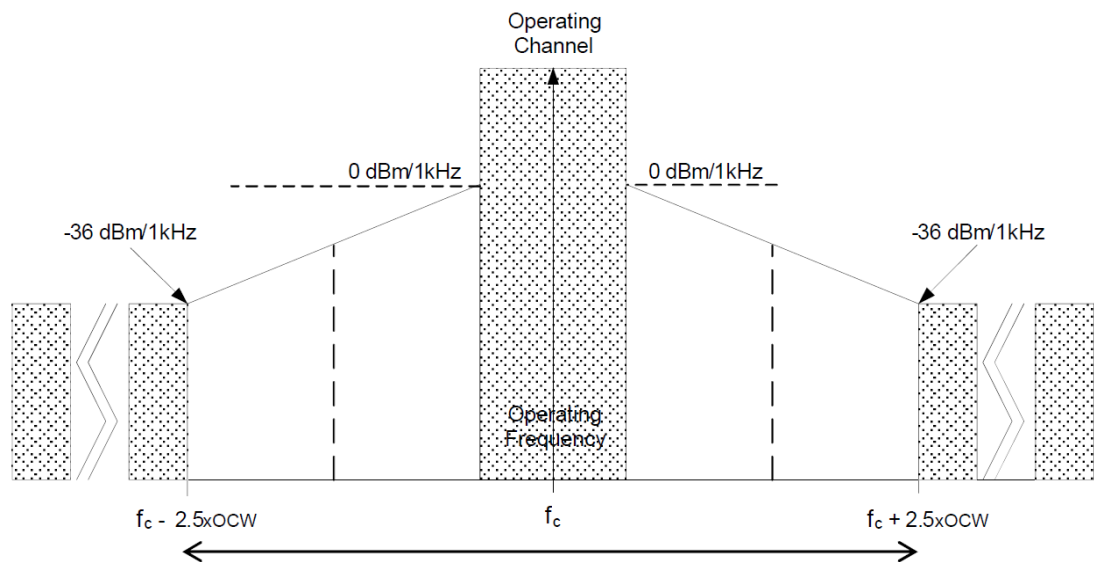


Date: 2 DEC 2018 20:29:11

## ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.3.5 - TX OUT OF BAND EMISSIONS

### Definition

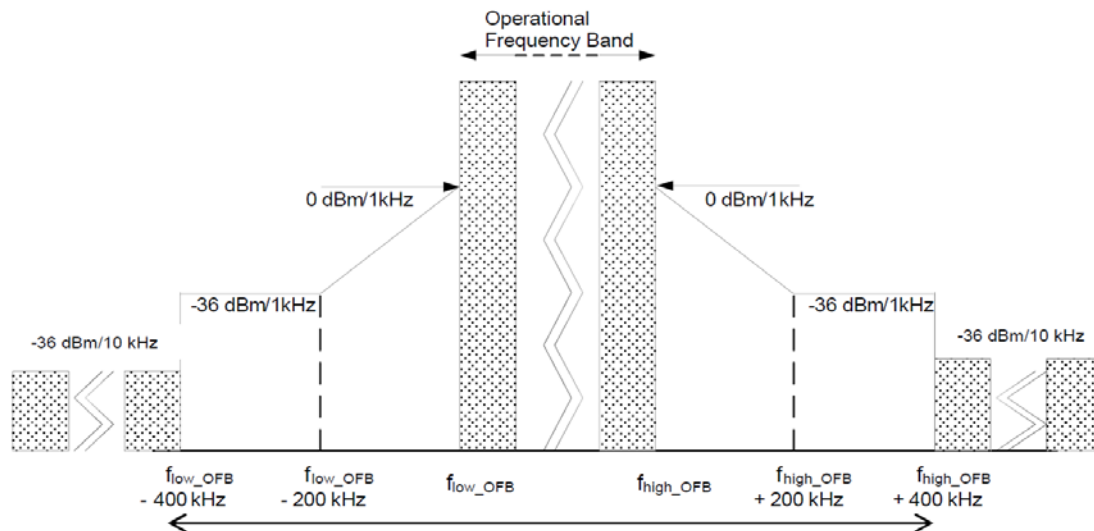
Two OOB domains are defined, one for OC (see Figure 5) and one for Operational Frequency band (see Figure 6). The spectrum masks for these two OOB domains may overlap.



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

Unwanted emissions in the Out Of Band domain are those falling in the frequency range immediately below the lower, and above the upper, frequency of the Operating Channel. The OOB domain includes both frequencies outside the Operating Channel within the Operational Frequency Band and frequencies outside the Operational Frequency Band.

The relevant Out Of Band domain is shown in Figure 5 and applies within the Operational Frequency Band.



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

Specific limits apply at frequencies immediately above and below the Operational Frequency Band as shown in Figure 6.

NOTE:  $f_{low\_OFB}$  is the lower edge of the Operational Frequency Band.

$f_{high\_OFB}$  is the upper edge of the Operational Frequency Band.

## Limits

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)	$f \leq f_{low\_OFB} - 400 \text{ kHz}$	10 kHz	-36 dBm
	$F_{low\_OFB} - 400 \text{ kHz} \leq f \leq f_{low\_OFB} - 200 \text{ kHz}$	1 kHz	-36 dBm
	$f_{low} - 200 \text{ kHz} \leq f < f_{low\_OFB}$	1 kHz	See Figure 6
	$f = f_{low\_OFB}$	1 kHz	0 dBm
	$f = f_{high\_OFB}$	1 kHz	0 dBm
	$F_{high\_OFB} < f \leq f_{high\_OFB} + 200 \text{ kHz}$	1 kHz	See Figure 6
	$F_{high\_OFB} + 200 \text{ kHz} \leq f \leq f_{high\_OFB} + 400 \text{ kHz}$	1 kHz	-36 dBm
	$F_{high\_OFB} + 400 \text{ kHz} \leq f$	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. $F_{low\_OFB}$ is the lower edge of the Operational Frequency Band. $F_{high\_OFB}$ is the upper edge of the Operational Frequency Band. OCW is the operating channel bandwidth.			



## Method of measurement

The test equipment shall be configured as appropriate for the parameters shown in Table 16.

**Table 16: Test Parameters for Out Of Band for Operating Channel Measurement**

Spectrum Analyser Setting	Value	Notes
Centre frequency	Operating Frequency	
Span	6 x Operating Channel width	
RBW	1 kHz (see note)	Resolution bandwidth for Out Of Band domain measurements
Detector Function	RMS	
Trace Mode	Linear AVG	Applies only for EUT generating D-M2 test signal. An appropriate number of samples should be averaged to give a stable reading
	Max Hold	Applies only for EUT generating D-M2a or D-M3 test signal.
NOTE: If the value of RBW used is different from $RBW_{REF}$ in clause 5.8.2, use the bandwidth correction in clause 4.3.10.1.		

All other steps according to ETSI EN 300 220-1 CLAUSE 5.8.3

## Test Data

### Environmental Conditions

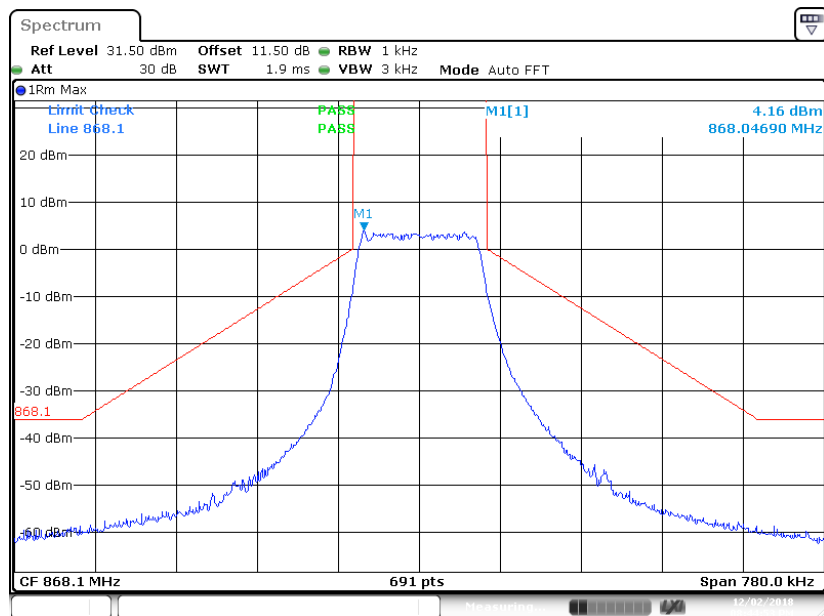
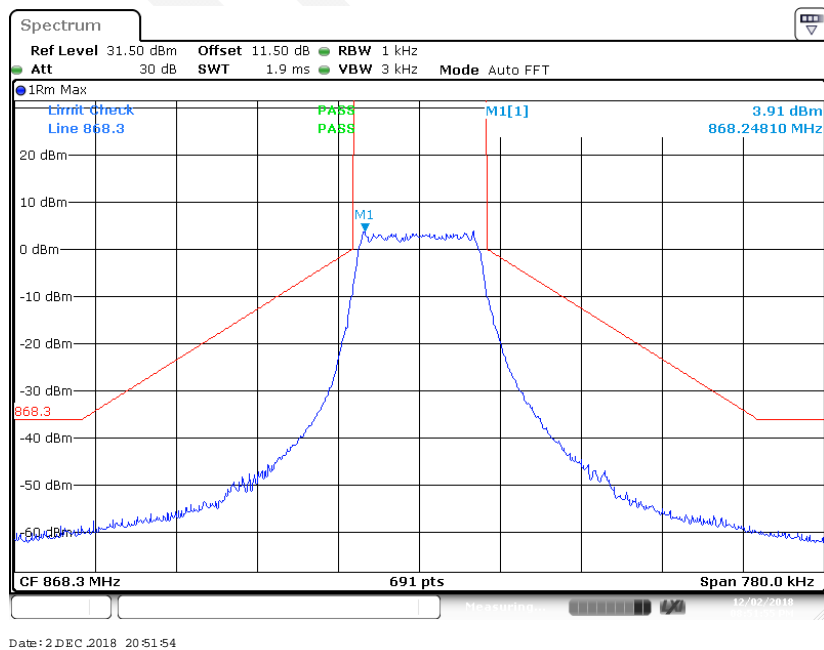
Temperature:	24.5 °C
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2018-12-02.

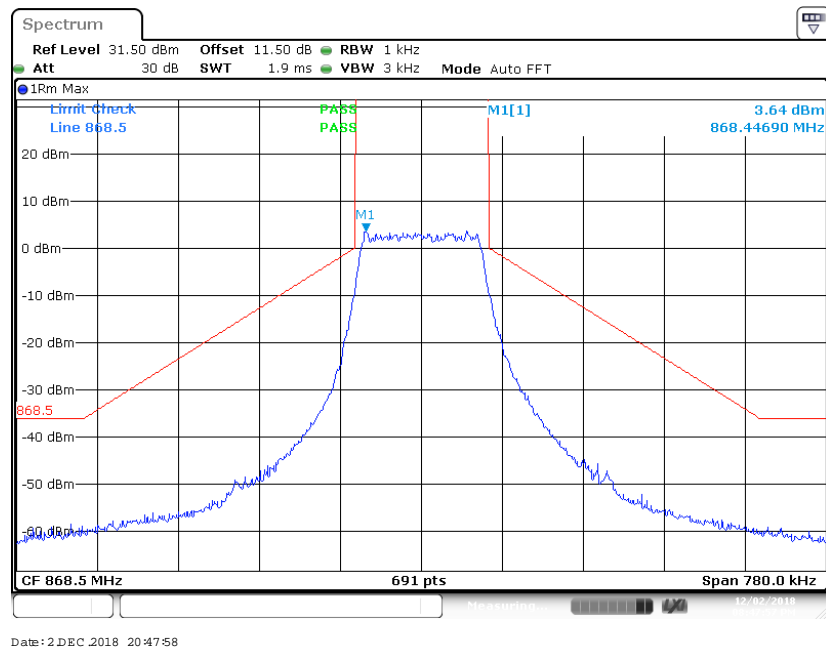
**Test result:** Compliant.

*Test Mode: Transmitting*

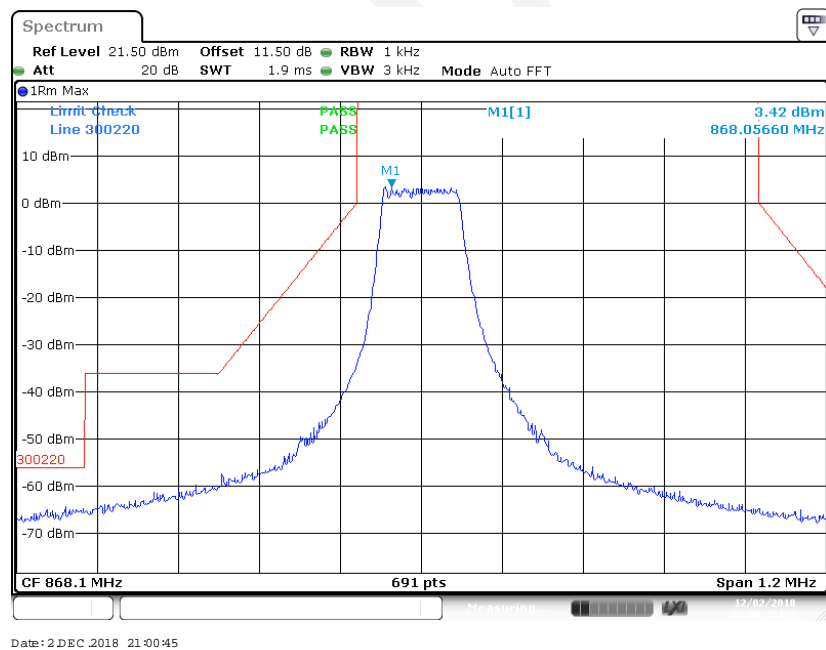
Test Frequency (MHz)	Test Condition					Result
868.10	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance
868.30	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance
868.50	N.V. N.T.	L.V. L.T.	L.V. H.T.	H.V. L.T	H.V. H.T	Compliance

**Normal Condition Test Data as below:***Test with conducted measurement.***OOB****868.10MHz****868.30MHz**

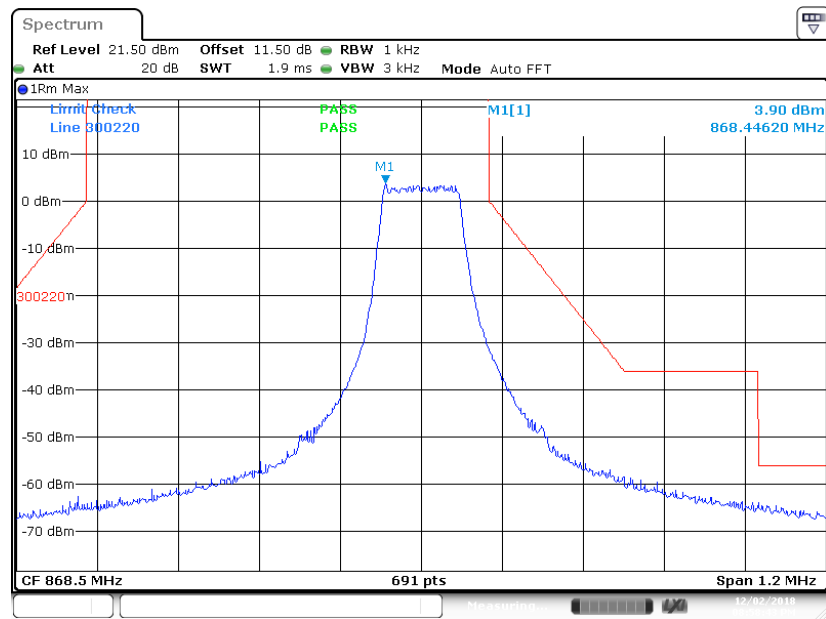
# 868.50MHz



## OFB(F<sub>low</sub>)



OFB(F<sub>high</sub>)



Date: 2 DEC 2018 20:58:43

**ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.3.6 - TRANSIENT POWER****Definition**

Transmitter transient power is power falling into frequencies other than the operating channel as a result of the transmitter being switched on and off.

**Limits**

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

**Method of measurement**

The output of the EUT shall be connected to a spectrum analyser or equivalent measuring equipment. The measurement shall be undertaken in **zero span** mode. The analyser's centre frequency shall be set to an offset from the operating centre frequency. These offset values and their corresponding RBW configurations are listed in Table 24.

**Table 24: RBW for Transient Measurement**

Measurement points: offset from centre frequency	Analyser RBW	RBW <sub>REF</sub>
-0,5 x OCW - 3 kHz 0,5 x OCW + 3 kHz Not applicable for OCW < 25 kHz	1 kHz	1 kHz
±12,5 kHz or ±OCW whichever is the greater	Max (RBW pattern 1, 3, 10 kHz) ≤ Offset frequency/6 (see note)	1 kHz
-0,5 x OCW - 400 kHz 0,5 x OCW + 400 kHz	100 kHz	1 kHz
-0,5 x OCW - 1 200 kHz 0,5 x OCW + 1 200 kHz	300 kHz	1 kHz
NOTE: Max (RBW pattern 1, 3, 10 kHz) means the maximum bandwidth that falls into the commonly implemented 1, 3, 10 kHz RBW filter bandwidth incremental pattern of spectrum analysers. EXAMPLE: If OCW is 25 kHz then the RBW value corresponding to one OCW offset frequency is 3 kHz. The rest of the analyser settings are listed in Table 25, and if OCW is 250 kHz then the RBW value corresponding to one OCW offset frequency is 30 kHz.		

**Table 25: Parameters for Transient Measurement**

Spectrum Analyser Setting	Value	Notes
VBW/RBW	10	At higher RBW values VBW may be clipped to its maximum value
Sweep time	500 ms	
RBW filter	Gaussian	
Trace Detector Function	RMS	
Trace Mode	Max hold	
Sweep points	501	
Measurement mode	Continuous sweep	
NOTE: The ratio between the number of sweep points and the sweep time shall be the same ratio as above if different number of sweep points is used.		

The used modulation shall be D-M3. The analyser shall be set to the settings of Table 25 and a measurement shall be started for each offset frequency. The EUT shall transmit at least five D-M3 test signal. The peak value shall be recorded and the measurement shall be repeated at each offset frequency mentioned in Table 24.

The recorded power values shall be converted to power values measured in  $RBW_{REF}$  by the formula in CLAUSE 4.3.10.1.

## Test Data

### Environmental Conditions

Temperature:	24.3 °C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

*The testing was performed by Max Min on 2018-02-28.*

**Test result:** Compliant.

*Test Mode: switched on and off*

Test with conducted measurement.

Center Frequency (MHz)	Measurement Points: Offset from centre frequency	Analyzer RBW (kHz)	A (dBm)	B (dBm)	Limit (dBm)	Result
868.10	Fc-0.5*OCW-3kHz	1	-15.21	-15.21	0	Pass
	Fc-OCW	10	-37.29	-47.29	0	Pass
	Fc-0.5*OCW-400kHz	100	-51.92	-71.92	-27	Pass
	Fc-0.5*OCW-1200kHz	300	-54.83	-79.60	-27	Pass
	Fc+0.5*OCW+3kHz	1	-14.36	-14.36	0	Pass
	Fc+OCW	10	-34.96	-44.96	0	Pass
	Fc+0.5*OCW+400kHz	100	-52.27	-72.27	-27	Pass
	Fc+0.5*OCW+1200kHz	300	-54.77	-79.54	-27	Pass
868.30	Fc-0.5*OCW-3kHz	1	-15.26	-15.26	0	Pass
	Fc-OCW	10	-37.24	-47.24	0	Pass
	Fc-0.5*OCW-400kHz	100	-52.04	-72.04	-27	Pass
	Fc-0.5*OCW-1200kHz	300	-54.79	-79.56	-27	Pass
	Fc+0.5*OCW+3kHz	1	-14.50	-14.50	0	Pass
	Fc+OCW	10	-34.98	-44.98	0	Pass
	Fc+0.5*OCW+400kHz	100	-52.18	-72.18	-27	Pass
	Fc+0.5*OCW+1200kHz	300	-54.66	-79.43	-27	Pass
868.50	Fc-0.5*OCW-3kHz	1	-15.56	-15.56	0	Pass
	Fc-OCW	10	-37.43	-47.43	0	Pass
	Fc-0.5*OCW-400kHz	100	-52.08	-72.08	-27	Pass
	Fc-0.5*OCW-1200kHz	300	-54.68	-79.45	-27	Pass
	Fc+0.5*OCW+3kHz	1	-14.44	-14.44	0	Pass
	Fc+OCW	10	-35.11	-45.11	0	Pass
	Fc+0.5*OCW+400kHz	100	-52.18	-72.18	-27	Pass
	Fc+0.5*OCW+1200kHz	300	-54.90	-79.67	-27	Pass

**Note:**

A is the Measure Transient Power at the wider measurement bandwidth  $RBW_{measured}$ ;  
B is the corresponding value at  $RBW_{REF}$ .

## ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.3.8 - TX BEHAVIOUR UNDER LOW VOLTAGE CONDITIONS

### Definition

The TX behaviour under low voltage condition is the ability of the equipment to maintain its operating frequency and not produce emissions which exceed any relevant limit when the battery voltage falls below the lower extreme voltage level.

### Limits:

The TX behaviour under low voltage condition is the ability of the equipment to maintain its operating frequency and not produce emissions which exceed any relevant limit when the battery voltage falls below the lower extreme voltage level.

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.

### Method of measurement

#### Step 1:

Operation of the EUT shall be started, on Operating Frequency as declared by the manufacturer, with the appropriate test signal and with the EUT operating at nominal operating voltage.

The centre frequency of the transmitted signal shall be measured and noted.

#### Step 2:

The operating voltage shall be reduced by appropriate steps until the voltage reaches zero.

The centre frequency of the transmitted signal shall be measured and noted.

Any abnormal behaviour shall be noted.

### Test Data

#### Environmental Conditions

Temperature:	24.3 °C
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

*The testing was performed by Max Min on 2018-07-01.*

**Test result:** Compliant.



Test Condition		Frequency of Lower point (MHz)	Frequency of Upper point (MHz)	Result
Frequency (MHz)	Voltage ( $V_{DC}$ )			
868.10	$V_{nom}$	868.0378	868.1630	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-10\%$	868.0346	868.1615	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-20\%$	868.0373	868.1654	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-30\%$	/	/	Shut down
868.30	$V_{nom}$	868.2378	868.3630	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-10\%$	868.2351	868.3637	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-20\%$	868.2343	868.3655	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-30\%$	/	/	Shut down
868.50	$V_{nom}$	868.4378	868.5630	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-10\%$	868.4356	868.5643	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-20\%$	868.4386	868.5671	Within Operating frequency band and without exceeding any applicable limits
	$V_{nom}-30\%$	/	/	Shut down

**ETSI EN 300 220-2 V3.1.1 (2017-02) CLAUSE 4.3.5 – BLOCKING****Description**

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses or the adjacent channels or bands.

**Limit**

The blocking levels at the specified frequency offsets shall be equal to or greater than the limits Table 40&41&42&43, except at frequencies where spurious responses are found.

**Table 1: Receiver categories**

Receiver category	Description
1	Category 1 is a high performance level of receiver. In particular to be used where the operation of a SRD may have inherent safety of human life implications.
1.5	Category 1.5 is an improved performance level of receiver category 2.
2	Category 2 is standard performance level of receiver.
3	Category 3 is a low performance level of receiver. Manufacturers have to be aware that category 3 receivers are not able to work properly in case of coexistence with some services such as a mobile radio service in adjacent bands. The manufacturer shall provide another mean to overcome the weakness of the radio link or accept the failure.

**Table 40: Blocking level parameters for RX category 3**

Requirement	Limits
	Receiver category 3
Blocking at $\pm 2$ MHz from OC edge $f_{\text{high}}$ and $f_{\text{low}}$	$\geq -80$ dBm
Blocking at $\pm 10$ MHz from OC edge $f_{\text{high}}$ and $f_{\text{low}}$	$\geq -60$ dBm
Blocking at $\pm 5$ % of Centre Frequency or 15 MHz, whichever is the greater	$\geq -60$ dBm

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

Requirement	Limits
	Receiver category 2
Blocking at $\pm 2$ MHz from OC edge $f_{\text{high}}$ and $f_{\text{low}}$	$\geq -69$ dBm
Blocking at $\pm 10$ MHz from OC edge $f_{\text{high}}$ and $f_{\text{low}}$	$\geq -44$ dBm
Blocking at $\pm 5$ % of Centre Frequency or 15 MHz, whichever is the greater	$\geq -44$ dBm

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

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

**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

Additionally it is necessary to perform steps 1 to 4 with a +40 dB increased level for signal generator A in CLAUSE 5.18.6.4.

### Method of measurement

According to ETSI EN 300 220-1 CLAUSE 5.18.6

### Test Data

#### Environmental Conditions

<b>Temperature:</b>	24.3 °C
<b>Relative Humidity:</b>	51 %
<b>ATM Pressure:</b>	101.2 kPa

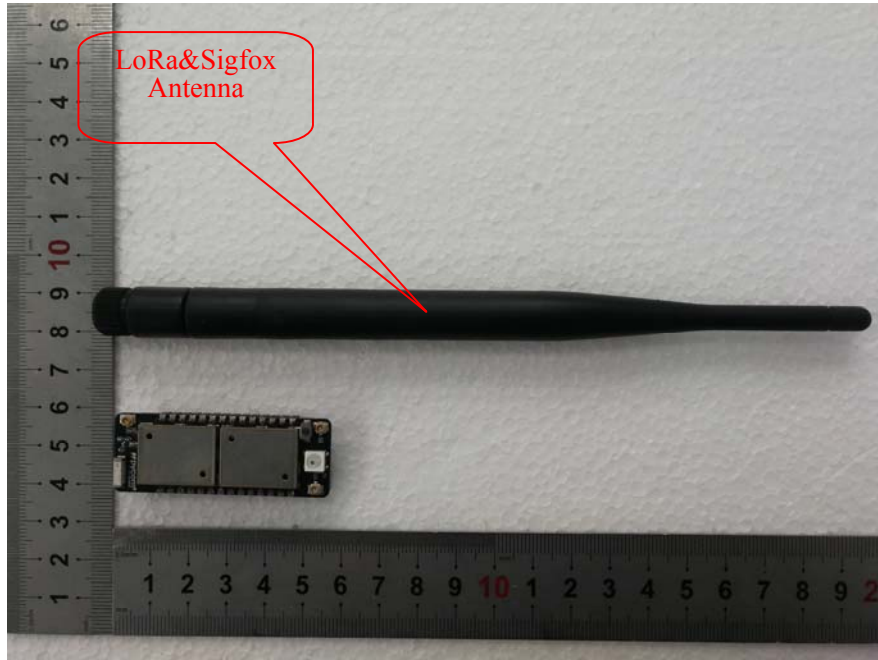
*The testing was performed by Max Min on 2018-07-01.*

**Test result:** Compliant.

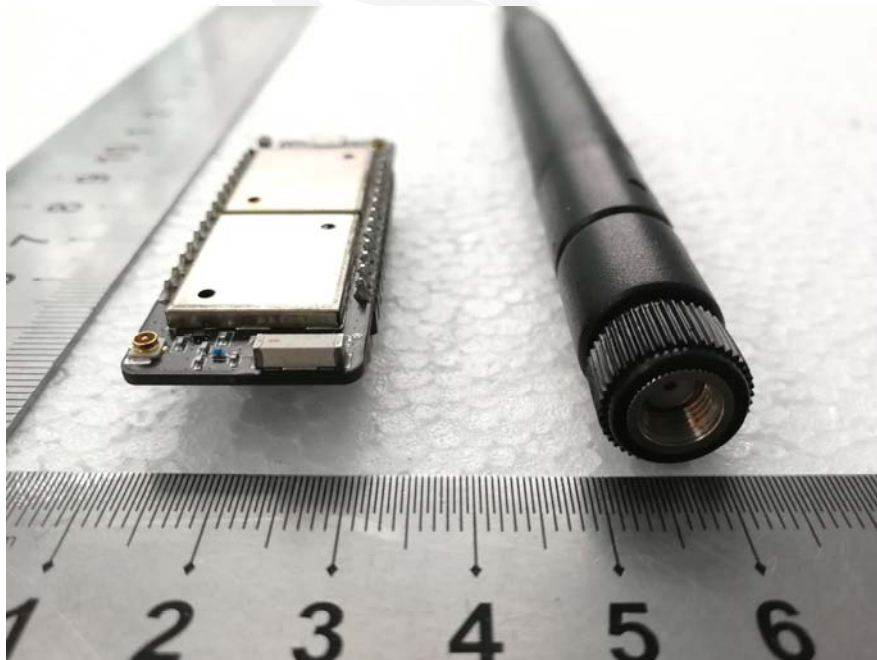
Receiver category	Wanted signal Frequency (MHz)	Blocking signal Frequency (MHz)	Frequency offset (MHz)	Blocking Level (dBm)	Limit (dBm)
2	868.10	866.0378	$F_{low}-2$	-53	$\geq -69$
		870.1630	$F_{high}+2$	-51	$\geq -69$
		858.0378	$F_{low}-10$	-34	$\geq -44$
		878.1630	$F_{high}+10$	-36	$\geq -44$
		911.5050	$+5\%F_{centre}$ or $F_{centre}+15\text{MHz}$ , whichever is the greater	-33	$\geq -44$
		824.6950	$-5\%F_{centre}$ or $F_{centre}-15\text{MHz}$ , whichever is the greater	-35	$\geq -44$
	868.30	866.2378	$F_{low}-2$	-54	$\geq -69$
		870.3630	$F_{high}+2$	-50	$\geq -69$
		858.2378	$F_{low}-10$	-36	$\geq -44$
		878.3630	$F_{high}+10$	-37	$\geq -44$
		911.7150	$+5\%F_{centre}$ or $F_{centre}+15\text{MHz}$ , whichever is the greater	-35	$\geq -44$
		824.8850	$-5\%F_{centre}$ or $F_{centre}-15\text{MHz}$ , whichever is the greater	-38	$\geq -44$
	868.50	866.4378	$F_{low}-2$	-53	$\geq -69$
		870.5630	$F_{high}+2$	-52	$\geq -69$
		858.4378	$F_{low}-10$	-35	$\geq -44$
		878.5630	$F_{high}+10$	-37	$\geq -44$
		911.9250	$+5\%F_{centre}$ or $F_{centre}+15\text{MHz}$ , whichever is the greater	-35	$\geq -44$
		825.0750	$-5\%F_{centre}$ or $F_{centre}-15\text{MHz}$ , whichever is the greater	-38	$\geq -44$

## EXHIBIT B - EUT PHOTOGRAPHS

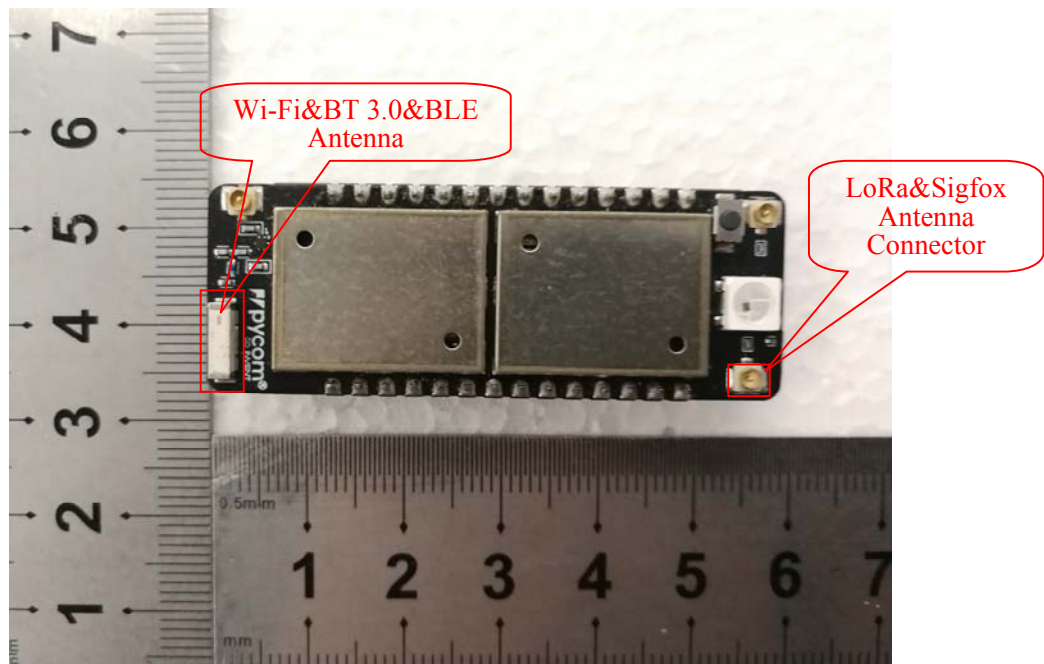
**EUT – All View**



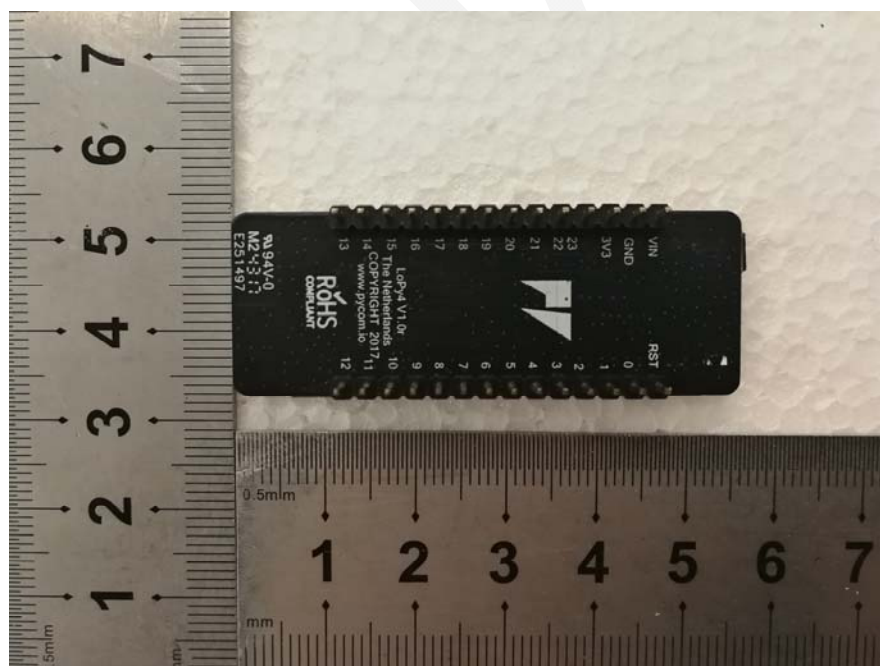
**EUT – Antenna Port View**



### EUT - Top View

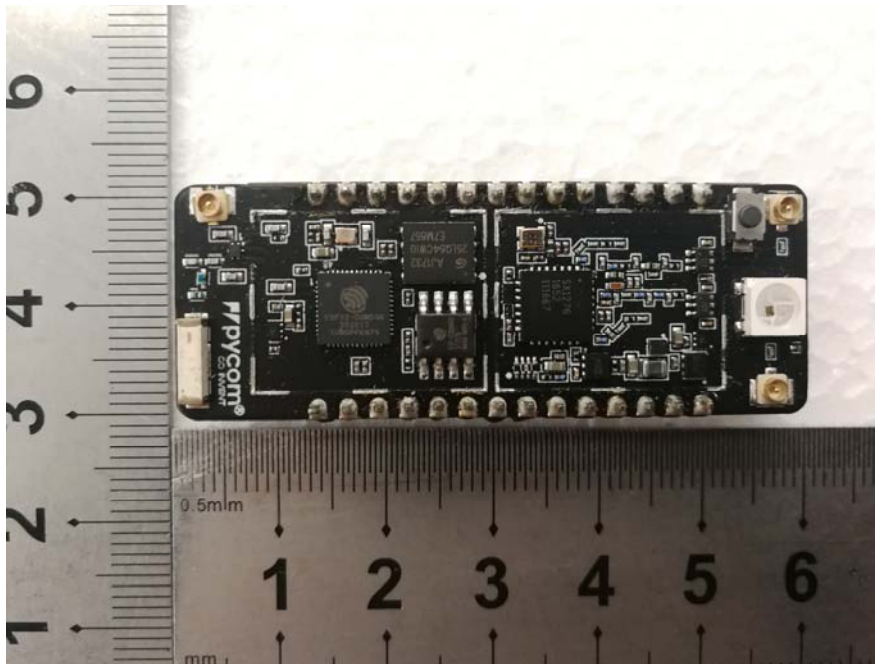


### EUT - Bottom View





**EUT - Shielding off View**

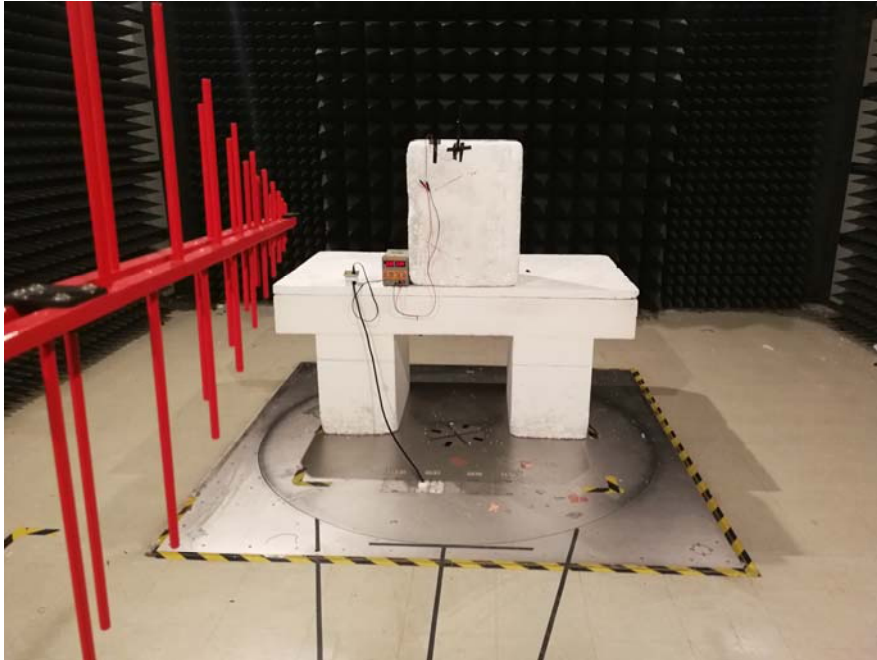


**EUT – IC Chip View**



## EXHIBIT C - TEST SETUP PHOTOGRAPHS

**Spurious Radiation - Below 1GHz View**



**Spurious Radiation - Above 1GHz View**



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