



***Test Report No. 9712329820***

***Applicant:***  
***Amarel Engineering Services***

***Transceiver module***  
***Model: LorAES***  
***FCC ID: 2AOZ7-LORAAES-01***

***From The Standards Institution  
Of Israel  
Industry Division  
Telematics Laboratory  
EMC Section***



***Certificate Number: AT-1359***



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<b>Applicant:</b>	Amarel Engineering Services
<b>Address:</b>	3 Hatamar Street, Yokneam Illit, 2062002, Israel.
<b>Sample for test selected by:</b>	The customer
<b>The date of tests:</b>	7, 10, 19 December 2017

**Equipment under test information**

<b>Description of Equipment Under Test (EUT):</b>	Transceiver module
<b>Model:</b>	LorAES
<b>Software version:</b>	N/A
<b>Hardware version:</b>	PCB-NT02-010 Rev. 01
<b>Manufactured by:</b>	Amarel Engineering Services

**2. Test performance**

<b>Location:</b>	SII EMC Section
<b>Purpose of test:</b>	Apparatus compliance verification in accordance with emission requirements
<b>Test specifications:</b>	47CFR part 15.247, 15.207, 15.205, 15.209 and part 1 §1.1310

**Reference Documents:**

❖	CFR 47 FCC:	Rules and Regulations; Part 15. "Radio frequency devices"; <u>Subpart C</u> : "Intentional radiators" Section 15.205. "Restricted bands of operations", Section 15.209. "Radiated emission limits, general requirements". "Radiated Emission Limits, Additional Provisions"; Section 15.247. "Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5875 MHz".
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This Test Report contains 45 pages  
and may be used only in full.

This Test Report applies only to the specimen tested and may not  
be applied to other specimens of the same product.



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### **Normative References.**

FCC 47 CFR Part 15, Subpart C, 2017	Radio Frequency Devices Subpart C – Intentional Radiators
ANSI C63.4: 2014	American National Standard for Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10: 2013	American National Standard for Testing of Unlicensed Wireless Devices.

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### 3. Summary of test

**The EUT was found to be in compliance with requirements of:** 47CFR Part 15, §§ 15.247, 15.205 and 15.207, 15.209.

Transmitter characteristics	Subclasses
Occupied bandwidth, channel frequency separation	15.247(a)(1)(i)
Maximum peak conducted output power	15.247(b)(2)
Number of hopping channels, average time of occupancy	15.247(a)(1)(i)
Out of band spurious emissions radiated	15.205, 15.247(d)
Conducted emissions on AC power line	15.207
Unwanted radiated emissions below 1 GHz	15.209

Telematics Laboratory

January 2018

Name: Eng. Yuri Rozenberg  
Position: Head of EMC Branch

Name: Michael Feldman  
Position: Test Technician

The test equipment was calibrated according to its recommended procedures and is within the manufacturer's published limit of error.

The laboratory calibrates its standards by a third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements.

In the following table the uncertainty calculation is given.

Test description	Calculated uncertainty $U_{LAB}$
<b>Conducted measurements</b>	
Frequency error	37.6 Hz
Spurious emission	$\pm 2.98$ dB
<b>Radiated emissions</b>	
Electric field strength in a SAR at 3 m distance 30 MHz – 1.0 GHz	$\pm 4.32$ dB
Electric field strength in a FAR at 3 m distance 1.0 GHz – 18 GHz	$\pm 4.47$
<b>Substitution measurements</b>	
In a FAR at 3 m distance 1.0 GHz – 18 GHz	$\pm 3.41$ dB



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FCC 47 CFR Part 15, Subpart C, 2017	Radio Frequency Devices Subpart C – Intentional Radiators
ANSI C63.4: 2014	American National Standard for Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10: 2013	American National Standard for Testing of Unlicensed Wireless Devices.

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#### 4. Equipment under test description.

\*The customer provided description.

##### 4.1 General description

The Equipment under Test (hereinafter: EUT) is a transmission module for wireless application in control irrigation systems used LoRa technology.

##### EUT technical characteristics

Transmitter technical characteristics.		Note
Assigned frequency range	902 MHz – 928 MHz	-
Operating frequency range	902.18 MHz – 927.68 MHz	-
Declare Occupied Bandwidth	125 kHz/250 kHz	-
Spread spectrum technique used	Frequency hopping (FHSS)	-
Number of hops	50 (for 125 kHz OBW) / 50 (for 250 kHz OBW)	-
Channel dwell time (msec)	369/354 msec	-
Type of modulation	LoRa	-
Type of antenna connector	SMA female	Professional installation
Antenna information		
Type	Manufacturer	Antenna gain, dBi
External Omni antenna	2J Ltd	Max 0.3



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No	Channel No	Frequency, MHz	No	Channel No	Frequency, MHz
1	32	909,005	26	109	925,945
2	110	926,165	27	1	902,405
3	113	926,825	28	23	907,245
4	5	903,065	29	30	908,565
5	107	925,505	30	28	908,125
6	15	905,265	31	2	902,625
7	108	925,725	32	33	909,225
8	106	925,285	33	14	905,045
9	4	903,945	34	116	927,485
10	31	908,785	35	36	909,885
11	12	904,605	36	104	924,845
12	22	906,805	37	29	908,345
13	18	905,925	38	36	909,885
14	20	906,365	39	104	924,845
15	27	907,905	40	29	908,345
16	11	905,385	41	7	903,505
17	17	905,705	42	24	907,245
18	10	904,165	43	9	903,945
19	112	926,605	44	35	909,665
20	105	925,065	45	6	903,285
21	111	926,385	46	21	906,585
22	34	909,445	47	8	903,725
23	25	907,465	48	3	902,625
24	13	907,075	49	19	906,145
25	0	902,185	50	114	927,045



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No	Channel No	Frequency, MHz	No	Channel No	Frequency, MHz
1	64	927,475	26	26	912,275
2	2	902,675	27	27	912,675
3	62	926,675	28	28	913,075
4	4	903,475	29	29	913,475
5	58	925,075	30	30	913,875
6	6	904,275	31	15	907,875
7	20	909,875	32	34	915,475
8	8	905,075	33	33	915,075
9	55	923,875	34	32	914,675
10	10	905,875	35	13	907,075
11	25	911,875	36	36	916,275
12	12	906,675	37	22	910,675
13	35	915,875	38	38	917,075
14	14	907,475	39	53	923,075
15	31	914,275	40	60	925,875
16	16	908,275	41	9	905,475
17	59	925,475	42	56	924,275
18	18	909,075	43	24	911,475
19	19	909,475	44	5	903,875
20	7	904,675	45	17	908,675
21	21	910,275	46	54	923,475
22	37	916,675	47	61	926,275
23	23	911,075	48	3	903,075
24	57	924,675	49	63	927,075
25	11	906,275	50	1	902,275

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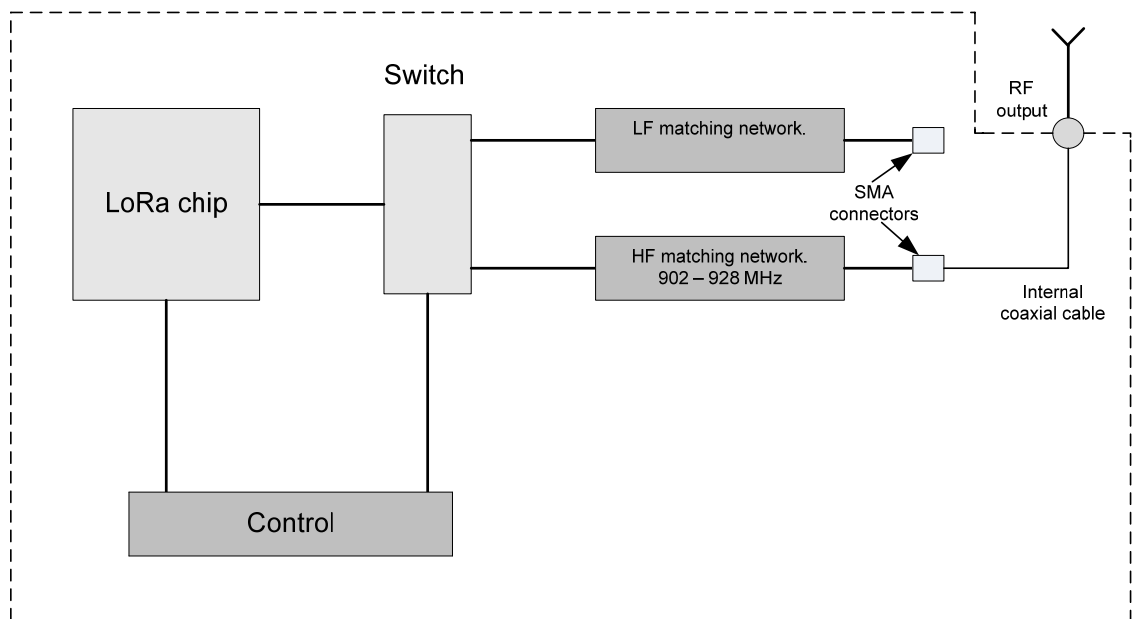
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## 4.2 EUT configuration.



**Figure 1. Transmission module block diagram.**

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## 5. Test results

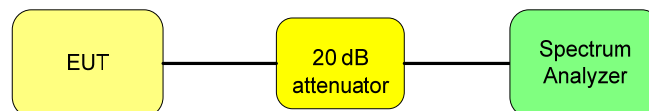
### 5.1 Transmitter characteristics

#### 5.1.1 Occupied bandwidth and channel frequencies separation.

FCC requirements	15.247(a)(1)(i)
Operating Frequency Range	902.185 – 927.685 MHz
Ambient Temperature 22 <sup>0</sup> C	Relative Humidity 55% Air Pressure 1008 hPa

Occupied bandwidth.	Carrier frequency MHz	Measured 20 dB bandwidth, MHz	Reference to plots #
125 kHz	902.185	0.216	1
	915.0	0.217	2
	927.685	0.214	3
250 kHz	902.310	0.362	4
	915.0	0.362	5
	927.560	0.364	6

Occupied bandwidth.	Frequency range MHz	Maximum carrier frequency separation, MHz	Reference to plots #
125 kHz	902.185 – 927.685	0.23	7, 8
250 kHz	902.310 – 927.560	0.38	9, 10



**Figure 2. Test setup block diagram.**

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Operating frequency range, MHz	Channel carrier frequency separation.
902 - 928	25 kHz or 20 dB bandwidth, whichever is greater. Maximum allowed 20 dB bandwidth 500 kHz

**TEST PROCEDURE**

The measurements were performed in hopping transmission mode of operation for carrier (channel) frequency at bottom, middle and at the top of 902 – 928 MHz frequency band and maximum transmitting data rate.

**TEST EQUIPMENT USED:**

1	2	9				
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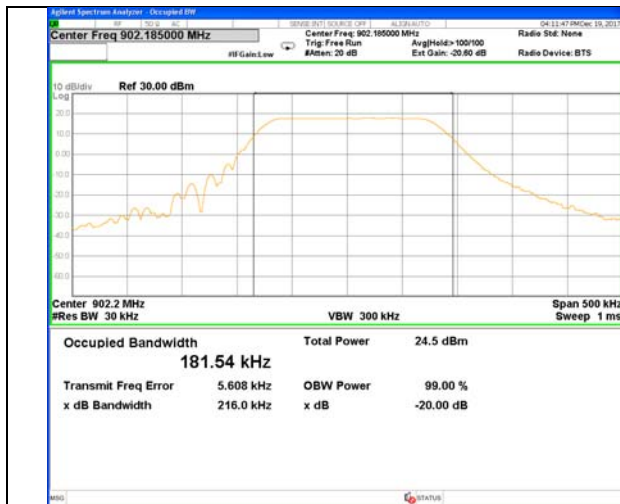
Title: Transceiver module

Model: LorAES

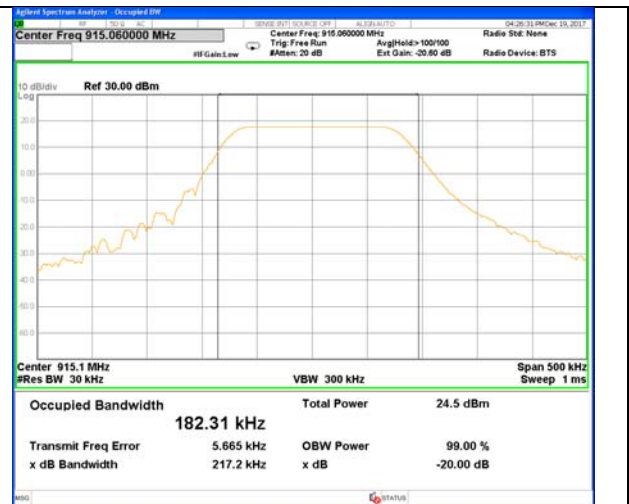
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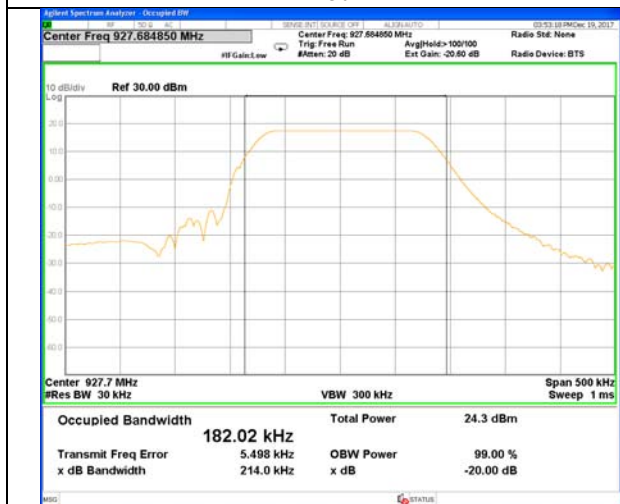
OBW<250 kHz



Plot # 1



Plot # 2



Plot # 3

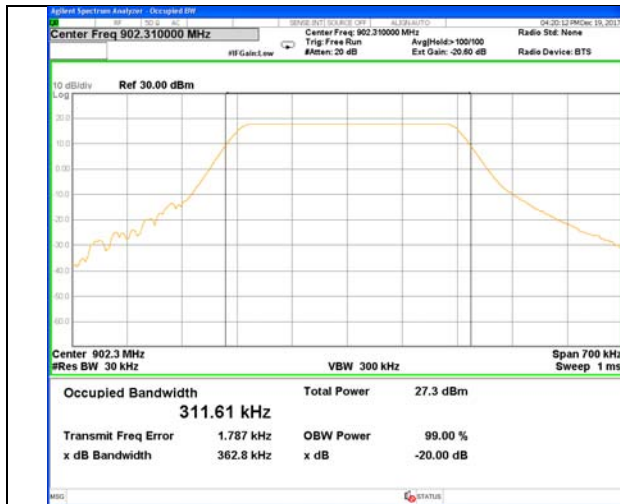


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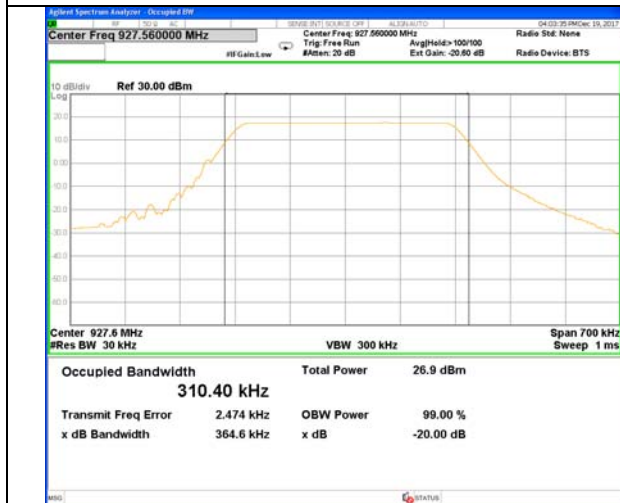
OBW>250 kHz



Plot # 4



Plot # 5



Plot # 6



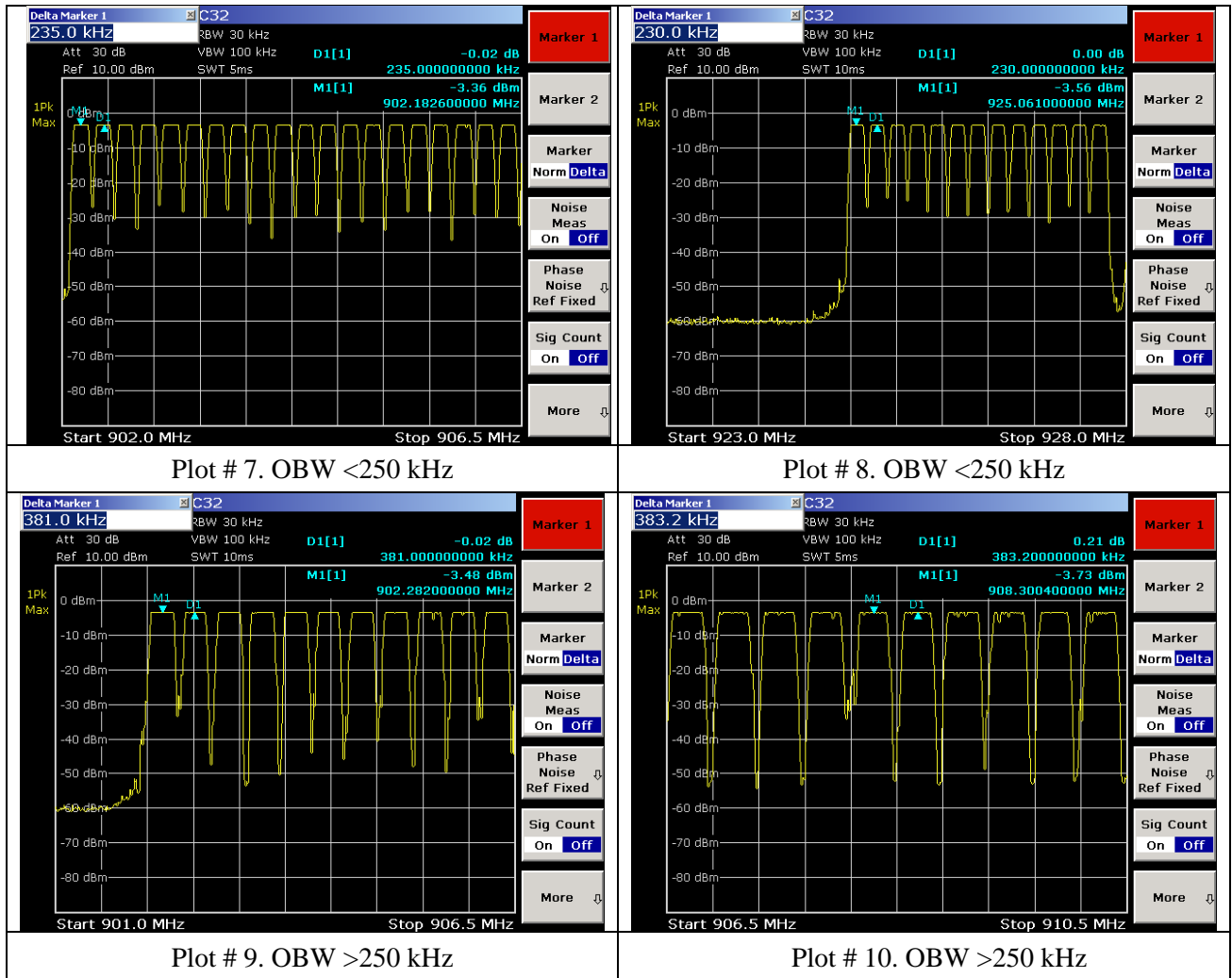
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### 5.1.2 Maximum peak conducted output power test.

FCC requirement	15.247(b)(2)		
Operating Frequency Band	902 – 928 MHz		
Ambient Temperature	22 <sup>0</sup> C	Relative Humidity	55%      Air Pressure      1008 hPa

#### 125 kHz OBW

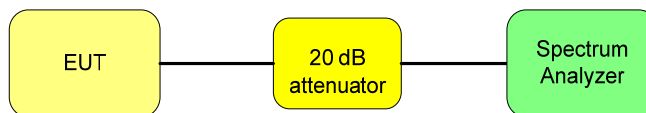
Carrier frequency, MHz	Peak output power, dBm	Limit, dBm	Reference to plots #
902.185	17.5	30	7
915.0	17.4	30	8
927.685	17.3	30	9

#### 250 kHz OBW.

Carrier frequency, MHz	Peak output power, dBm	Limit, dBm	Reference to plots #
902.310	17.5	30	7
915.0	17.4	30	8
927.560	17.3	30	9

#### LIMIT

Operating frequency band, MHz	Maximum output power
902 - 928	For systems employing at least 50 hopping channels 1W (30 dBm).



**Figure 3. Test setup block diagram.**



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## TEST PROCEDURE

Measurement of transmitter carrier emission was performed with Fig. 2 block diagram. Transmitter was operated in continuous transmit mode at bottom, middle and top of the 902 - 928 MHz frequency band.

## TEST EQUIPMENT USED:

1	2	9		10	14	
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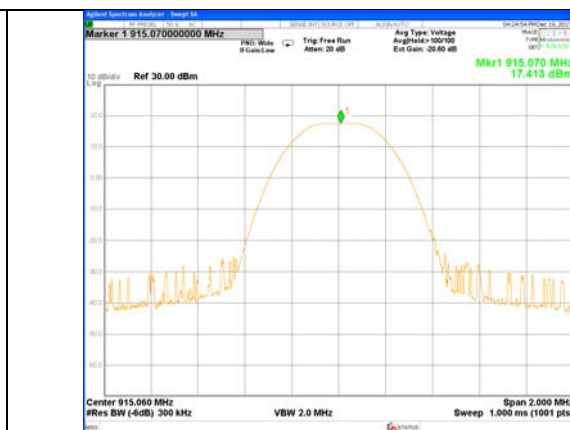
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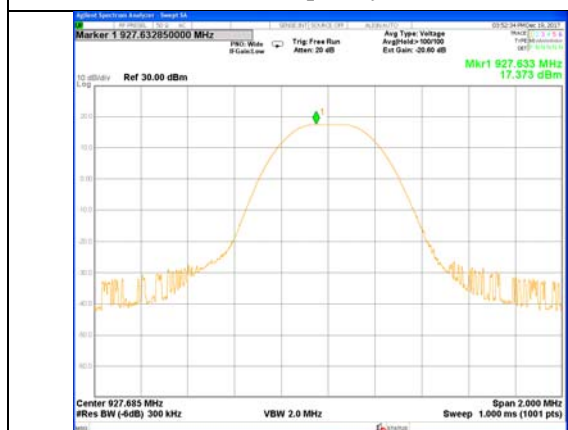
125 kHz OBW.



Plot # 11. Carrier frequency – 902.185 MHz.



Plot # 12. Carrier frequency – 915.0 MHz.



Plot # 13. Carrier frequency – 927.685 MHz.

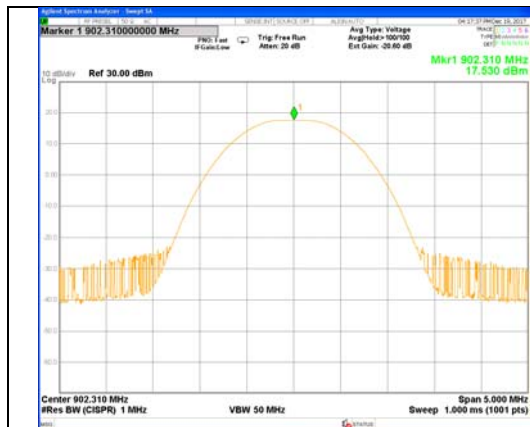


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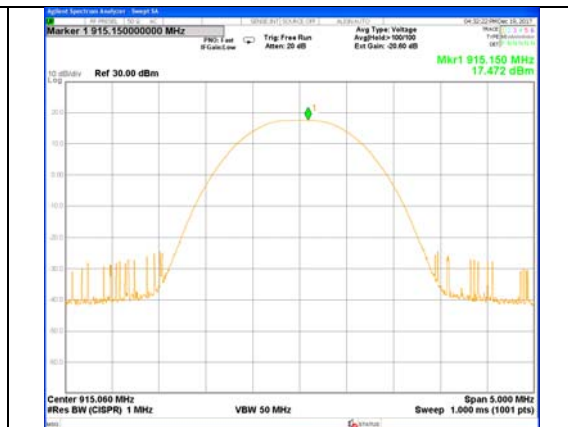
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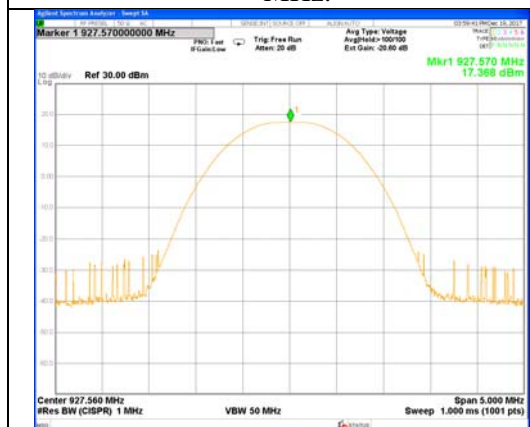
250 kHz OBW.



Plot # 14. Carrier frequency – 902.310 MHz.



Plot # 15. Carrier frequency – 915.0 MHz.



Plot # 16. Carrier frequency – 927.560 MHz.

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### 5.1.3 Number of hopping channels and average time occupancy test.

FCC requirements	15.247(a)(1)(i)		
Operating Frequency Range	902 – 928 MHz		
Ambient Temperature	22° C	Relative Humidity	55% Air Pressure 1008 hPa

OBW < 250 kHz.

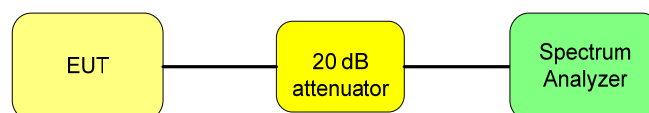
Frequency band, MHz	Number of hopping frequencies	Average time of occupancy	Reference to plots #
902 - 928	50	369 msec	17 - 23

OBW >250 kHz

Frequency band, MHz	Number of hopping frequencies	Average time of occupancy	Reference to plots #
902 - 928	50	354 msec	24 - 31

### LIMIT

902 – 928 MHz band	Number of hopping channels	Average time of occupancy
OBW < 250 kHz	≥ 50 channels	≤ 0.4 s within the period of 20 sec.
OBW >250 kHz	≥ 25 channels	≤ 0.4 s within the period of 10 sec.



**Figure 4. Test setup block diagram.**



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#### TEST PROCEDURE

The test was performed in hopping transmission mode of operation for carrier (channel) frequency at bottom, middle and at the top of 902 – 928 MHz frequency band and maximum transmitting data rate.

#### TEST EQUIPMENT USED:

1	2	9				
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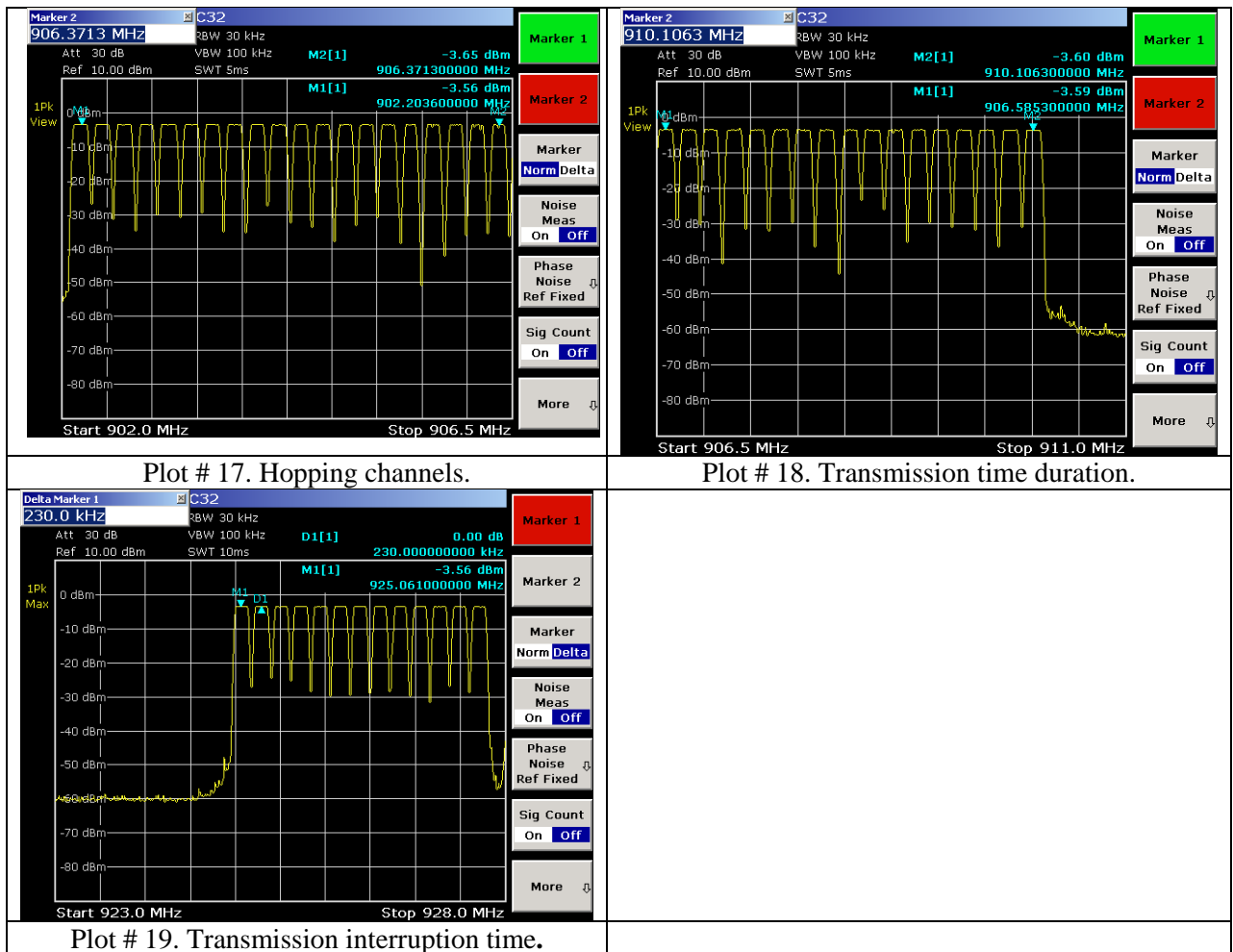
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OBW<250 kHz.







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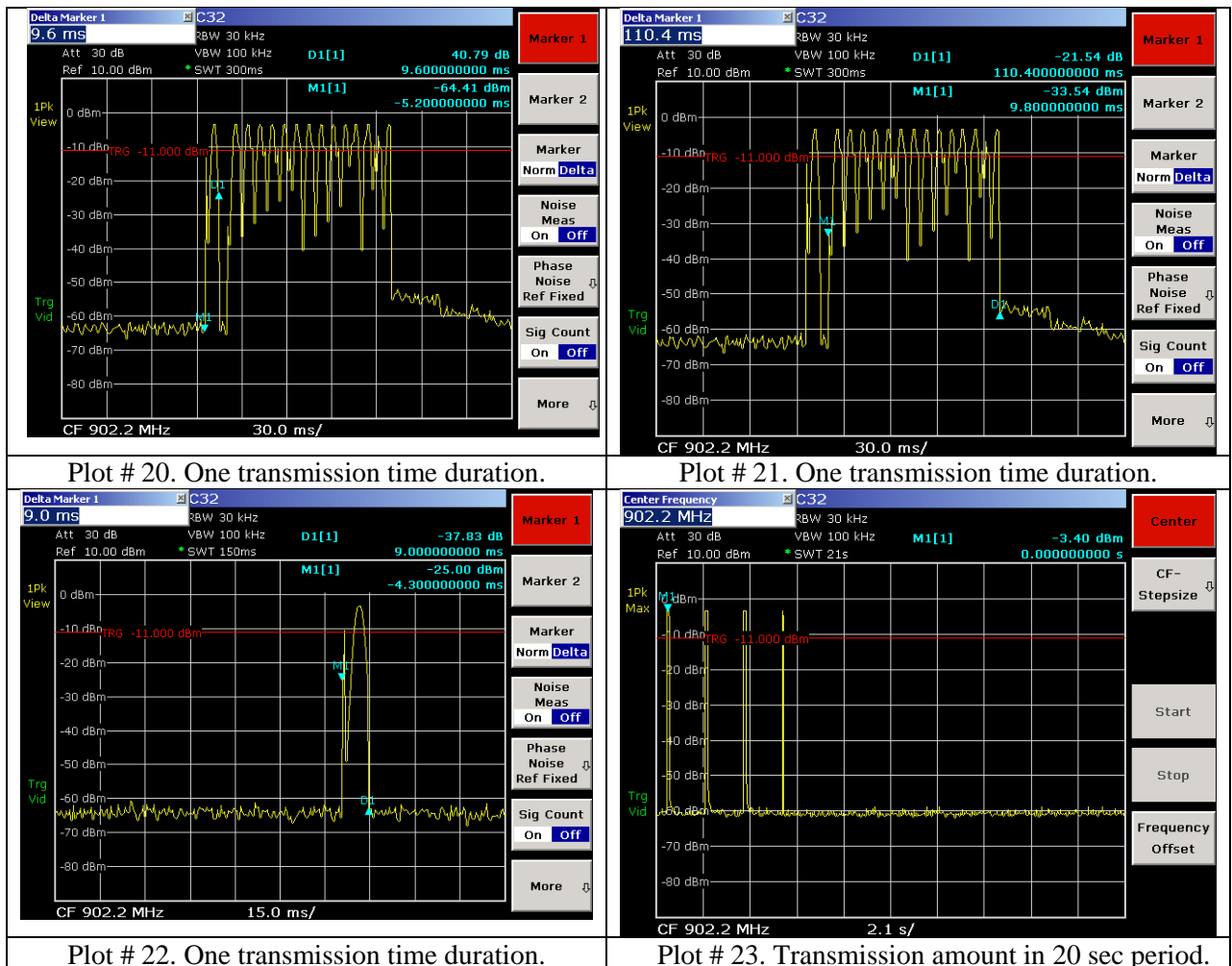
Title: Transceiver module

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Average time of occupancy test.



The average time of occupancy was calculated as follow:

$$3 \text{ transmissions of } 120 \text{ msec (9.6ms + 110.4ms) duration} + 1 \text{ transmission } 9.0 \text{ msec duration} = 369 \text{ msec.}$$



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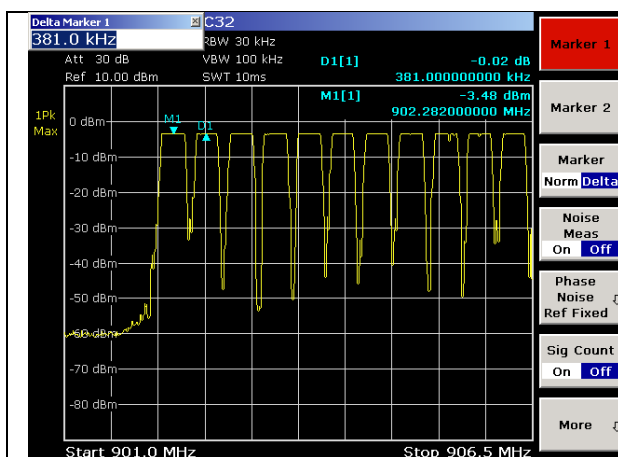
Title: Transceiver module

Model: LorAES

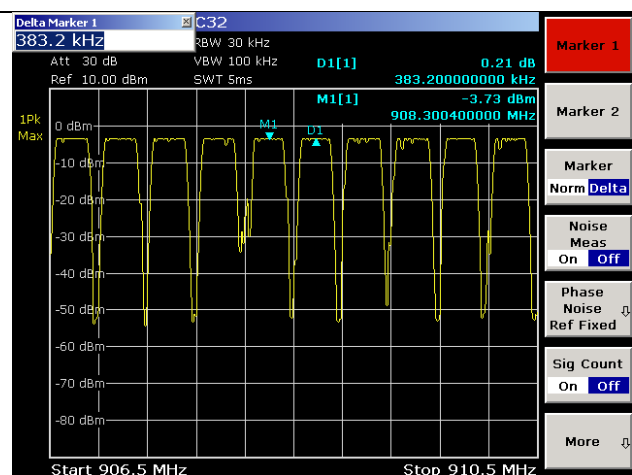
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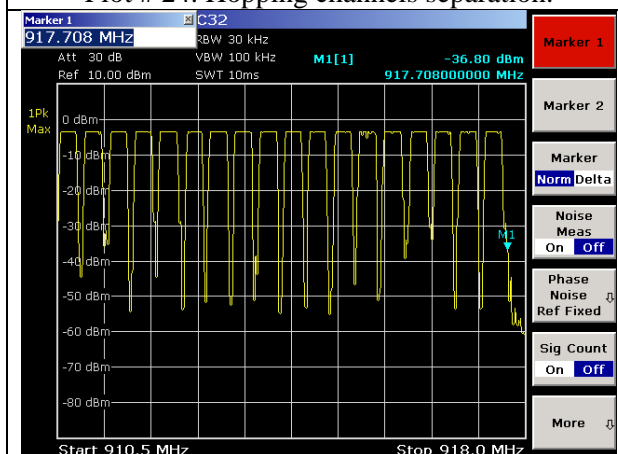
OBW&gt;250 kHz



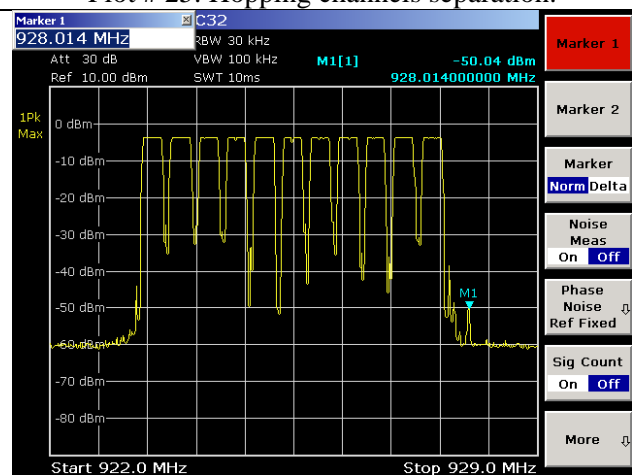
Plot # 24. Hopping channels separation.



Plot # 25. Hopping channels separation.



Plot # 26.



Plot # 27.



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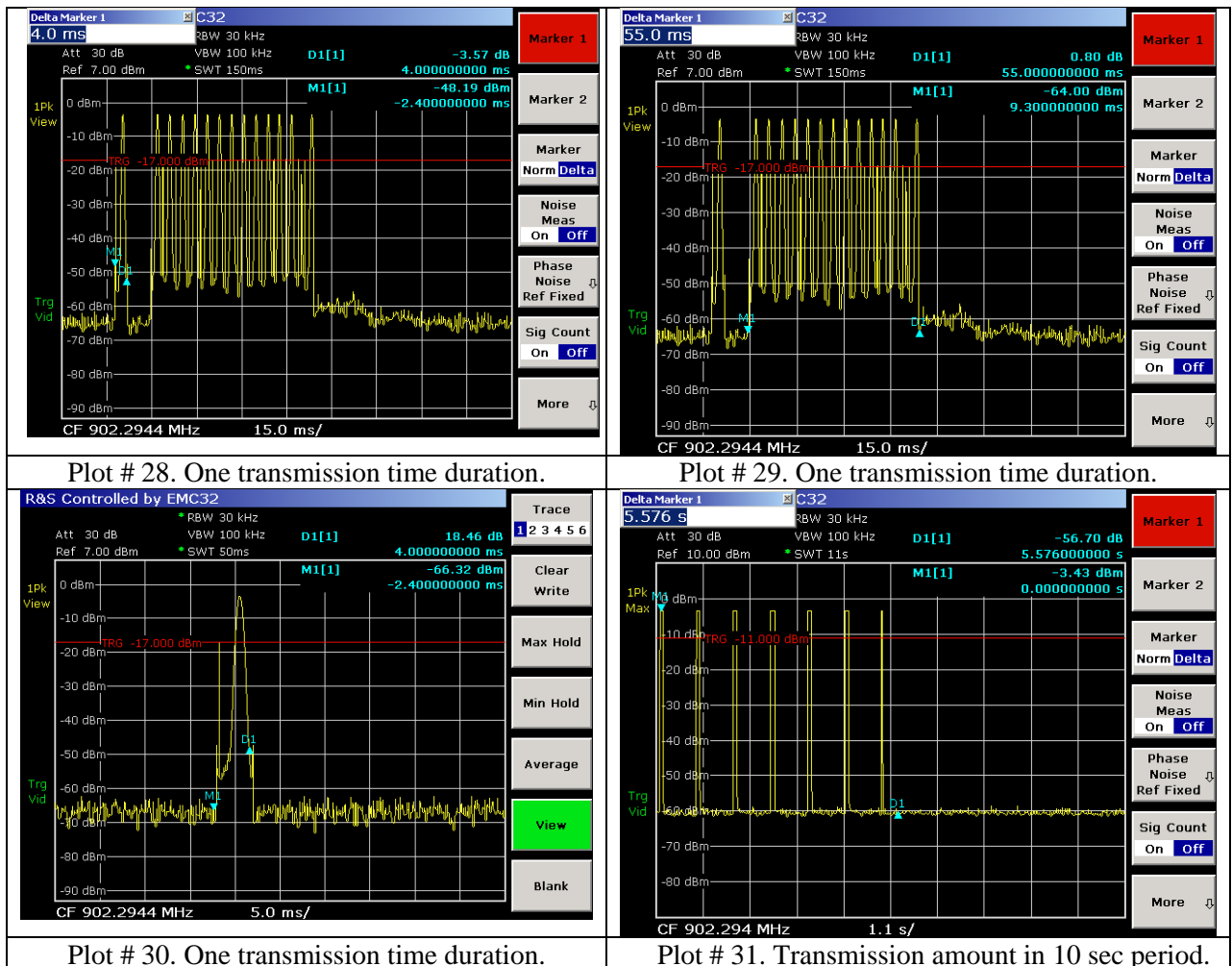
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Average time of occupancy test.



The average time of occupancy was calculated as follow:

Six transmissions of 59 msec (4ms + 55ms) duration + one transmission of 4.0 msec duration = 354 msec.

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#### 5.1.4 Out of band radiated emissions test according to §15.247(d), 15.205

Method of measurement	ANSI 63.10 §§ 6.5, 6.6		
Operating Frequency Range	902 – 928 MHz		
Ambient Temperature	23 <sup>0</sup> C	Relative Humidity	56% Air Pressure 1011 hPa

The frequency spectrum was investigated from the lowest radio frequency signal generated in the equipment and up to ten harmonic. For the test results refer to tables and plots in this section.

##### Carrier frequency 902.185 MHz

Frequency, MHz	Radiated emissions, dBμV/m	Peak limit, dBμV/m	Avg limit, dBμV/m	Margin, dB	Note	Reference to plot#
902.0	91.5	91.6	-	0.1	Detector peak	33
954.1	38.2	91.6	-	>20	Detector peak	34
1805	54.2	91.6	-	>20	Detector peak	35
2706.5	54.4	74.0	-	19.6	Detector peak	37
2706.5	49.2	-	54.0	4.8	Detector average	37
3608.8	57.1	74.0	-	16.9	Detector peak	38
3608.7	51.2	-	54.0	2.8	Detector average	38
6315.3	54.2	91.6	-	>20	Detector peak	39

##### Carrier frequency 915.0 MHz

Frequency, MHz	Radiated emissions, dBμV/m	Peak limit, dBμV/m	Avg limit, dBμV/m	Margin, dB	Note	Reference to plot#
902.0	67.1	92.5	-	>20	Detector peak	41
928.0	65.6	92.5	-	>20	Detector peak	41
1829.9	48.3	92.5	-	>20	Detector peak	45
2745.2	56.3	74.0	-	17.7	Detector peak	46
2745.0	50.5	-	54	3.5	Detector average	46
3659.9	60.5	74.0	-	13.5	Detector peak	47
3659.9	51.3	-	54.0	2.7	Detector average	47
4575.1	55.6	74.0	-	18.4	Detector peak	48
4575.1	50.1	-	54.0	3.9	Detector average	48

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Carrier frequency 927.56 MHz

Frequency, MHz	Radiated emissions, dBμV/m	Peak limit, dBμV/m	Avg limit, dBμV/m	Margin, dB	Note	Reference to plot#
928.0	74.5	92.5	-	17.5	Detector peak	52
1855.4	51.8	92.5	-	>20	Detector peak	55
2783.2	54.8	74	-	19.2	Detector peak	56
2783.1	48.0	-	54	6.0	Detector average.	56
4638.5	52.2	74	-	>20	Detector peak	57
4638.5	45.1	-	54	8.9	Detector average.	57

**TEST PROCEDURE**

The measurements were performed in hopping transmission mode of operation for carrier (channel) frequency at bottom, middle and at the top of 902 – 928 MHz frequency band and maximum transmitting data rate. To find maximum radiation the turntable was rotated 360°, measuring antenna height was changed from 1 to 4 m, and the antenna polarization was changed from vertical to horizontal.

**LIMIT**

In any 100 kHz bandwidth outside the frequency band the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below in band highest level desired power.

Radiated emissions, which fall in the restricted bands, must comply with the radiated emissions limit specified in section 15.205(c).

**TEST SAMMARY**

All emissions outside of the 902 - 928 MHz band were found below 15.247(d) limit.

**TEST EQUIPMENT USED:**

1	2	3	6	13	16	
---	---	---	---	----	----	--



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Carrier frequency – 902.185 MHz







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Plot # 38



Plot # 39



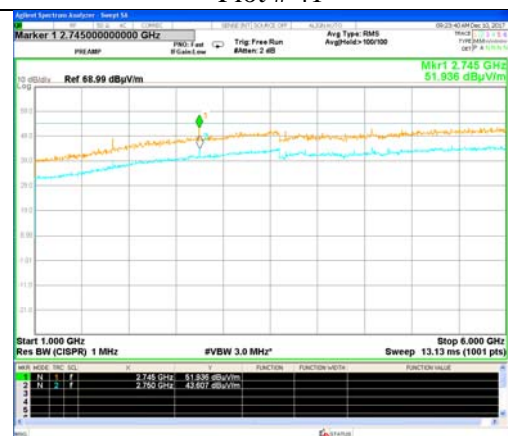


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Carrier frequency – 915.0 MHz.

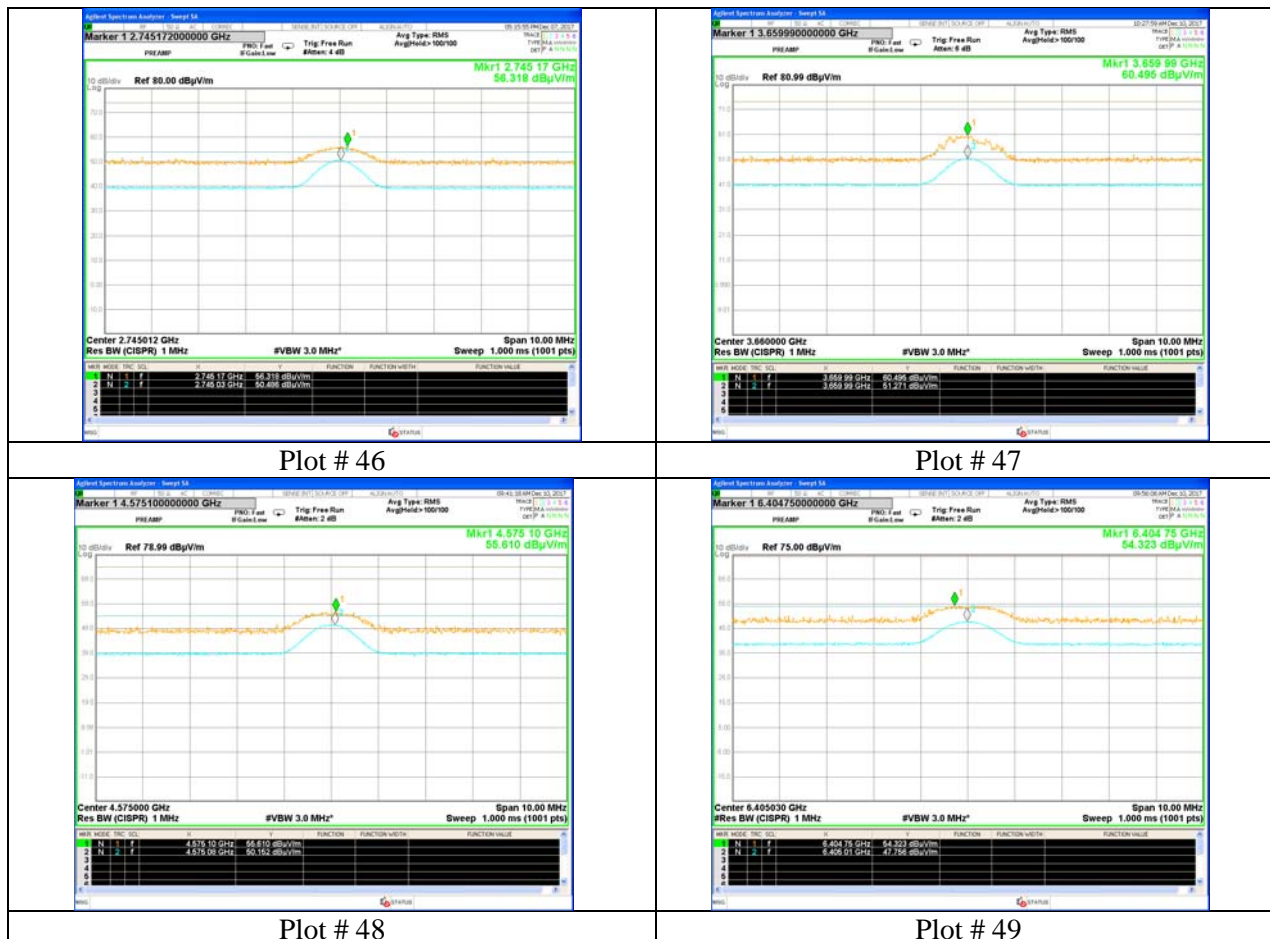




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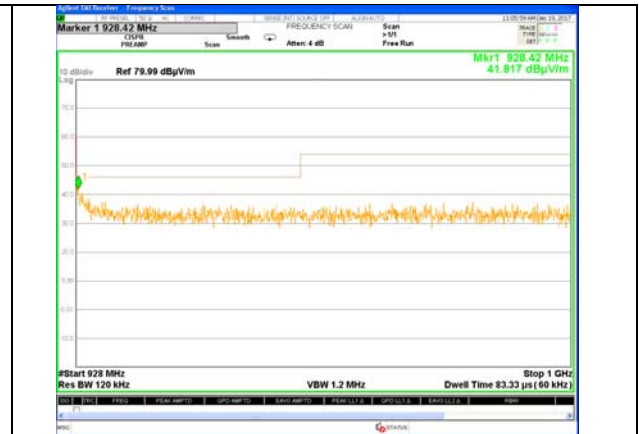
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FCC ID: 2AOZ7-LORAAES-01

Carrier frequency 927.56 MHz



Plot # 50



Plot # 51



Plot # 52



Plot # 53



Plot # 54



Plot # 55



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Title: Transceiver module

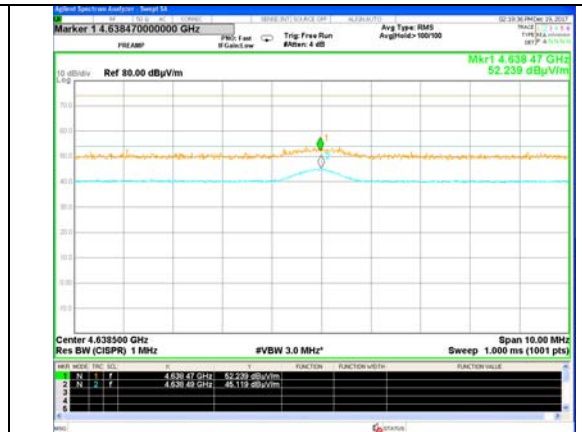
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Plot # 56



Plot # 57



**Test report N:** 9712329820**Page** 34 of 45**Title:** Transceiver module**Model:** LorAES**FCC ID:** 2AOZ7-LORAAES-01**6. Radiated emissions test according to §15.209.**

Method of measurement	ANSI 63.10 §§ 6.4, 6.5		
Operating Frequency Range	902 – 928 MHz		
Ambient Temperature	23 <sup>0</sup> C	Relative Humidity	58%      Air Pressure      1009 hPa

**TEST DESCRIPTION:**

The measurements were performed in semi anechoic chamber at 3 m test distance. The transmitter was placed on the turn - table. The Biconilog antenna was used in 30 to 1000 MHz frequency range. The frequency range was investigated and the measurements were performed at each frequency at which the signal was 10 dB below the limit or less. The level was maximized by initially rotating turntable through 360°, varying the antenna height between 1 m and 4 m, rerouting EUT cables and changing antenna polarization from vertical to horizontal.

**REQUIREMENTS:**

EUT radiated emission shall not exceed value required in section 15.209

**TEST RESULT:**

Test results are presented in the table in this section.



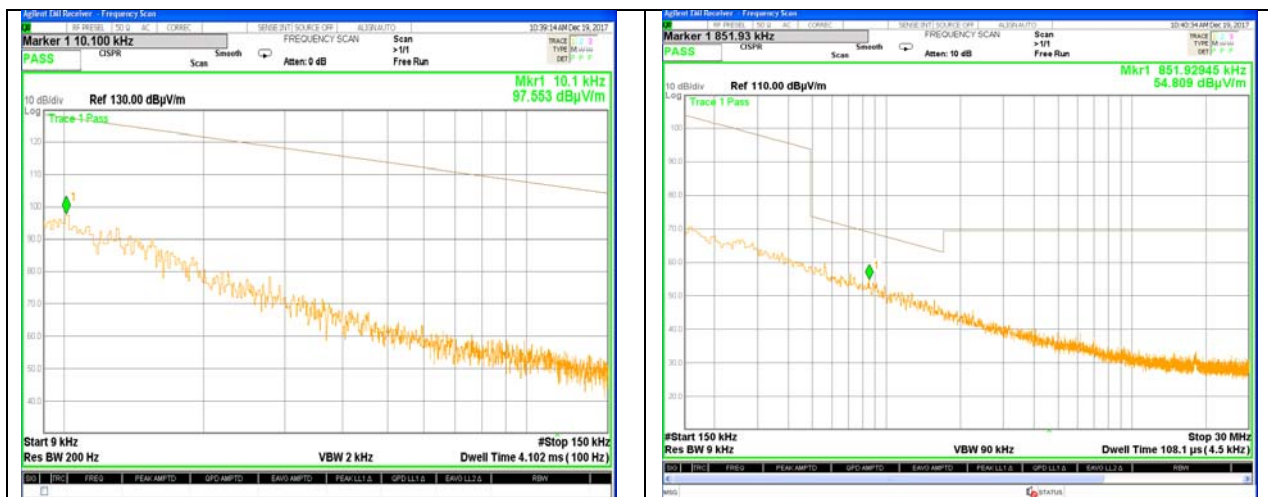
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Plot # 58. Investigation result in 0.15 – 30 MHz frequency range.



Plot # 59\_Investigation result in 30 - 100 MHz frequency range.

**Test report N:** 9712329820**Page** 36 of 45**Title:** Transceiver module**Model:** LorAES**FCC ID:** 2AOZ7-LORAAES-01**Radiated emission test results.**

Frequency (MHz)	Antenna Polariz V/H	Turn- table Angle (°)	Antenna Height (m)	Emission Level Note 1 dB $\mu$ V/m	Limit @ 3m dB $\mu$ V/m	Margin Note 2 dB	Verdict
30.9	V	251	1.0	31.5	40.0	8.5	Pass
48.0	V	107	1.0	27.2	40.0	12.8	Pass
63.5	V	336	1.0	22.5	40.0	17.4	Pass

Note 1: Emission level = E Reading (dB $\mu$ V) + Cable loss (dB) + Antenna Factor (dB/m).  
For Cable Loss and Antenna Factor refer to Appendix 2.

Note 2: Margin (dB) = Limit (dB $\mu$ V/m) – Emission level (dB $\mu$ V/m)

**TEST EQUIPMENT USED:**

1	6	13				
---	---	----	--	--	--	--



**Test report N:** 9712329820**Page** 37 of 45**Title:** Transceiver module**Model:** LorAES**FCC ID:** 2AOZ7-LORAAES-01**7. Conducted emissions test according to § 15.207.**

Method of measurement	ANSI 63.10 § 6.2		
Ambient Temperature	23 <sup>0</sup> C	Relative Humidity	54%      Air Pressure      1010 hPa

Frequency, MHz	Class B equipment, dB (μV)	
	QP	AVRG
0.15 - 0.5	66 - 56*	56 - 46*
0.5 - 5	56	46
5 - 30	60	50

\* Decreases linearly with the logarithm of the frequency.

**TEST PROCEDURE**

EUT was connected to 120VAC main via auxiliary 5VDC power supply. The was placed on a wooden table in an anechoic chamber at a height 40 cm from the horizontal reference plane and at more than 80 cm from any other metal surfaces. The measurements were performed at mains terminals by means of LISN, connected to spectrum analyzer in the frequency range as referred to in the table above. The measurements were made with quasi-peak (CISPR) and average detectors. The position of the EUT cables was varied to determine maximum emission level.

**TEST RESULTS:**

Test results present at plots # 60 for line Phase and # 61 for line Neutral.

**TEST EQUIPMENT USED:**

1	11	12				
---	----	----	--	--	--	--

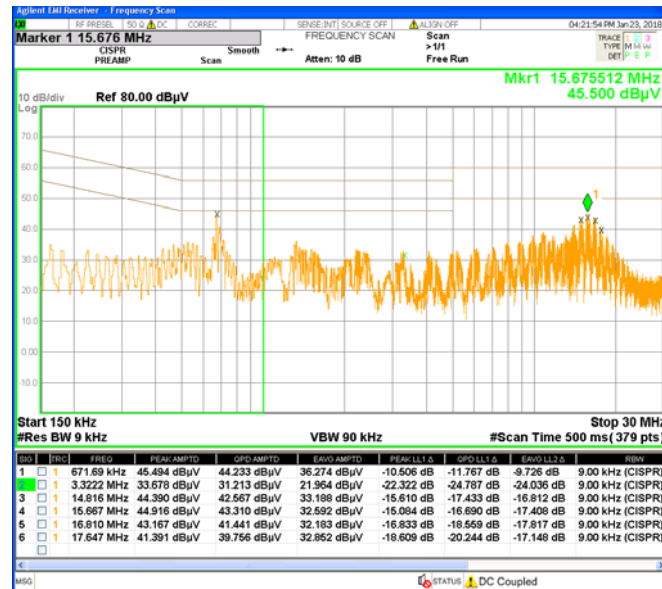
Test report N: 9712329820

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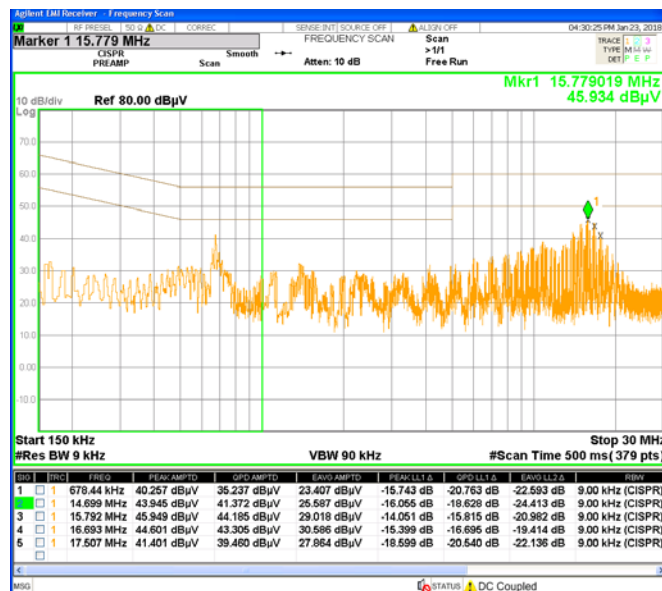
Title: Transceiver module

Model: LorAES

FCC ID: 2AOZ7-LORAAES-01



Plot # 60. AC line conducted emissions test. Line Phase



Plot # 61. AC line conducted emissions test. Line Neutral

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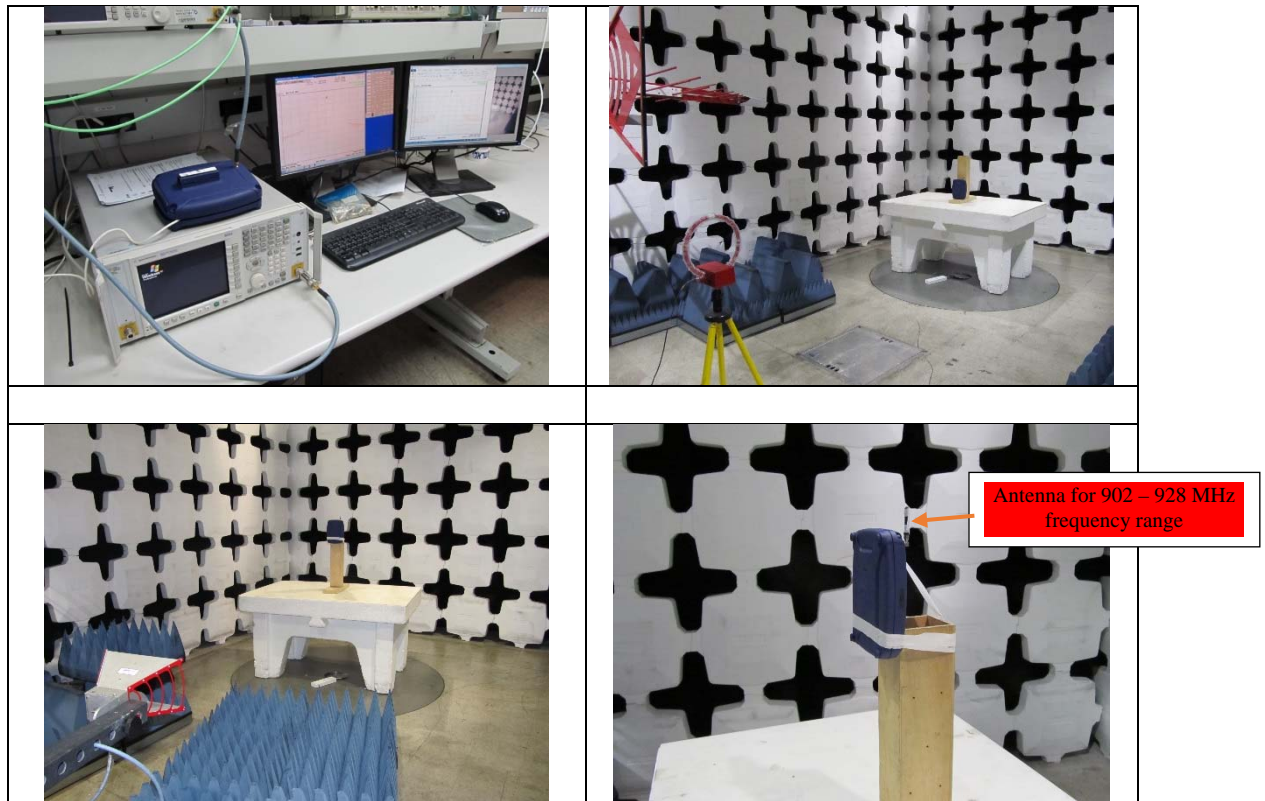
**Title:** Transceiver module

**Model:** LorAES

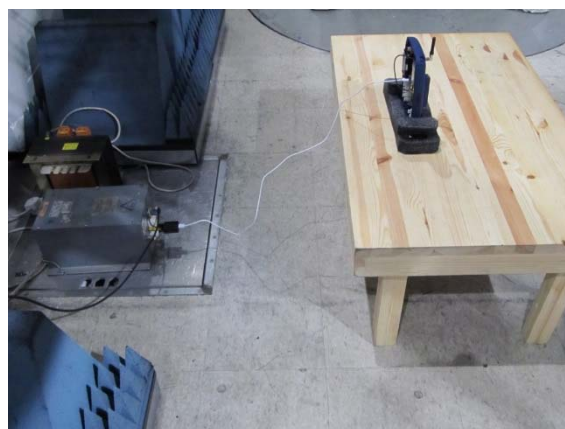
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## 8. APPENDIX A. Photo of the test setups.



**Photo 1. Conducted and radiated emissions test setups.**



**Photo 2. Conducted AC main setup.**

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## 9. APPENDIX B. Test equipment.

### Test equipment used

No	Description	Manufacturer information			Due Calibration date
		Name	Model	Serial No	
1	MXE EMI Receiver 20 Hz -26.5 GHz	Agilent	N9038A	MY52130048	April 2018
2	Cable RF 1.5 m	Midwest Microwave	LCSX10079	10-11-004	October 2018
3	Double Ridged Guide Antenna 0.75 – 18 GHz	ETS-Lindgren	3115	00143138	December 2018
4	Broadband Horn antenna 15 – 40 GHz	Schwarzbeck Mess-Electronik	BBHA 9170	9170-341	December 2018
5	Double Ridged Waveguide Horn Antenna 1 – 18 GHz	ETS-Lindgren	3117	00139055	December 2018
6	Antenna Biconilog 26 – 6000 MHz	ETS-Lindgren	31142D	0146490	December 2018
7	Spectrum analyzer 20 Hz-40 GHz	Rohde&Schwarz	ESU 40	100168	November 2018
8	MXG Signal Generator 100 KHz - 20 GHz	Agilent	N5183A	6501148	May 2018
9	Attenuator 20 dB DC – 12.4 GHz	HP	8491A	50480	October 2018
10	USB preamplifier 2 GHz – 50 GHz	Keysight	U7227F	MY55380004	January 2018
11	LISN 9 kHz – 30 MHz	Fischer Custom	FCC - LISN -50-25- 2	4025	February 2018
12	Transient limiter 0.009-200 MHz	HP	11947A	3107105	August 2018
13	Cable RF 4m	Huber-Suhner	Sucoflex 104PE	21329/4PE	October 2018
14	Cable RF 0.5m	Huber-Suhner	Multiplex 141	520201	October 2018
15	Spectrum analyzer 9 kHz-6 GHz	Rohde&Schwarz	FSL	101027	May 2018
16	Active Loop antenna 1.0 kHz – 30 MHz	ETS-Lindgren	6507	00144641	December 2018

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**Title:** Transceiver module

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**Cable Loss (Mast 6 m set cable.)**

Point	Frequency (MHz)	Cable Loss (dB)	Point	Frequency (MHz)	Cable Loss (dB)
1	30	0.3	21	1000	2.5
2	50	0.4	22	1100	2.6
3	100	0.6	23	1200	2.8
4	150	0.8	24	1300	2.9
5	200	1.0	25	1400	3.1
6	250	1.1	26	1500	3.2
7	300	1.2	27	1600	3.3
8	350	1.3	28	1700	3.5
9	400	1.5	29	1800	3.6
10	450	1.6	30	1900	3.7
11	500	1.7	31	2000	3.9
12	550	1.8	32	2100	4.0
13	600	1.9	33	2200	4.1
14	650	1.9	34	2300	4.2
15	700	2.0	35	2400	4.4
16	750	2.1	36	2500	4.6
17	800	2.1	37	2600	4.7
18	850	2.2	38	2700	4.8
19	900	2.3	39	2800	4.9
20	950	2.4	40	2900	5.0



**Test report N:** 9712329820**Page** 42 of 45**Title:** Transceiver module**Model:** LorAES**FCC ID:** 2AOZ7-LORAAES-01**Antenna factor****Biconilog Antenna, ETS-Lindgren mod. 31142D, S/N: 0146490 3m calibration.**

f / MHz	AF / dB/m	f / MHz	AF / dB/m	f / MHz	AF / dB/m
30	18.7	250	12.0	2750	31.0
35	15.7	300	13.8	3000	31.2
40	12.9	400	16.2	3250	32.7
45	10.6	500	18.6	3500	34.5
50	9.0	600	20.2	3750	34.3
60	7.3	700	21.8	4000	34.5
70	7.7	800	22.9	4250	35.3
80	8.2	900	24.1	4500	35.5
90	9.2	1000	24.8	4750	36.1
100	9.4	1250	26.9	5000	37.4
120	8.5	1500	30.2	5250	38.4
140	8.5	1750	28.5	5000	39.9
160	9.1	2000	28.9	5750	38.2
180	10.5	2250	29.8	6000	39.1
200	10.9	2500	32.5		

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**Title: Transceiver module**

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**Antenna Factor**

**Double Ridged Guide Antenna mfr ETS-Lindgren model 3115 1m calibration**

Point	Frequency (MHz)	Antenna Factor (dB/m)
1	1000	23.7
2	1500	25.5
3	2000	28.5
4	2500	28.1
5	3000	29.6
6	3500	31.1
7	4000	32.5
8	4500	32.5
9	5000	33.5
10	5500	34.7
11	6000	36.1
12	6500	36.5
13	7000	37.3
14	7500	38.0
15	8000	37.3
16	8500	37.9
17	9000	38.1
18	9500	38.5
19	10000	38.7
20	10500	38.8
21	11000	38.6
22	11500	38.8
23	12000	38.9
24	12500	39.3
25	13000	40.2
26	13500	40.6
27	14000	40.6
28	14500	40.4
29	15000	39.6
30	15500	39.5
31	16000	39.8
32	16500	40.4
33	17000	41.3
34	17500	42.6
35	18000	43.2

**Cable Loss**

**Type: Sucoflex 104PE; Ser.No.21329/4PE; 4 m length**

Point	Frequency (GHz)	Cable Loss (dB)
0	0.0-1.8	1.67
1	1.8 – 3.6	2.39
2	3.6 – 5.4	3.04
3	5.4-7.2	3.58
4	7.2-9.0	4.06
5	9.0-10.8	4.49
6	10.8-12.6	4.91
7	12.6-14.4	5.31
8	14.4-16.2	5.66
9	16.2-18.00	6.01



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**Antenna Factor**  
**Broadband Horn Antenna model BBHA 9170 1m calibration**

Point	Frequency (GHz)	Antenna Factor (dB/m)
1	15.0	38.5
2	16.0	37.7
3	17.0	38.1
4	18.0	37.9
5	19.0	38.0
6	20.0	38.0
7	21.0	37.9
8	22.0	38.2
9	23.0	39.6
10	24.0	39.6
11	25.0	39.3
12	26.0	39.5
13	27.0	39.6
14	28.0	39.6
15	30.0	40.1
16	32.0	41.2
17	34.0	41.5
18	35.0	41.9
19	36.0	42.2
20	38.0	43.8
21	40.0	43.2

**Antenna Factor**  
**For Antenna Loop MFR ETS Lindgren, Type/Model 6507, S/N: 00144641**

No.	Frequency MHz	Magnetic antenna factor, dB/m	Electric antenna factor, dB/m
1	9	-21.5	30.0
2	10	-22.0	29.5
3	20	-27.7	23.8
4	50	-32.2	19.4
5	75	-33.0	18.5
6	100	-33.4	18.2
7	150	-33.6	17.9
8	250	-33.7	17.9
9	500	-33.8	17.8
10	750	-33.8	17.7
11	1000	-33.8	17.7
12	2000	-33.7	17.9
13	3000	-33.8	17.8
14	4000	-34.0	17.5
15	5000	-34.3	17.2
16	10000	-35.2	16.4
17	15000	-35.8	15.8
18	20000	-36.0	15.6
19	25000	-36.2	15.3
20	30000	-36.4	15.2

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## 10. APPENDIX C. Abbreviations and acronyms.

The following abbreviations and acronyms are applicable to this test report:

AC	alternating current
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB( $\mu$ V)	decibel referred to one microvolt
dB( $\mu$ V/m)	decibel referred to one microvolt per meter
EBW	emission bandwidth.
EMC	electromagnetic compatibility
EUT	equipment under test
GHz	gigahertz
H	height
Hz	hertz
kHz	kilohertz
L	length
LNA	low noise amplifier
m	meter
Mbps	megabit per second
MHz	megahertz
NA	not applicable
OFDM	Orthogonal Frequency Division Multiple Access
PRBS	pseudo random binary sequence
QP	quasi-peak
RF	radio frequency
RE	radiated emission
SA	spectrum analyzer
rms	root mean square
W	width