



Test report issued under the responsibility of:
EMITECH LYON laboratory
MRA US-EU Designation Number: FR0013
Canadian CAB Identifier : FR0007

RADIO TEST REPORT

FCC part 15.247
RSS-247_Issue 2, February 2017

Company: **INSIGHT SIP**
Address.....: 13 chemin de la halte
06130 GRASSE
FRANCE

Test item description: **LoRa and bluetooth low energy module with integrated antenna**
Trade Mark: InsightSIP
Manufacturer: InsightSIP
Model/Type reference.....: ISP4520-US
FCC ID.....: 2AAQS-ISP4520
IC: 1136A-ISP4520
Ratings.....: 1.8Vdc to 3.6Vdc

Testing Laboratory: **EMITECH LYON laboratory**
Address.....: ZI de Mi-Plaine
7 rue Georges Méliès
69680 CHASSIEU
FRANCE

Report Reference No: **R120-19-105 133-01-5_A**
Test procedure: FCC IC Certification
Diffusion.....: Mr MOREL
Applicant's name: INSIGHT SIP
Date of issue.....: 11/01/2021
Total number of pages.....: 58
Revision.....: 0
Modified page(s).....: Creation
Compiled by.....: T VINAY
Approved by (+ signature).....: D MONTAULON (Technical Manager)



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This document is the result of testing a specimen or a sample of the product submitted. It does not imply an assessment of the conformity of
the whole manufactured products of the tested sample.*



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1. GENERAL INFORMATION

This document submits the results of Radio tests performed on the equipment **LoRa and bluetooth low energy module with integrated antenna ISP4520-US** (denominated hereafter E.U.T.: equipment under test) according to document(s) listed in §2 of this test report.

TESTING PROCEDURE AND TESTING LOCATION:

Testing Laboratory : EMITECH LYON laboratory
Address..... : ZI de Mi-Plaine
7 rue Georges Méliès
69680 CHASSIEU
FRANCE
Test procedure. : FCC IC Certification
Tested by : T VINAY
Test supervisor : None
Date of receipt of test item..... : N/A
Date (s) of performance of tests : The 31st of March of 2020, from 1st April to 3rd April of 2020
The 3rd of July of 2020, the 18th of August of 2020
The 9th of November 2020, the 7th of January of 2020

APPLICANT'S GENERAL INFORMATION:

Company name : INSIGHT SIP
Company address. : 13 chemin de la halte
 06130 GRASSE
 FRANCE
Person(s) present during the tests. : No representative for company attended the tests.
Responsible. : Mr MOREL

GENERAL REMARKS:

**The test results presented in this report relate only to the object tested.
The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.**

This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory. Throughout this report the decimal separator is point.

POSSIBLE TEST CASE VERDICTS:

Test case does not apply to the test object. . : N/A
 Information not communicated. : N/C
 Test case not performed..... : N/P
 Test object does meet the requirement. : P (Pass)
 Test object does not meet the requirement. . : F (Fail)
 Test object was not subjected to all tests. : I (Inconclusive)

DEFINITIONS AND ABBREVIATIONS:

E.U.T.	Equipment under test	AE	Ancillary equipment
RBW	Resolution bandwidth	VBW	Video bandwidth
OATS	Open area test site	FAR	Full anechoic room
RF	Radio frequency	NTR	Nothing to report
SRD	Short Range Device	GPS	Global Positioning System

2. REFERENCE DOCUMENT(S)

NORMATIVE REFERENCES:

The following referenced documents are necessary for the application of the present test report.

FCC part 15

Code of federal regulations. Title 47- Telecommunication Chapter 1- Federal Communication Commission. Part 15- Radio frequency devices Subpart B- Unintentional Radiators. Limits and methods of measurement of radio disturbance. Characteristic of information technology equipment.

FCC part 15.247

Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850MHz. (frequency hopping and digitally modulated)

RSS-247_Issue 2, February 2017

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence Exempt Local Area Network (LE-LAN) Devices

RSS/CNR-Gen, Issue 5, March 2019

Exigences générales et information relatives à la certification du matériel de radiocommunication

ANSI C 63.10:2013

American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

ANSI C 63.4:2014

American National Standard for Methods of measurement of Radio-Noise from low-voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

3. EQUIPMENT TECHNICAL DESCRIPTION

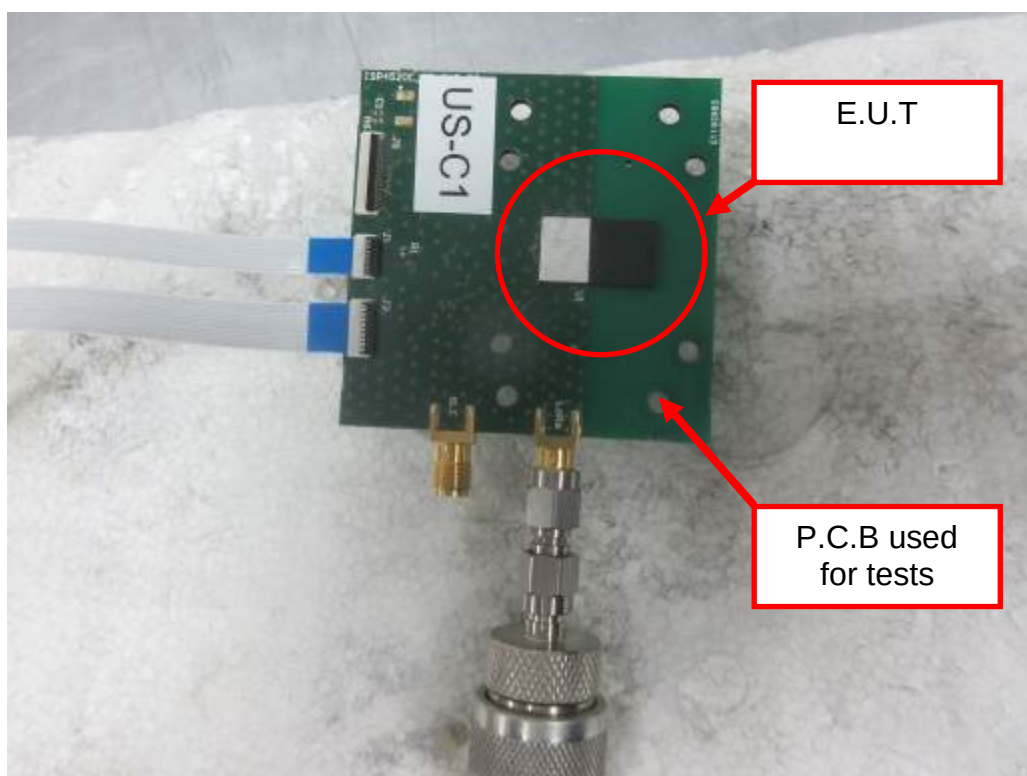
3.1. Test Conditions

Test item description. : LoRa and bluetooth low energy module with integrated antenna
Model/Type reference..... : ISP4520-EU
Trade Mark. : InsightSIP
FCC ID..... : 2AAQS-ISP4520
IC. : 1136A-ISP4520
Serial number (S/N)..... : Non applicable
Part number (P/N). : Non applicable
Software version..... : *BLE : DTM*
LoRa : custom test FW
Firmware version. : *BLE : DTM*
LoRa : custom test FW
Type of sample. : Standard equipment
Function(s)..... : LoRa and bluetooth low energy module with integrated antenna
Manufacturer name. : InsightSIP
Address..... : Village d'entreprise Green Side
400 Avenue Roumanille
BP 309
06906 SOPHIA ANTIPOLIS

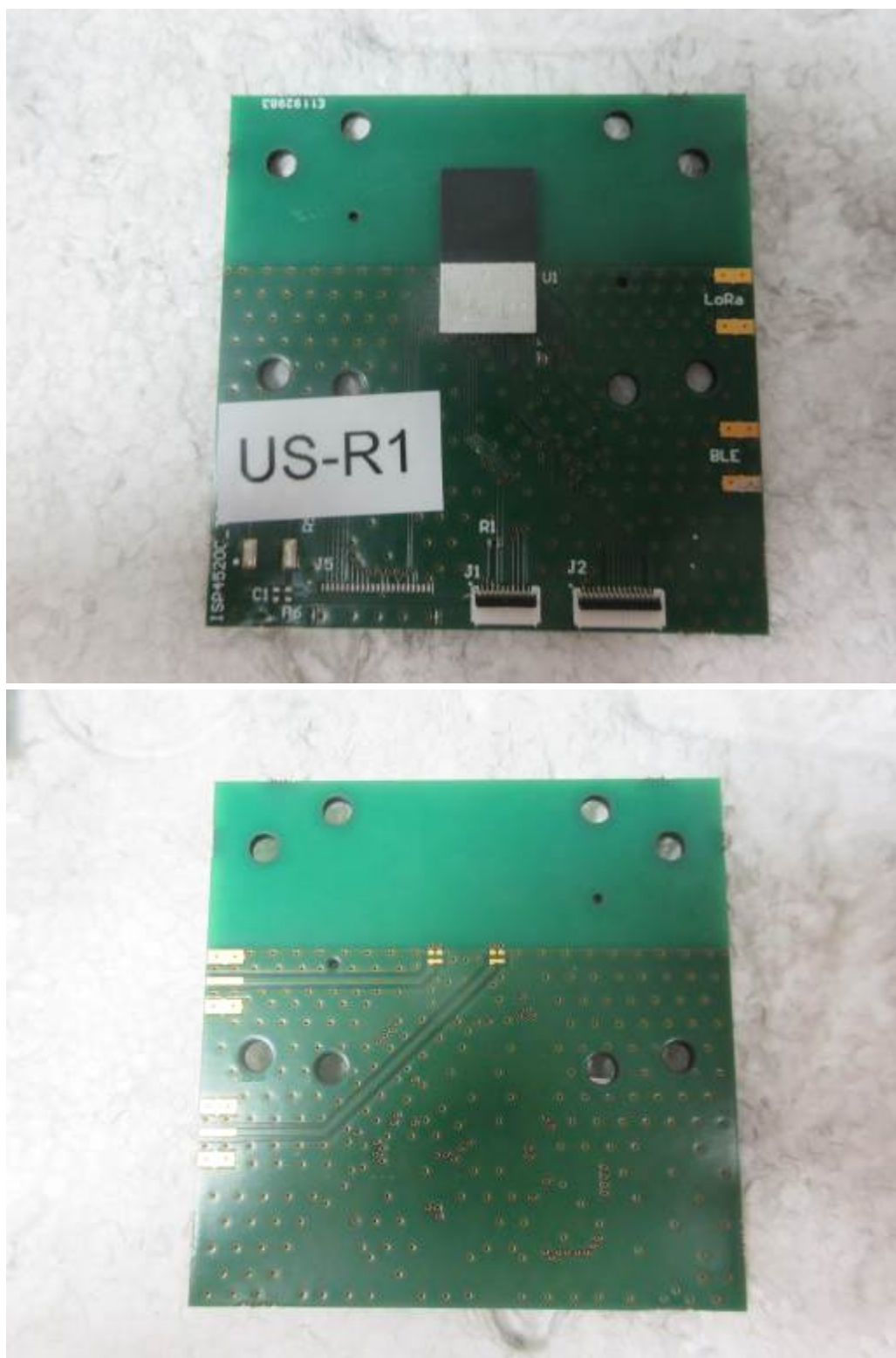
General product information:

N/A

3.2. EUT General view



3.3. EUT SRD Antenna + PCB



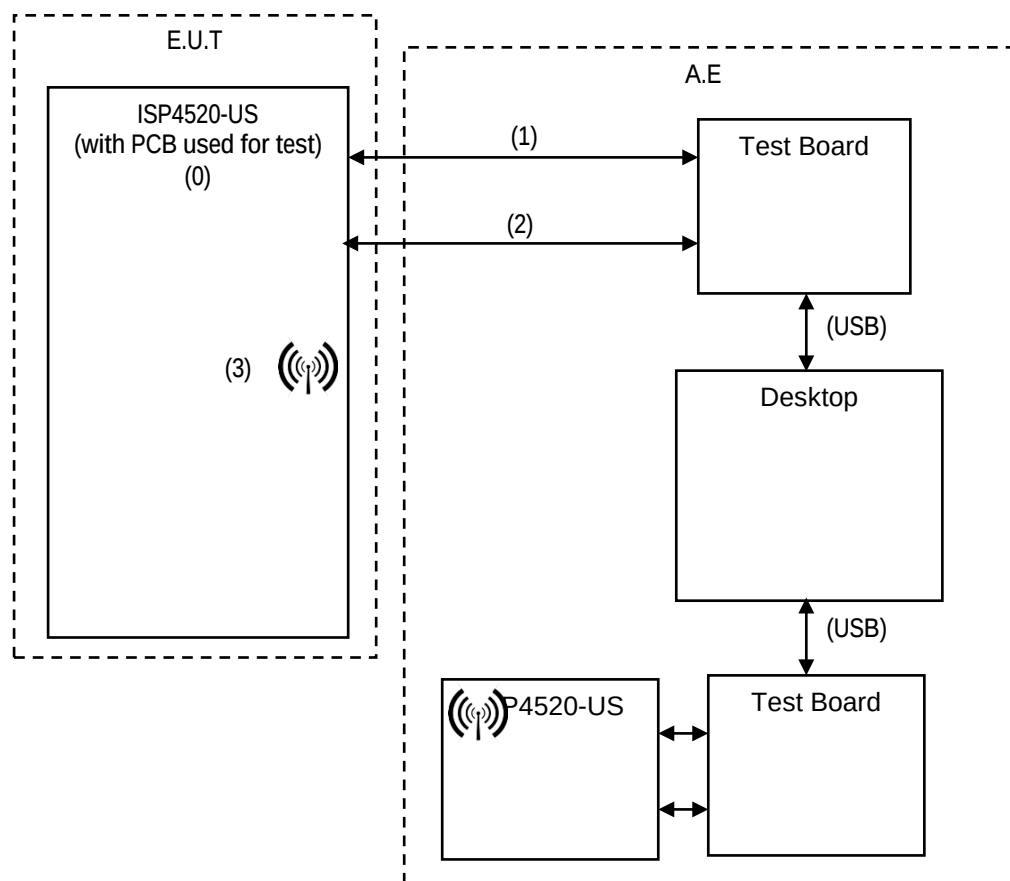
3.4. EUT Mechanical and Electrical Design

Power supply. : 3.3 Vdc
 Power supply range. : 1.8Vdc to 3.6Vdc
 Power type. : USB
 Power (W). : 0.400
 Nominal current (A). : 0.120
 Dimensions (L x W x H) (m). : 0.0098 x 0.0172 x 0.0017
 Weight (kg). : 0.062
 Temperature range (°C). : -30 to 85
 Ground bounding strap. : No

Comments:

N/A

3.5. EUT Input/Output ports



PORT	NAME	TYPE	LENGHT	CABLE TYPE	COMMENTS
0	Main frame	N/E	N/A	Metallic/cera mic	
1	Control cable 1	DC and I/O	L = 20cm	Unshielded	This cable is not part of the EUT. He is only present for EUT tests
2	Control cable 2	DC and I/O	L = 20cm	Unshielded	This cable is not part of the EUT. He is only present for

EUT tests					
3	RF Antennas	RF	N/E	N/E	BLE and LoRa

AC/DC : AC/DC Converter port

AC..... : Alternative current port

DC.....: Discontinuous current port

I/O.....: Input or Output port

TP : Telecommunication port

RF.....: Radio frequency port

N/E : Non Electrical port

3.6. Supporting Equipment Used During Test

Sample subject to the tests was tested with following equipment.

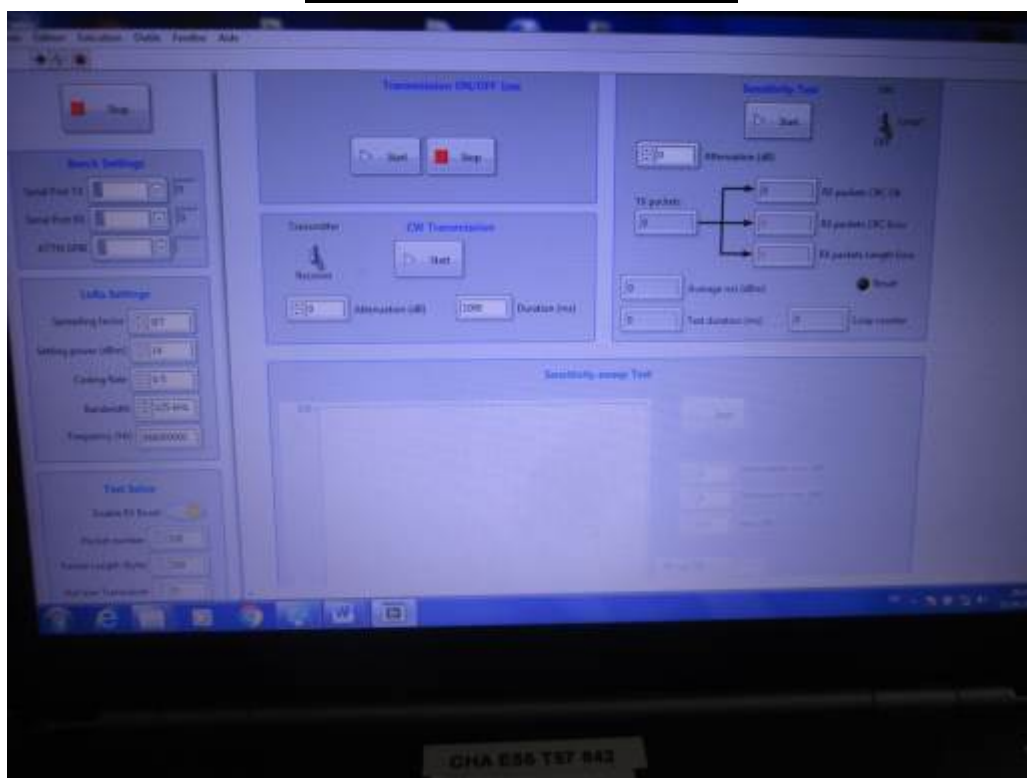
PRODUCT TYPE	MANUFACTURER	MODEL	N°EMITECH / COMMENTS
Desktop Interface board with RF module	DELL Insight SIP	N/A	Provided by the customer

(EA)

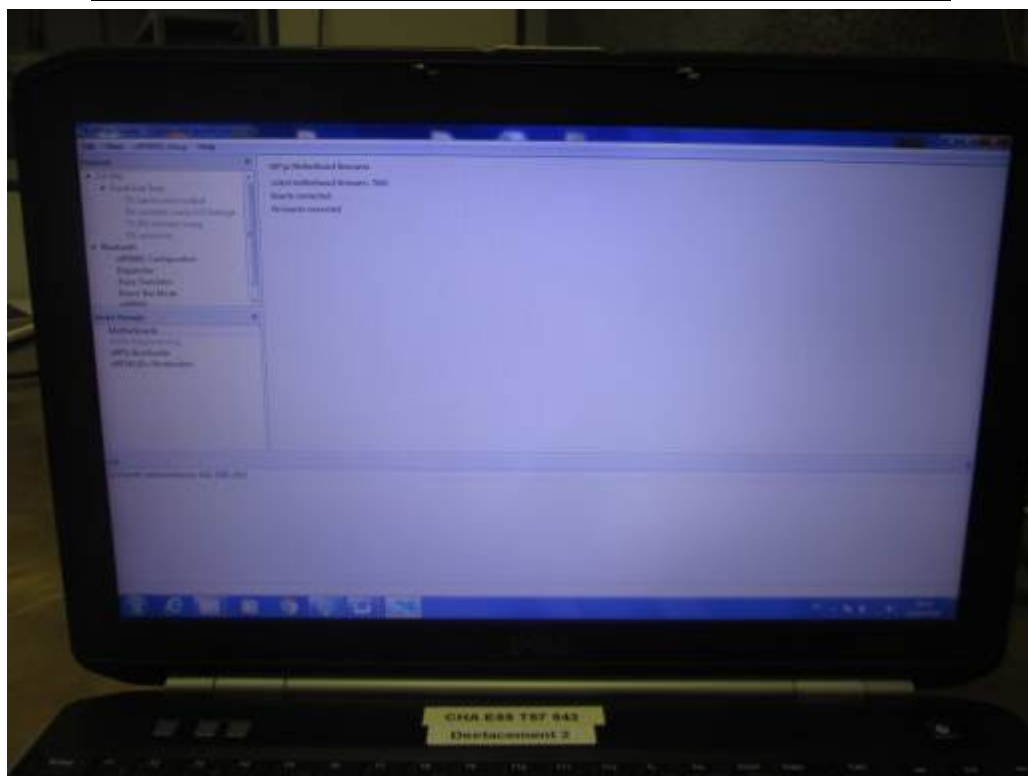
Desktop



HMI LoRa tester (Insight software)



HMI Bluetooth Low Energy (nRFgo Studio – Nordic semi conductor)



Interface board with RF module



3.7. EUT Radio Specifications

a) GENERAL INFORMATIONS	
According to manufacturer's declarations :	
EUT type.....	: Transmitter
Technology	: SRD
Environmental profile.....	: Data transmission
Temperature range.....	: -30/+85 °C
Antenna type	: Integral
Antenna Gain.....	: 6dBi (Max)
Comments:	
No	
b) TRANSMITTER PARAMITERS (Tx)	
Frequency bands.....	: 902MHz-928MHz
RF Power.....	: 1W max (standard value)
Number of channels / Separation.....	: 64 for FHSS/200kHz 8 for DSSS/1.6MHz
Modulation type	: LORA
Duty cycle	: N/C
Tested frequency.....	: 902.3MHz-914.9MHz (FHSS)
c) RECEIVER PARAMETERS (Rx)	
Frequency bands.....	: 902.3MHz-914.9MHz (FHSS)
Category/Class	: pointless
Bandwidth	: pointless

4. RESULT SUMMARY

TEST DESIGNATION	SEVERITY	VERDICT	BASIC STANDARDS / COMMENTS
SUBPART A - GENERAL			
Labeling requirements		PASS	15.19 / See certification documents
Information to user		PASS	15.21 / See certification documents
Home-built devices		N/A	15.23
Kits		N/A	15.25
Special Accessories		PASS	15.27 / See certification documents
Inspection by the Commission		N/A	15.29
Measurement standards		PASS	15.31
Test procedure for CPU boards and computer power supplies		N/A	15.32
Frequency range of radiated measurements		PASS	15.33
Measurement detector functions and bandwidths		PASS	15.35
Transition provisions for compliance with the rules		PASS	15.37 / See certification documents
SUBPART B – UNINTENTIONAL RADIATORS			
Equipment authorization			15.101
- Verification		N/A	
- Declaration of Conformity		N/A	
CPU boards and power supplies used in personal computers		N/A	15.102
Exempted device		N/A	15.103
Information to the user		PASS	15.105 / See certification documents
Conducted limits		N/A	15.107 / Eut powered by another by DC current coming from another equipment.
Radiated emission limits	Class B	PASS	15.109
Antenna power conduction limits for receivers		N/A	15.111
Power line carrier systems		N/A	15.113
TV interface devices, including cable system terminal devices		N/A	15.115
TV broadcast receivers		N/A	15.117
Cable ready consumer electronics equipment		N/A	15.118
Program blocking technology requirements for TV receivers		N/A	15.120
Scanning receivers and frequency converters used with scanning receivers		N/A	15.121
Labeling of digital cable ready products		N/A	15.123
SUBPART C –INTENTIONAL RADIATORS			

Equipment authorization requirement		PASS	15.201 / Transmitter part is subject to Certification procedure
Certified operating frequency range		N/A	15.202
Antenna requirement		PASS	15.203 / Dedicated integral antenna
External radio frequency power amplifiers and antenna modifications		N/A	15.204
Restricted bands of operation		PASS	15.204
Conducted limits	Class B	N/A	15.207 / Battery powered equipment
Radiated emission limits; general requirements	Class B	PASS	15.209
Tunnel radio systems		N/A	15.211
Modular transmitters		N/A	15.212
Cable locating equipment		N/A	15.213
Cordless telephones		N/A	15.214
Additional provisions to the general radiated emission limits		PASS	15.215
Operation within the band 902-928MHz, 2400-2483.5MHz and 5725-5850MHz			15.247
- Frequency hopping and digitally modulated		-	
- Frequency hopping system		PASS	BW = 125kHz
- Digital modulation system		N/P	
- Maximum peak conducted output power		-	
- For hopping system in the 2400-2483.5 MHz and 5725-5850 MHz bands		N/A	
- For hopping system in the 902-928MHz band		PASS	BW = 125kHz
- For system using digital modulation in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands		N/A	
- Operation with directional antenna gains > 6 dBi		N/A	c)
- Out-of-band emissions		PASS	d)
- Power spectral density conducted		PASS	
- Hybrid system		N/A	f)
- Frequency hopping additional requirements		PASS	g)
- Frequency hopping intelligence		PASS	h)
- RF exposure compliance		PASS	i)

Sample subject to the test complies with the requirements of the reference document(s) listed in §2 of this test report and, where applicable, with deviation(s) specified in this document.

To declare, or not, the compliance with the specifications, it was not explicitly taken account of uncertainty associated with the results.

Opinion(s) and interpretation(s): N/A

5. RF EXPOSURE

Conducted measurement = 21.182 dBm

Maximum antenna gain = 6dBi

Maximum EIRP with antenna gain of 6dBi = 522.637 mW (eirp) at 902.3MHz

In accordance with KDB 447498 D01 General RF Exposure Guidance v06:

$PSD = EIRP / (4 * \pi * R^2) = 522.6 / (4 * \pi * (20 \text{ cm})^2) = 0.10397 \text{ mW/cm}^2$

Limit = 0.61 mW/cm² (f /1500 if 300<f< 1500 MHz)

6. MEASUREMENT UNCERTAINTY

PARAMETER	MAXIMAL EMITECH UNCERTAINTY	MINIMAL STANDARD UNCERTAINTY
Radio frequency	$\pm 1 \times 10^{-7}$	$\pm 1 \times 10^{-7}$
RF power, conducted		
RF power	$\pm 0.8 \text{ dB}$	$\pm 1 \text{ dB}$
Power spectral density	$\pm 2.3 \text{ dB}$	$\pm 3 \text{ dB}$
Occupied bandwidth		
RF power	$\pm 1.2 \%$	$\pm 5 \%$
Conducted emission (spurious)		
$f \leq 1 \text{ GHz}$	$\pm 0.8 \text{ dB}$	$\pm 3 \text{ dB}$
1 GHz - 12.75 GHz	$\pm 1.6 \text{ dB}$	
Radiated emission (PAR / PIRE / RNE)		
$f \leq 62.5 \text{ MHz}$	$\pm 5.1 \text{ dB}$	$\pm 6 \text{ dB}$
62.5 MHz - 1 GHz	$\pm 5.1 \text{ dB}$	$\pm 6 \text{ dB}$
1 GHz - 18 GHz	$\pm 5.2 \text{ dB}$	$\pm 6 \text{ dB}$
18 GHz – 26 GHz	$\pm 5.1 \text{ dB}$	$\pm 6 \text{ dB}$
26 GHz – 40 GHz	$\pm 5.4 \text{ dB}$	$\pm 6 \text{ dB}$
PIRE and power spectral density with diode	$\pm 5.4 \text{ dB}$	$\pm 6 \text{ dB}$
Radiated emission (magnetic field)		
9kHz – 30MHz	$\pm 2.7 \text{ dB}$	$\pm 6 \text{ dB}$
Supply voltages	$\pm 3 \%$	$\pm 3 \%$
Temperature	$\pm 1 \text{ }^{\circ}\text{C}$	$\pm 1^{\circ}\text{C}$
Humidity	$\pm 5 \%$	$\pm 5 \%$
Time / Duty cycle	$\pm 4.4 \%$	$\pm 5 \%$
Radiated emission (electric field for FCC standard)		
9kHz – 30MHz	$\pm 2.7 \text{ dB}$	/
30MHz – 1GHz	$\pm 5.2 \text{ dB}$	/
1GHz – 18GHz	$\pm 5.3 \text{ dB}$	/
18GHz – 26GHz	$\pm 5.5 \text{ dB}$	/
26GHz – 40GHz	$\pm 5.5 \text{ dB}$	/

For the calcul of expanded uncertainty, the confidence interval is 95 % (k=2).

7. TEST CONDITIONS AND RESULTS

7.1. Occupied Bandwidth

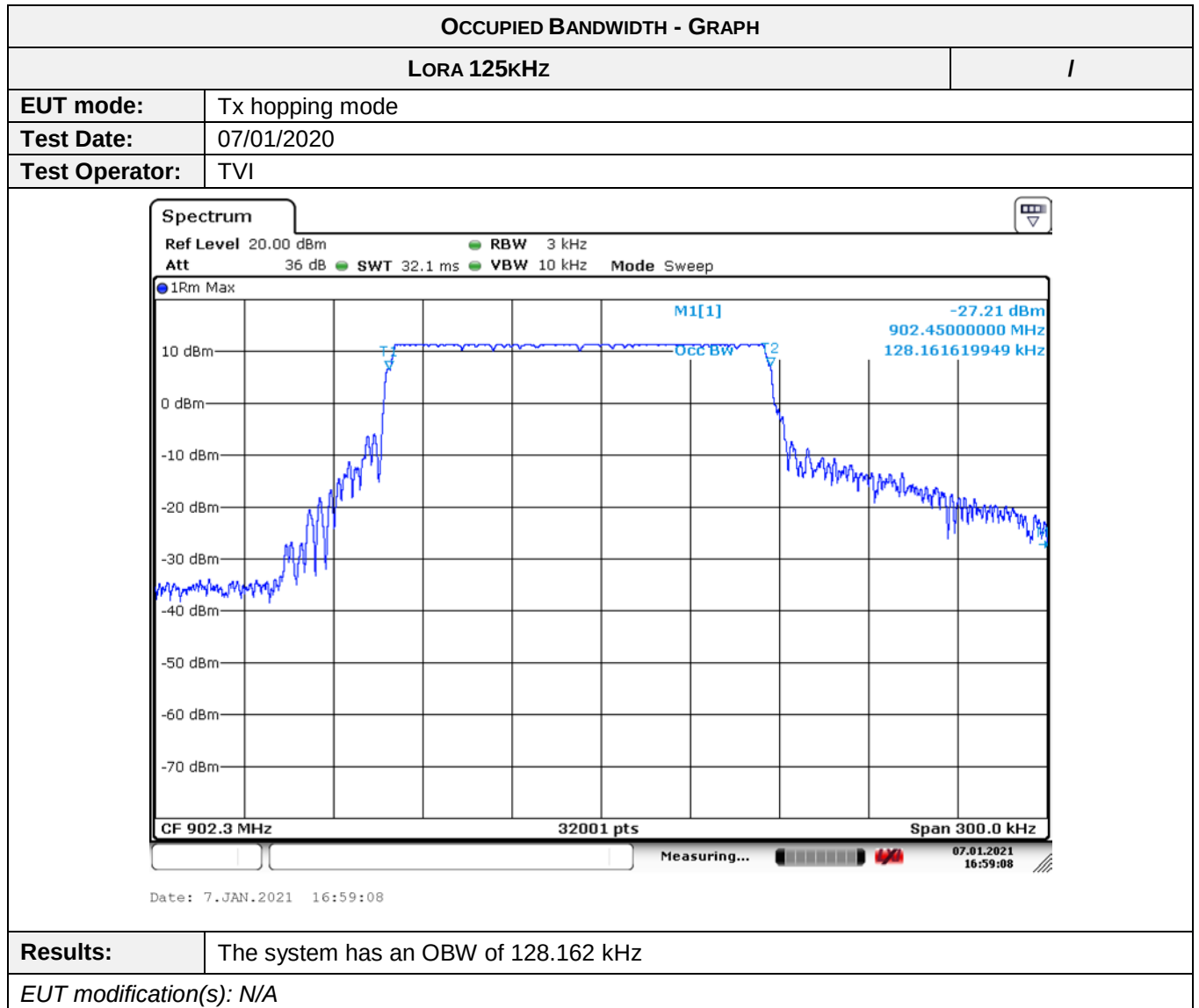
Reference standard:	FCC part 15 Radio part 15.247 and RSS-247
Test method:	FCC part 15.247 and RSS-247
Test description: The occupied bandwidth (OBW) is the Frequency Range in which 99 % of the total mean power of a given emission falls. The residual part of the total power being denoted as β, which, 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 %. The maximum occupied bandwidth includes all associated side bands above the appropriate emissions level and the frequency error or drift under extreme test conditions. EUT is connected to the measuring receiver via 50Ω attenuator(s).	

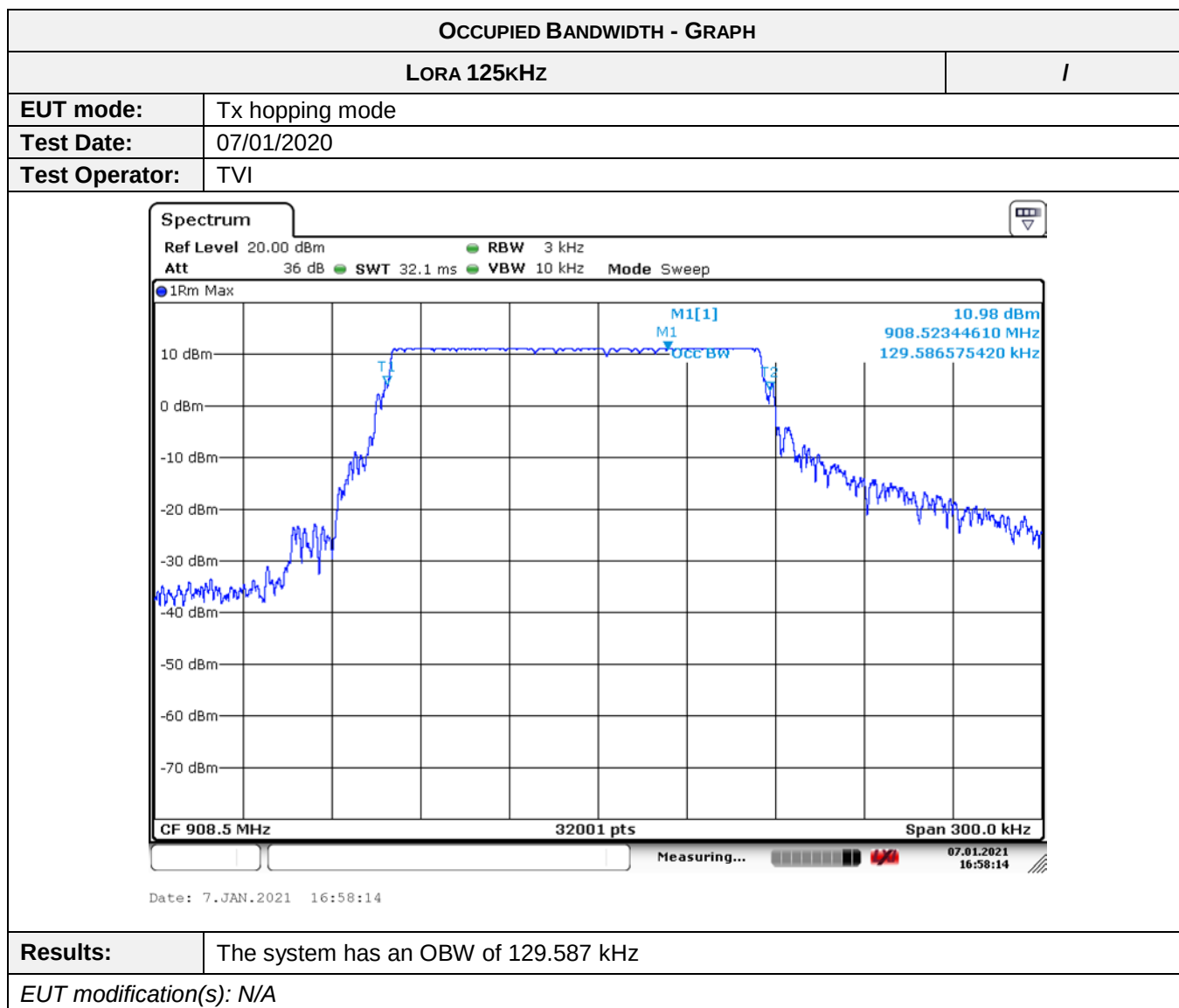
TESTED PARAMETER	OBW	SEVERITY	RESULT TAB.	VERDICT
Lora 125kHz	> 127.224 kHz	>125 kHz	/	PASS

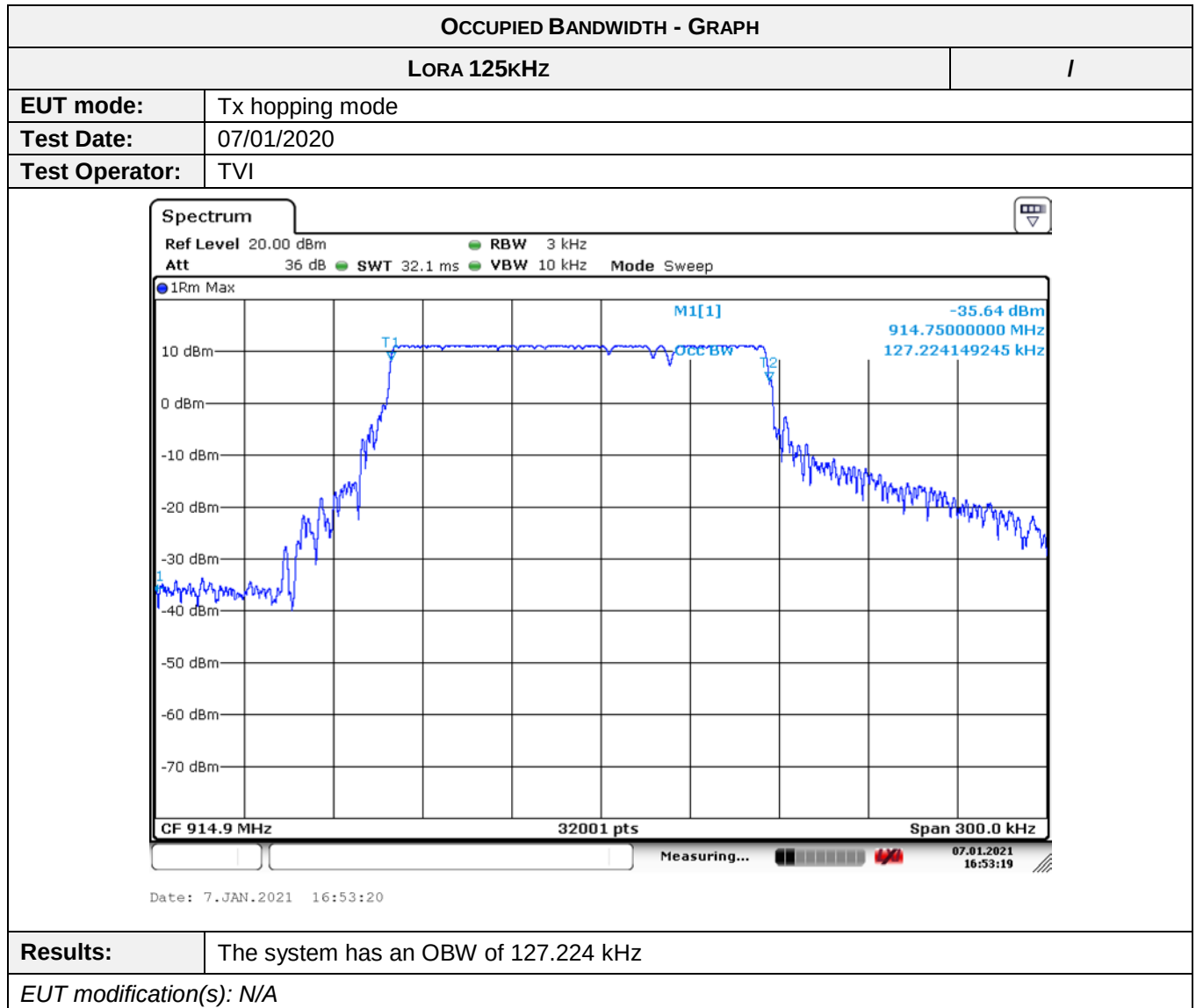
LABORATORY PARAMETERS:	REQUIRED PRIOR TO THE TEST	DURING THE TEST
Ambient Temperature	15 to 35 °C	16.4 °C
Relative Humidity	20 to 75 %	31.7 %
Atmospheric pressure	N/A	994 hPa
Test method deviation: N/A		
Supplementary information: N/A		

TEST EQUIPMENT USED					
CATEGORY	BRAND	TYPE	IDENTIFIER	CAL. DATE	CAL. DUE
Spectrum Analyzer	Rohde & Schwarz	FSV40	15776	23/12/2019	23/02/2021
Cable	H&S	N-1m	15931	04/12/2018	04/02/2021
Attenuator	Narda	6dB	6549	18/06/2019	18/08/2021

Blank cells = Permanent validity







7.2.20dB bandwidth, Carrier Frequency separation and Number of Hopping Channels

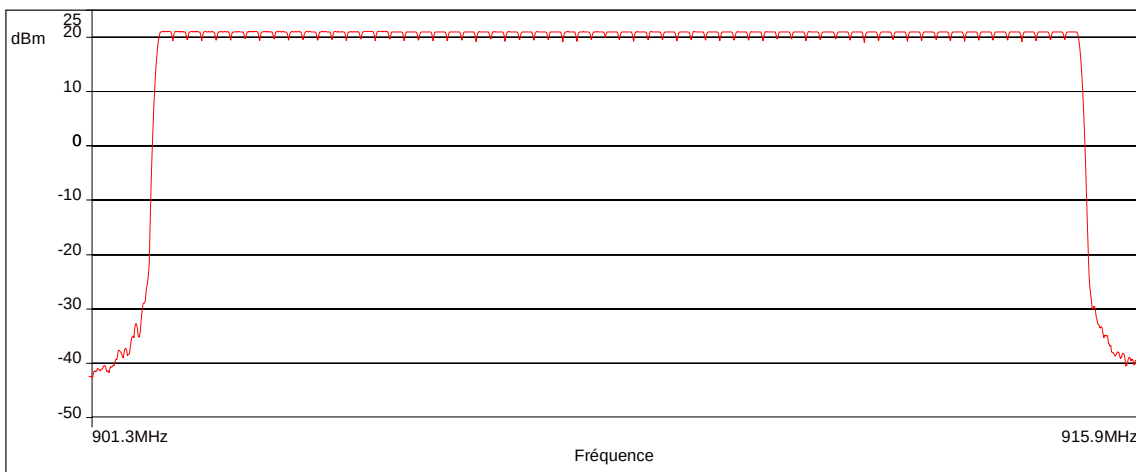
Reference standard:	FCC part 15 Radio part 15.247 and RSS-247
Test method:	FCC part 15.247 and RSS-247
Test description: a) (1) (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz. EUT is connected to the measuring receiver via 50Ω attenuator(s). Tests are done in max-hold mode in order to capture all channels.	

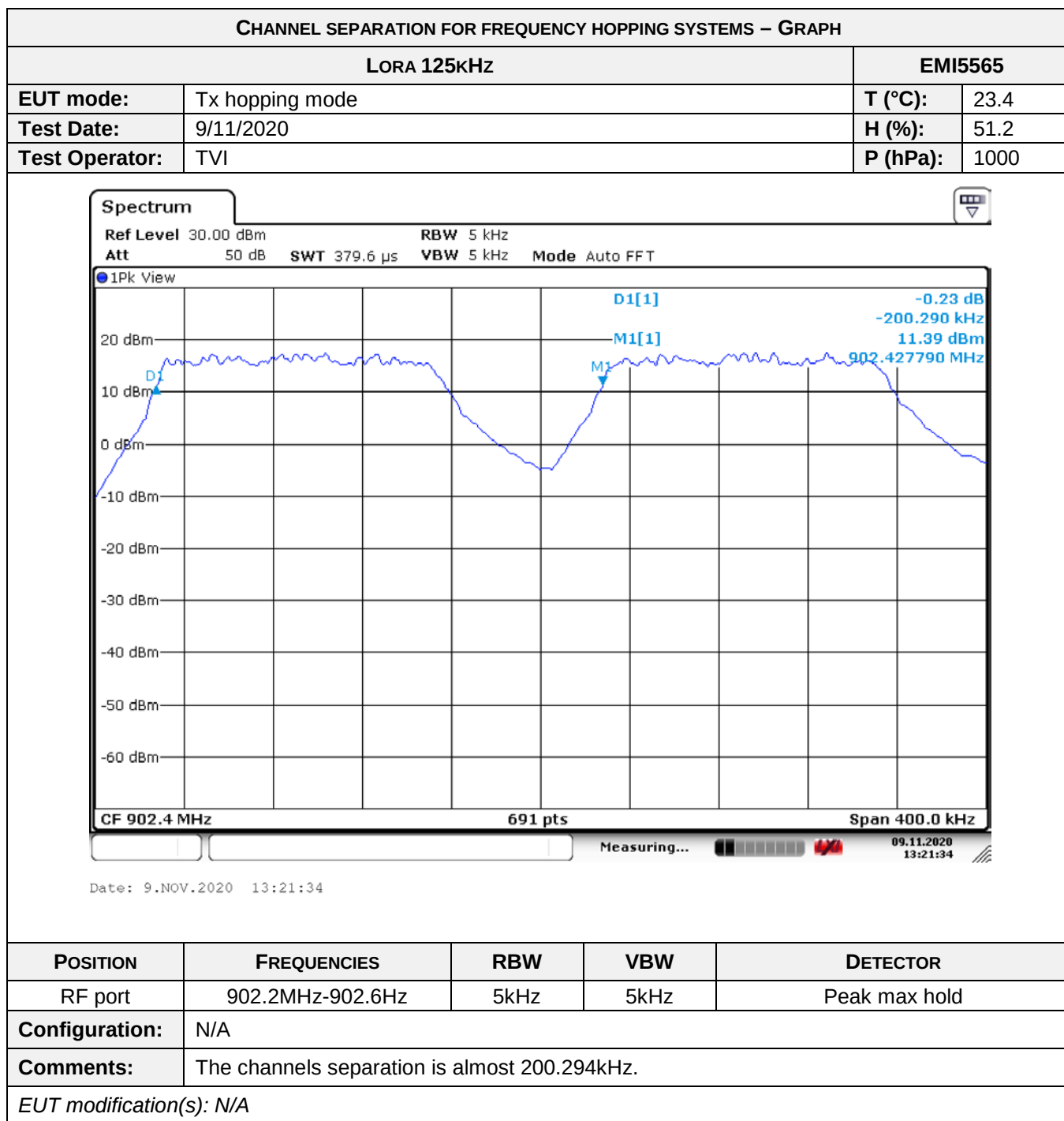
TESTED PARAMETER	RESULT	SEVERITY	RESULT TAB.	VERDICT
Number of channels	64	>50	/	PASS
Channels separation	200.44	>139.10kHz	/	PASS
6dB Bandwidth	126.71kHz	-	/	PASS
20dB Bandwidth	139.10kHz	<200.44kHz	/	PASS
Occupation time	53.77ms on 20s	400ms	/	PASS

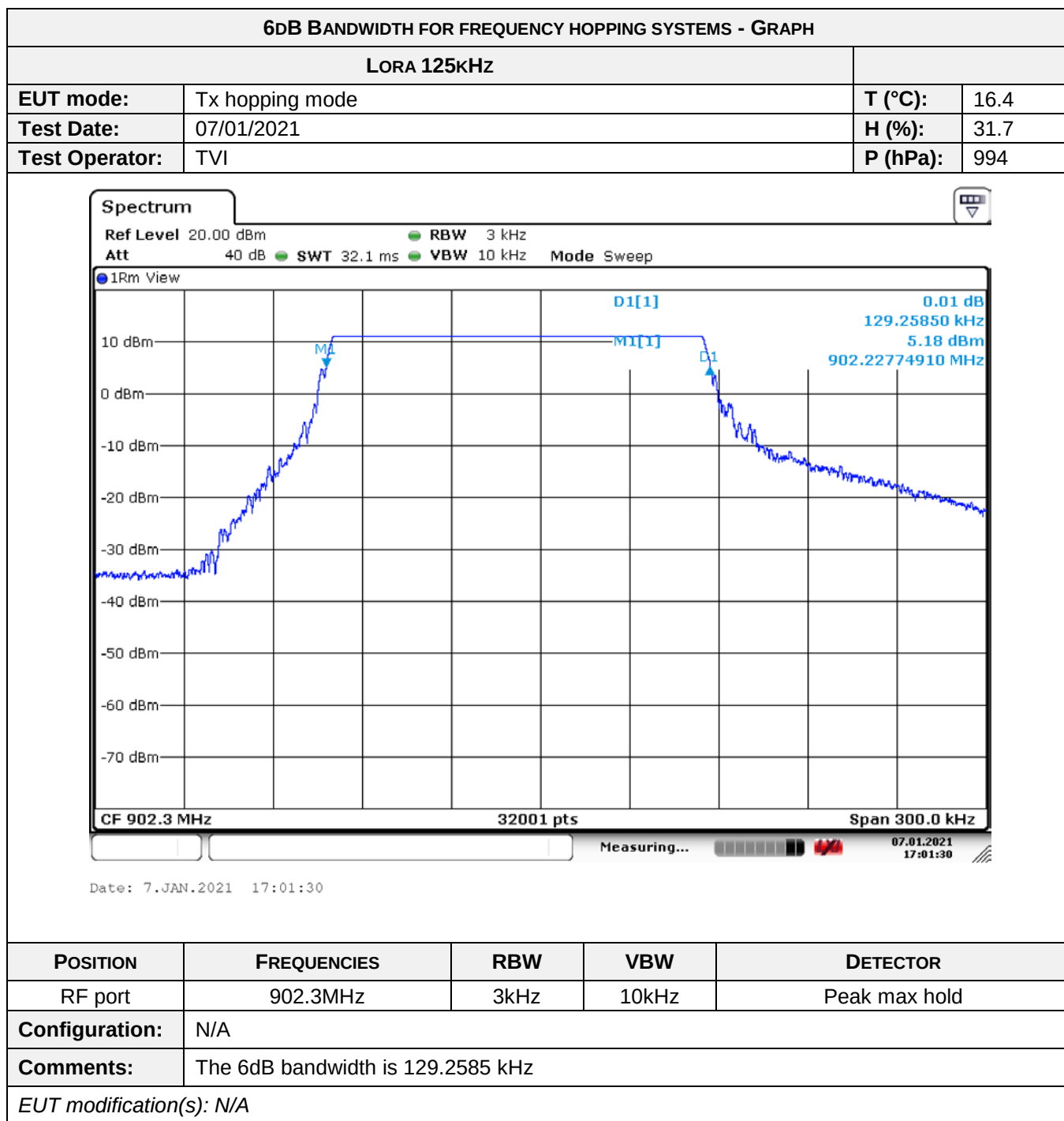
LABORATORY PARAMETERS:	REQUIRED PRIOR TO THE TEST	DURING THE TEST
Ambient Temperature	15 to 35 °C	See Graph(es)
Relative Humidity	20 to 75 %	See Graph(es)
Atmospheric pressure	N/A	See Graph(es)
Test method deviation: N/A		
Supplementary information: N/A		

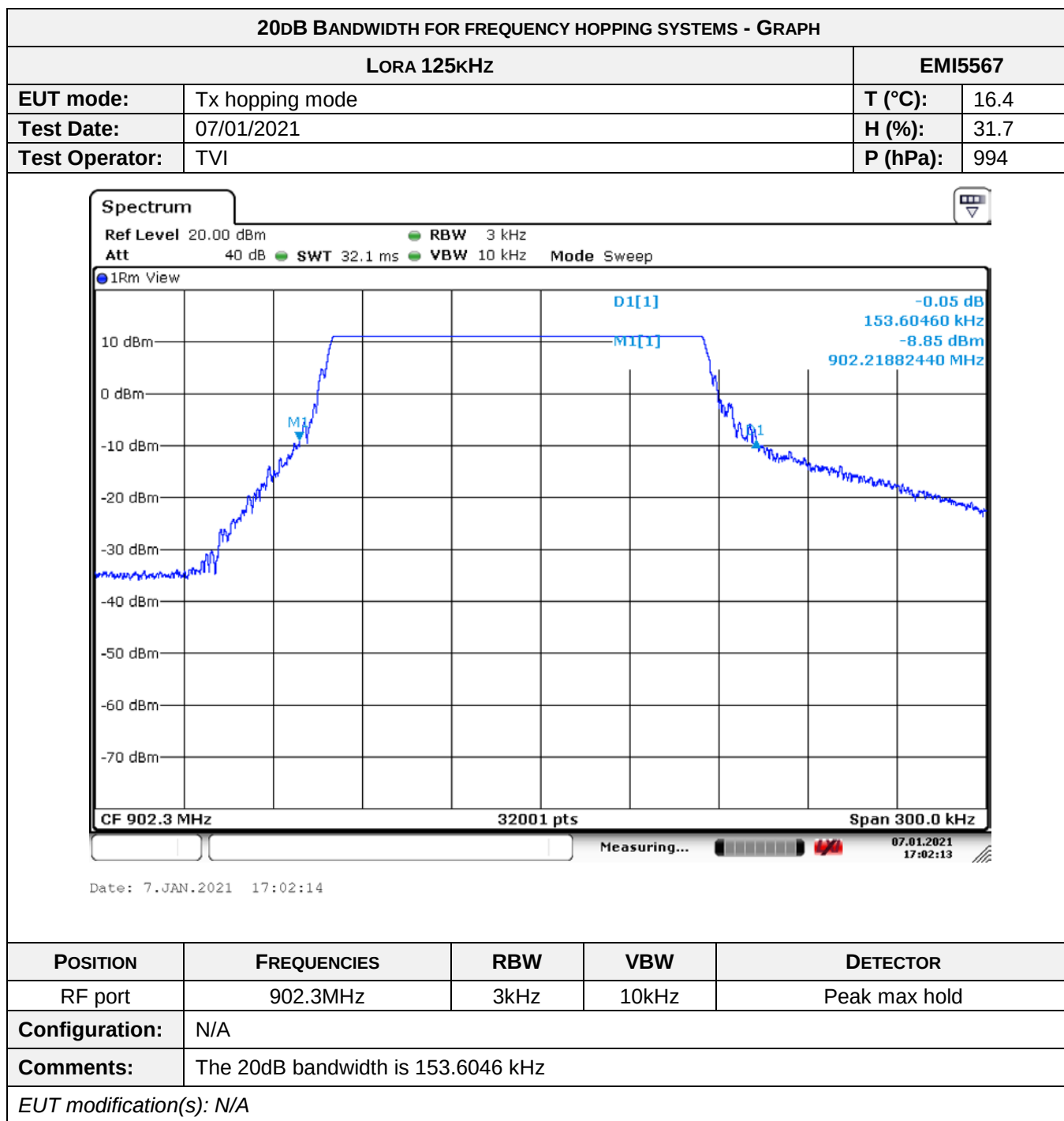
TEST EQUIPMENT USED					
CATEGORY	BRAND	TYPE	IDENTIFIER	CAL. DATE	CAL. DUE
Spectrum Analyzer	Agilent Technologies	N9010A	11316	14/05/2019	14/07/2020
Cable	H&S	N-1m	15931	04/12/2018	04/02/2021
Attenuator	Narda	6dB	6549	18/06/2019	18/08/2021

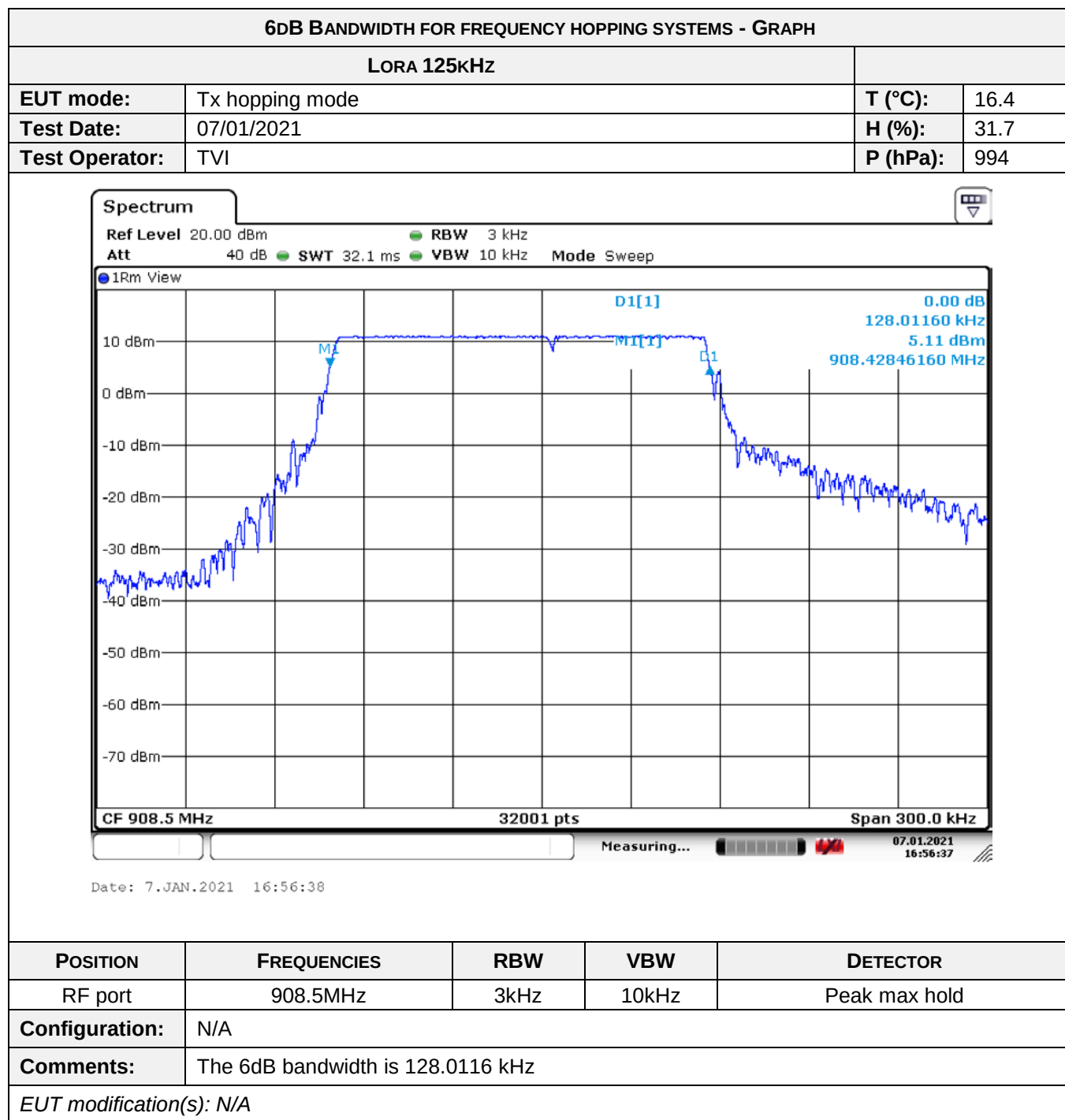
Blank cells = Permanent validity

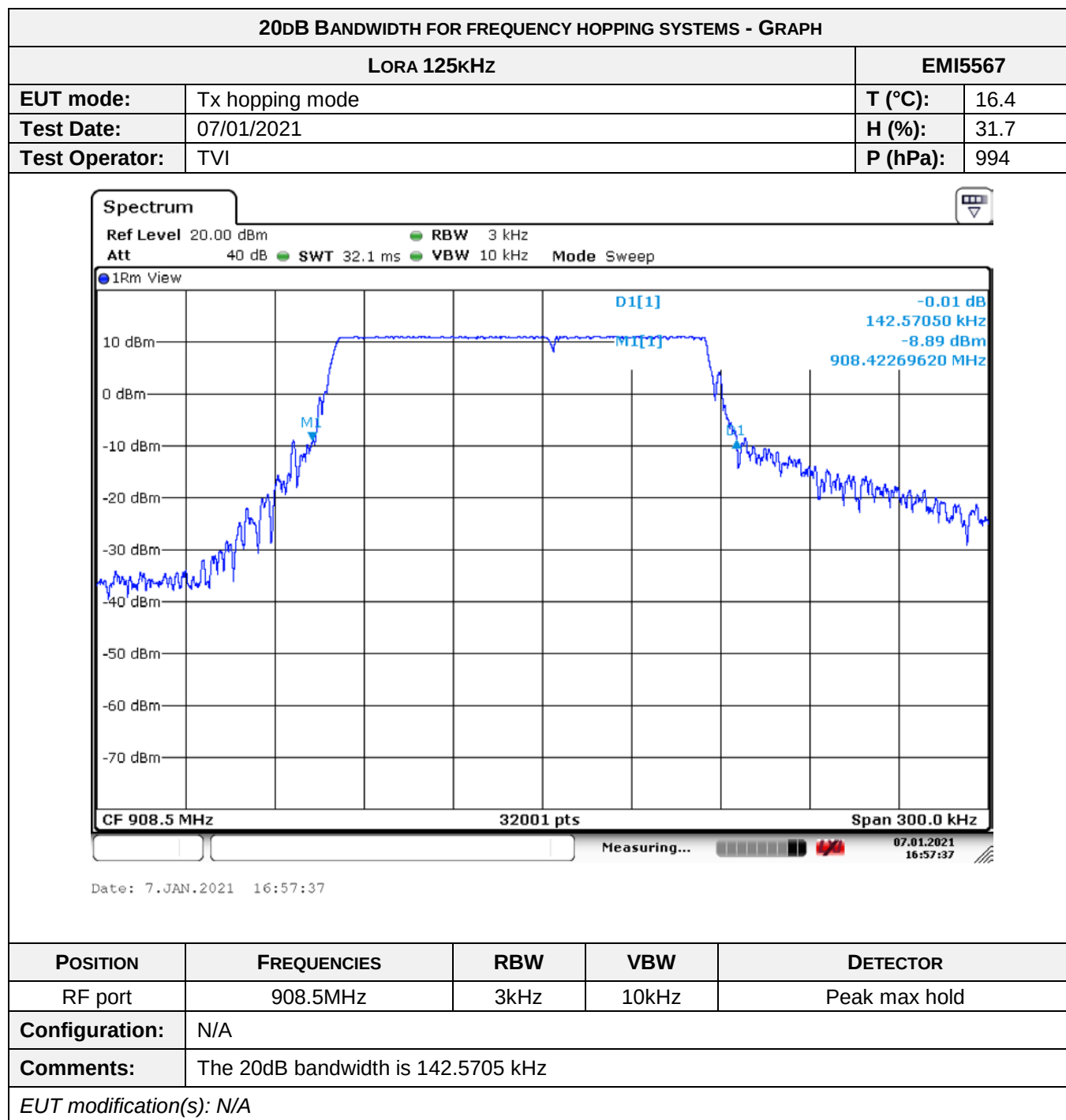
NUMBER OF CHANNELS FOR FREQUENCY HOPPING SYSTEMS - GRAPH				
LORA 125kHz			EMI4575	
EUT mode:	Tx hopping mode		T (°C):	16.4
Test Date:	31/03/2020		H (%):	31.7
Test Operator:	TVI		P (hPa):	994
Mes. Peak 				
POSITION	FREQUENCIES	RBW	VBW	DETECTOR
RF port	901.3MHz-915.9MHz	100kHz	300kHz	Peak max hold
Configuration:	N/A			
Comments:	The system uses 64 channels			
EUT modification(s): N/A				

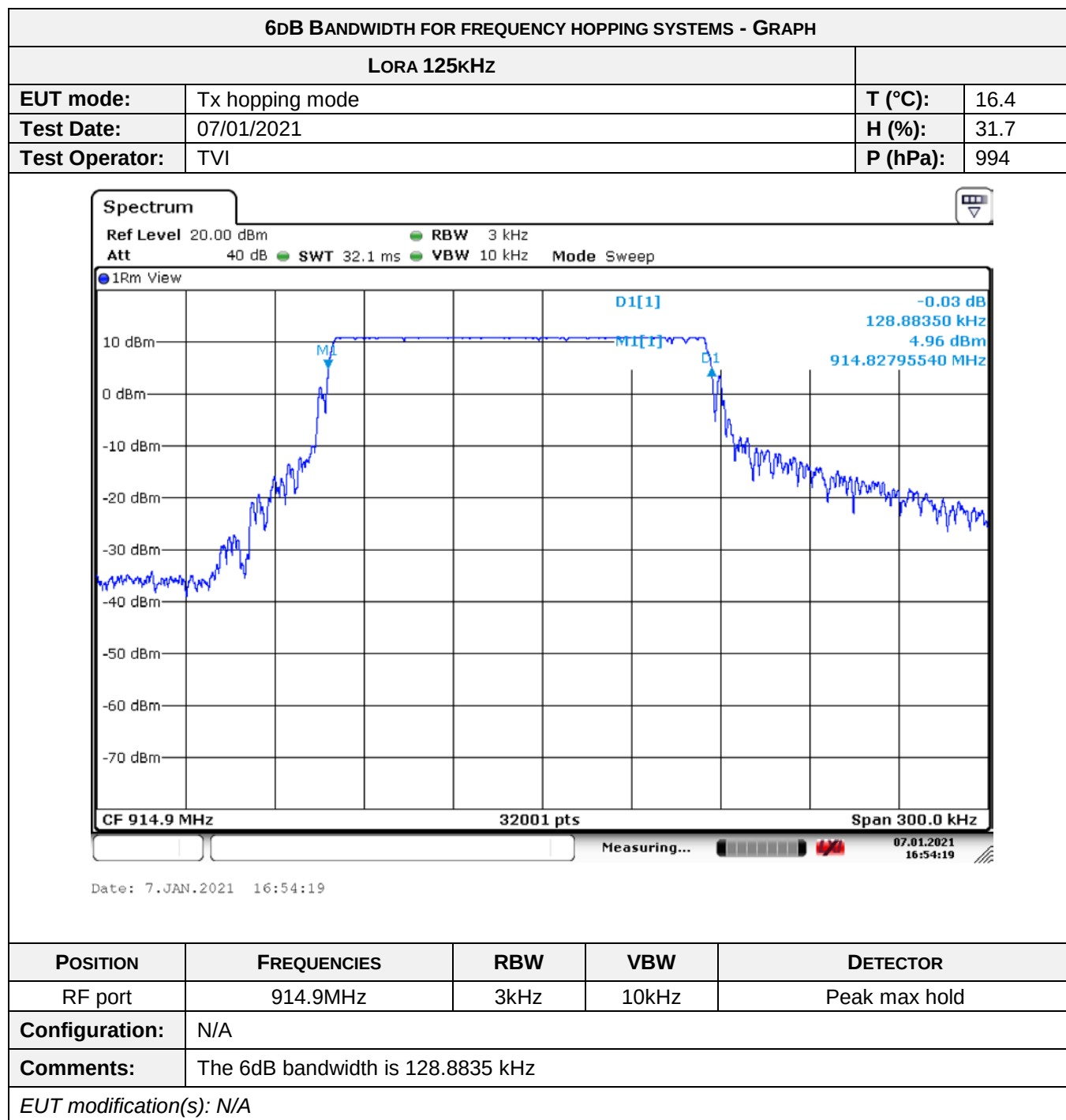


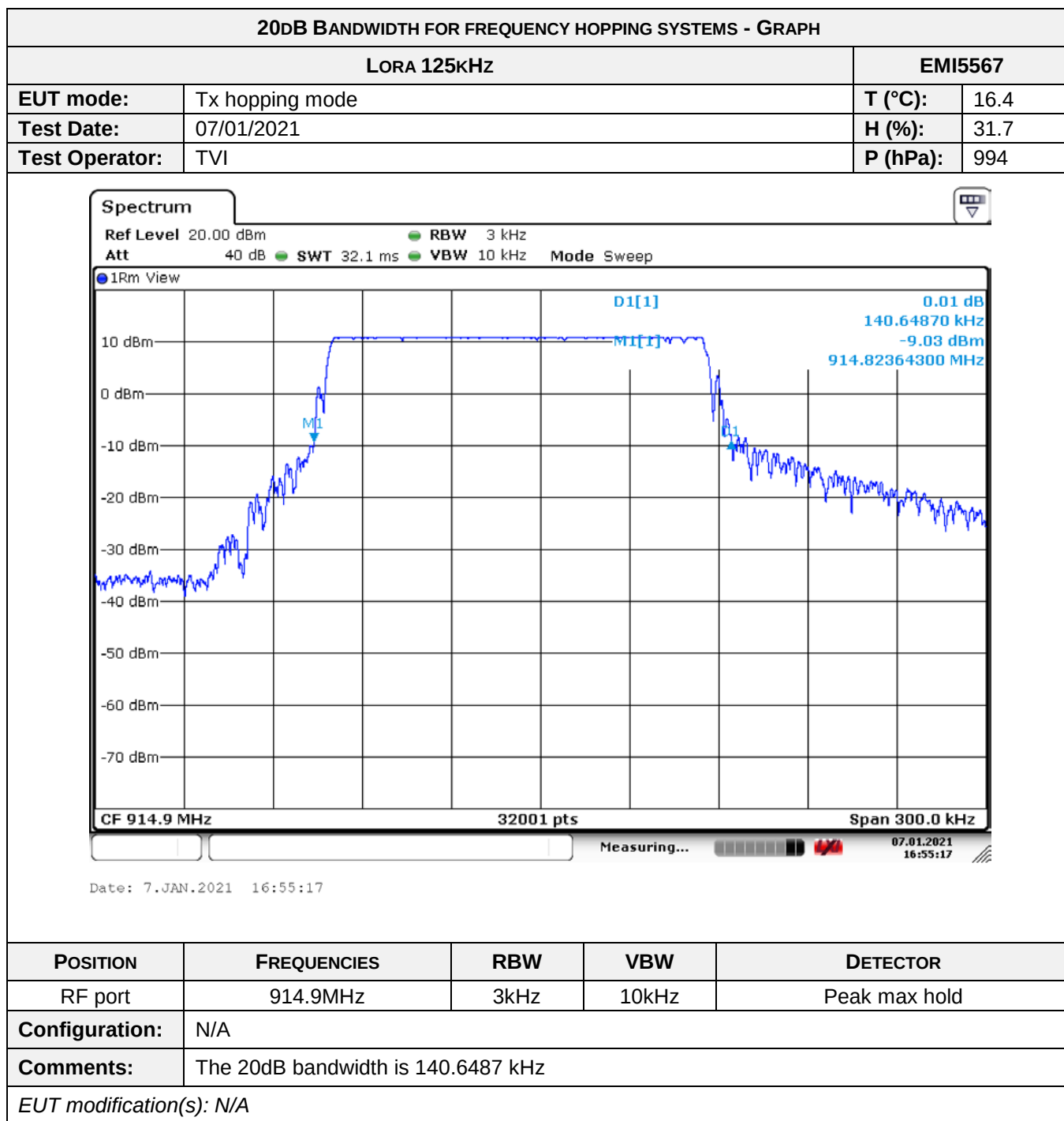








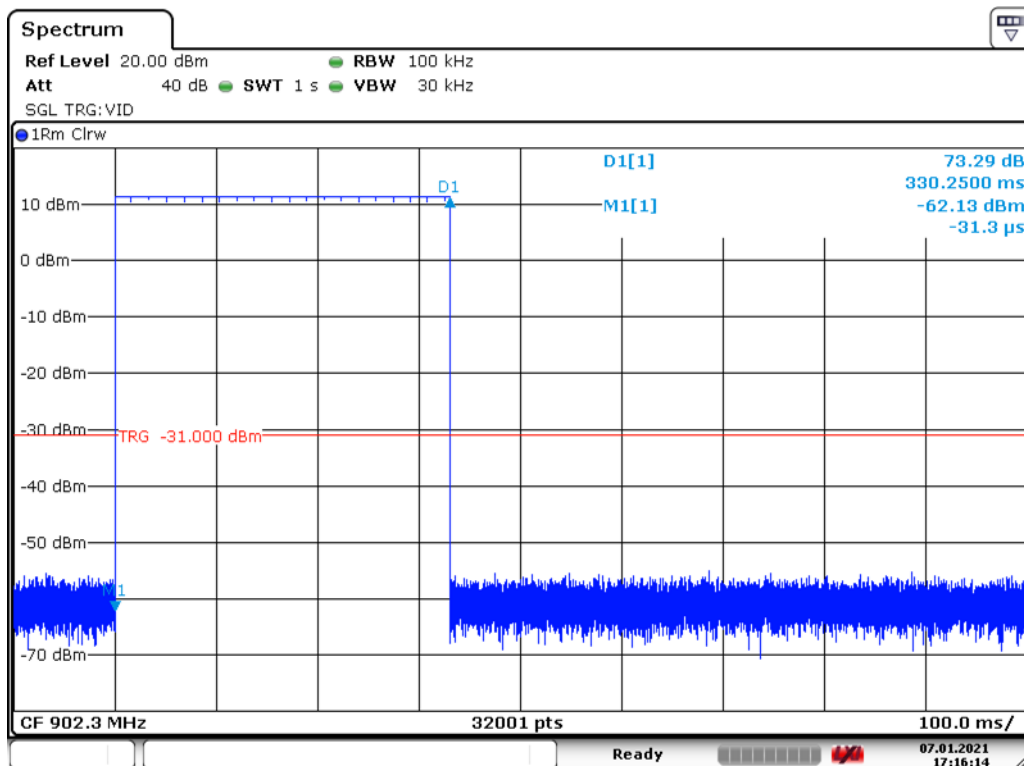




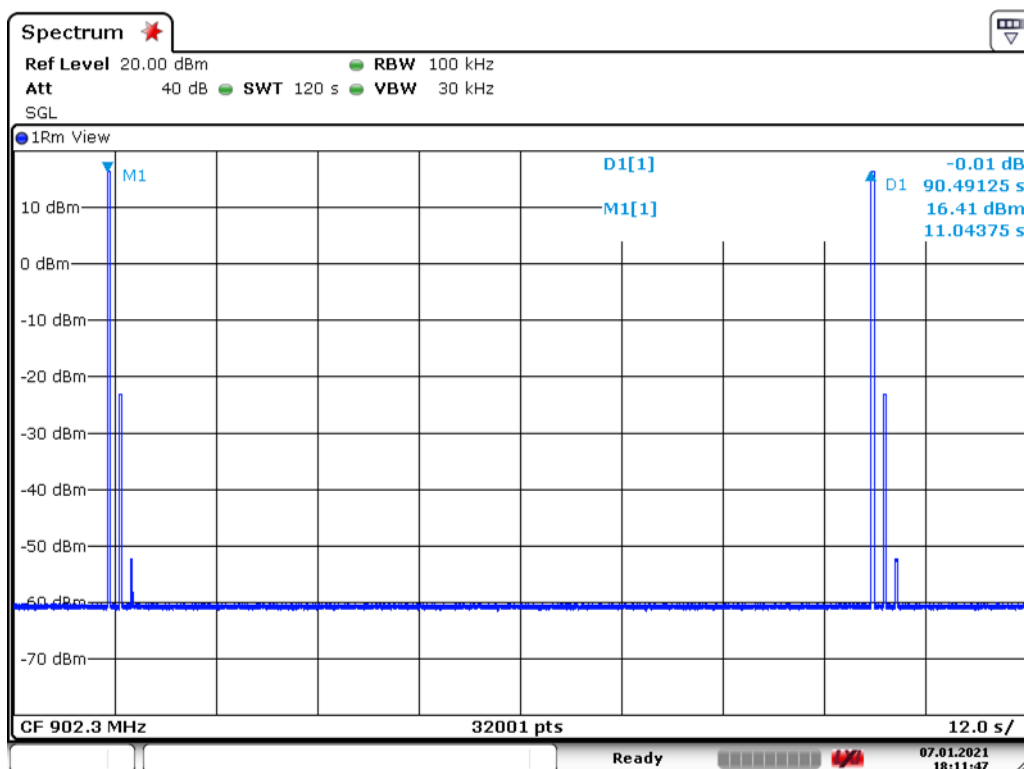
OCCUPATION TIME FOR FREQUENCY HOPPING SYSTEMS - GRAPH

LORA 125KHz

EUT mode:	Tx hopping mode	T (°C):	16.4
Test Date:	07/01/2021	H (%):	31.7
Test Operator:	TVI	P (hPa):	994



Date: 7.JAN.2021 17:16:14



Date: 7.JAN.2021 18:11:47

OCCUPATION TIME FOR FREQUENCY HOPPING SYSTEMS - GRAPH	
LORA 125kHz	
Results:	The system uses 64 channels in any conditions and the averaging time of occupancy on any channel is less than 0.4 seconds within a period of 20 seconds: The measurement during a long transmissions gives 330.25 ms every 90.49 s on each channel so the average time within a period of 20 second is 72.99 ms wich is less than the 400ms limit.

7.3. Maximum peak conducted power of the intentional radiator

Reference standard:	FCC part 15 Radio part 15.247 and RSS-247
Test method:	FCC part 15.247 and RSS-247
Test description: b) (2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section. EUT is connected to the measuring receiver via 50Ω attenuator(s). Only the highest levels are recorded.	

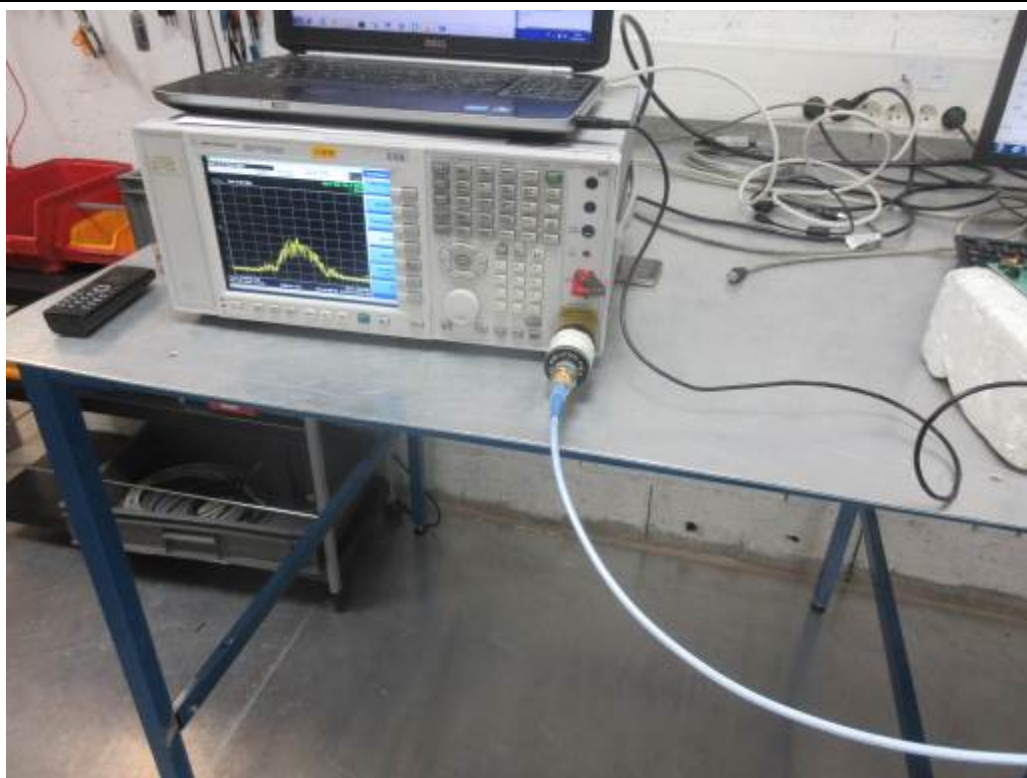
TESTED CONFIGURATION	RESULTS	SEVERITY	RESULT TAB.	VERDICT
Low channel – LoRa 125kHz	21.182 dBm	1W (30dBm)	EMI6021	PASS
Central channel – LoRa 125kHz	21.078 dBm	1W (30dBm)	EMI6021	PASS
High channel – LoRa 125kHz	21.020 dBm	1W (30dBm)	EMI6021	PASS

LABORATORY PARAMETERS:	REQUIRED PRIOR TO THE TEST	DURING THE TEST
Ambient Temperature	15 to 35 °C	25.3 °C
Relative Humidity	20 to 75 %	44.6 %
Atmospheric pressure	N/A	1021 hPa
Test method deviation: N/A		
Supplementary information: N/A		

TEST EQUIPMENT USED					
CATEGORY	BRAND	TYPE	IDENTIFIER	CAL. DATE	CAL. DUE
Spectrum Analyzer	Agilent Technologies	N9010A	11316	14/05/2019	14/07/2020
Cable	H&S	N-1m	15931	04/12/2018	04/02/2021
Attenuator	Narda	6dB	6549	18/06/2019	18/08/2021

Blank cells = Permanent validity

TEST SETUP PHOTO(S)



PUISSANCE MOYENNE CONDUITE - TABULATED RESULTS

LoRA 125kHz				EMI6021
Frequency (MHz)	P _{conducted} (dBm)	Gain _{dBi}	P _{eirp} (dBm)	Limit _{eirp} (dBm)
902.3	21.182	6dBi (Max)	27.182	36
	21.078	6dBi (Max)	27.078	36
914.9	21.020	6dBi (Max)	27.020	36

$P_{erp} = P_{conducted} + \text{antenna Gain}_{dBd}$; $\text{Gain}_{dBd} = \text{Gain}_{dBi} - 2.15dB$

$P_{erp} = P_{conducted} + \text{Gain}_{dBi} - 2.15dB$

$P_{eirp} = P_{erp} + 2.15dB$

$P_{eirp} = P_{conducted} + \text{Gain}_{dBi}$

In case of a dedicated antenna the antenna gain (in dB, i.e. relative to a dipole) is declared by the manufacturer.

Using the formula $E_{(V/m)} = \sqrt{(30P_{dBm}G_{dBi})}/d_{(m)}$ where P is the conducted power and G the maximum antenna gain. Equivalent maximum E-field should be approximatively of 122.41dBμV/m.

7.4. Band-edge compliance of conducted emissions (Transmitter)

Reference standard:	FCC part 15 Radio part 15.247 and RSS-247
Test method:	FCC part 15.247 subclause d) and RSS-247
Test description: d) In any 100 kHz bandwidth outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. EUT is connected to the measuring receiver via 50Ω attenuator(s). Only the highest levels are recorded.	

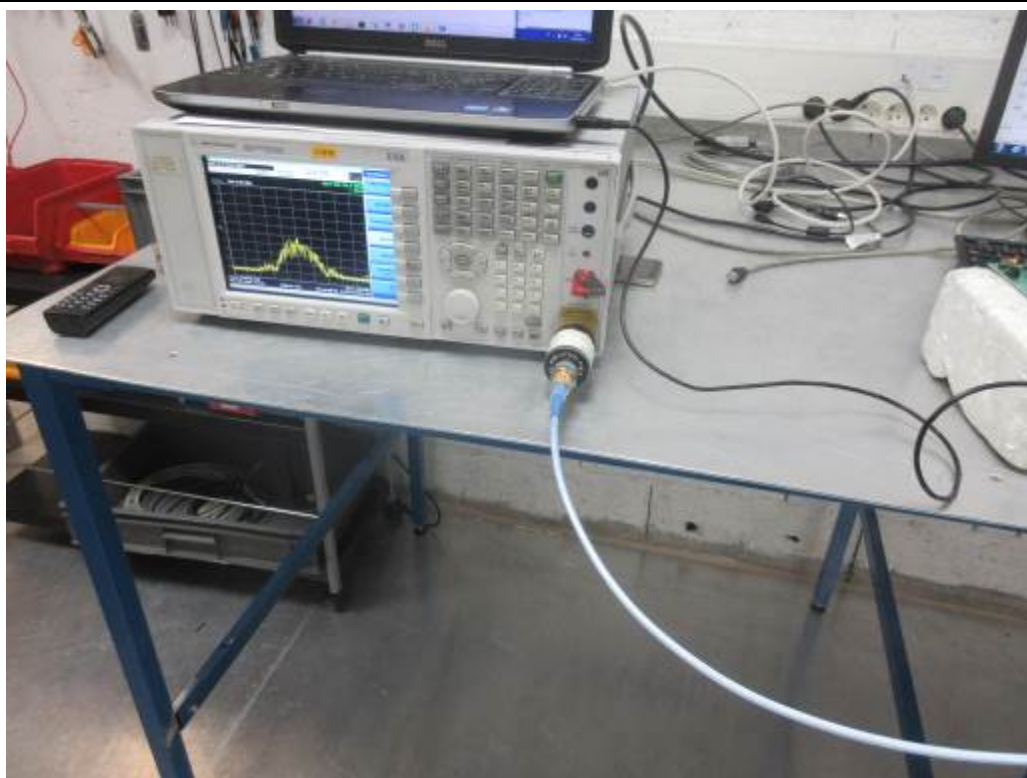
TESTED CONFIGURATION	PARAMETER	SEVERITY	RESULT TAB.	VERDICT
Lora / 125kHz	900MHz-930MHz	20dBc	EMI4575	PASS

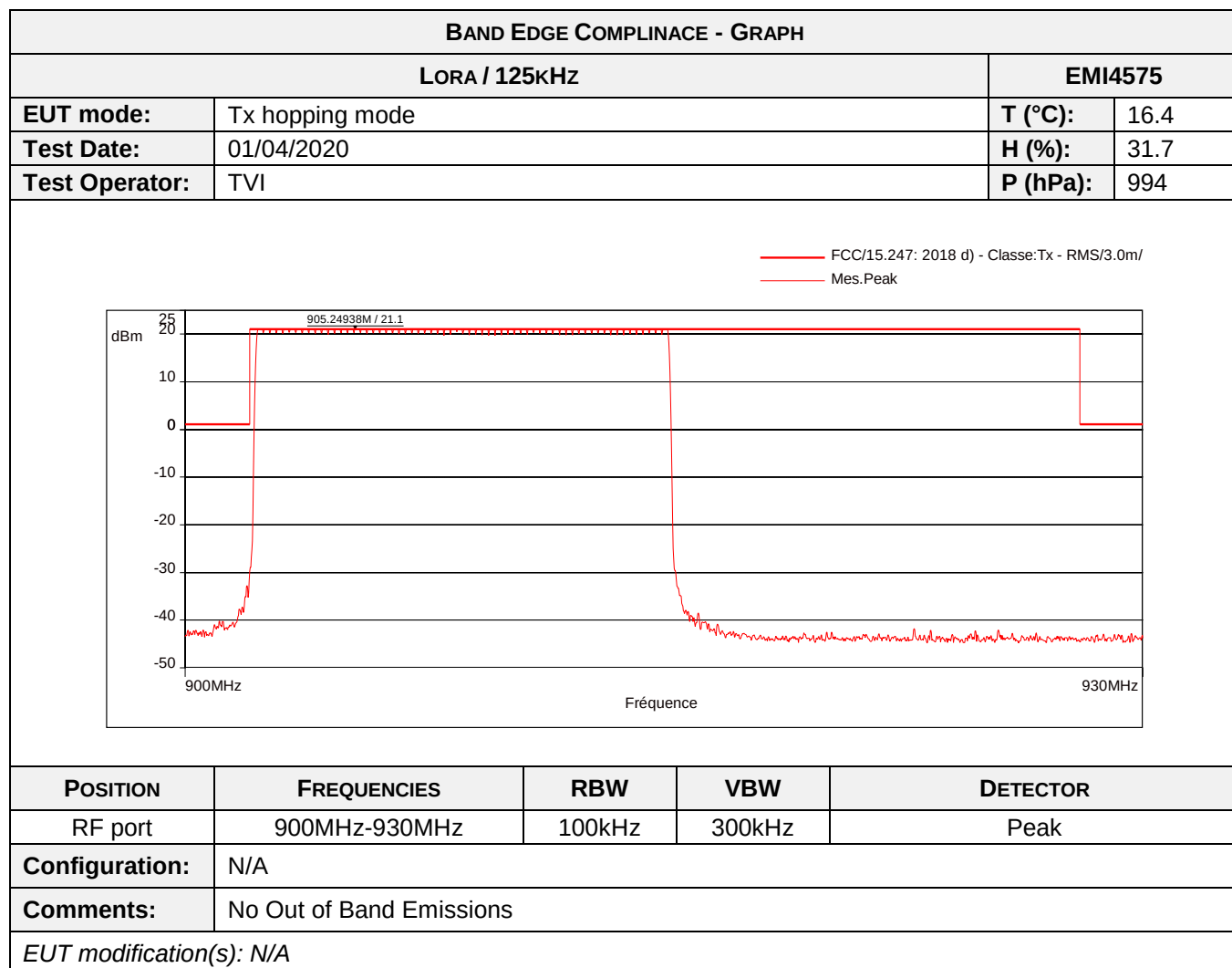
LABORATORY PARAMETERS:	REQUIRED PRIOR TO THE TEST	DURING THE TEST
Ambient Temperature	15 to 35 °C	25.3 °C
Relative Humidity	20 to 75 %	44.6 %
Atmospheric pressure	N/A	1021 hPa
Test method deviation: N/A		
Supplementary information: N/A		

TEST EQUIPMENT USED					
CATEGORY	BRAND	TYPE	IDENTIFIER	CAL. DATE	CAL. DUE
Spectrum Analyzer	Agilent Technologies	N9010A	11316	14/05/2019	14/07/2020
Cable	H&S	N-1m	15931	04/12/2018	04/02/2021
Attenuator	Narda	6dB	6549	18/06/2019	18/08/2021

Blank cells = Permanent validity

TEST SETUP PHOTO(S)





7.5. Radiated spurious emissions

Reference standard:	FCC part 15 Radio part 15.247 and RSS-247
Test method:	FCC part 15.109, 15.209, 15.205, 15.215 RSS-247, CNR Gen
General test setup: For $f < 30\text{MHz}$, EUT is set on an insulating support at 80cm above the ground reference plane. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3-meter in a semi-anechoic chamber. The EUT was rotated 360° in order to maximize radiated levels. Test antenna was oriented in 3 axes (0°, 45° and 90°). Final measurements (quasi-peak) were then performed in a 10-meter Open Area Test Site that complies to CISPR 16 in the same measurement conditions. For $f > 30\text{MHz}$, EUT is set on an insulating support at 80cm above the ground reference plane (150cm for $f > 1\text{GHz}$). Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3-meter. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in horizontal and vertical polarities. Final measurements (quasi-peak or average) were then performed in a semi-anechoic chamber or Open Area Test Site that complies to CISPR 16. The EUT was rotated 360° about its azimuth and adjusting the receive antenna height from 1 to 4 m. All frequencies were investigated, where applicable. For portable equipments a research of maximum level is done on the 3 axes. Only the highest levels are recorded.	

TESTED CONFIGURATION	PARAMETER	SEVERITY	RESULT TAB.	VERDICT
Lora Tx mode 125khz	9kHz-30MHz	15.209	See below	PASS
Lora Tx mode 125khz	30MHz-1GHz	15.209	See below	PASS
Lora Tx mode 125khz	1GHz-10GHz	15.209	See below	PASS

LABORATORY PARAMETERS:	REQUIRED PRIOR TO THE TEST	DURING THE TEST
Ambient Temperature	15 to 35 °C	See Graph(es)
Relative Humidity	20 to 75 %	See Graph(es)
Atmospheric pressure	N/A	See Graph(es)
Test method deviation: N/A		
Supplementary information: From 30MHz to 1GHz Quasi peak limit provided is the limit given in §15.209. Above 1GHz average limit in restricted bands §15.205 is 54dBμV/m. Otherwise, the limit is 20dB under carrier emission level at 3m without averaging.		

TEST EQUIPMENT USED					
CATEGORY	BRAND	TYPE	IDENTIFIER	CAL. DATE	CAL. DUE
Cable	HYTEM	N-7m	10134	29/01/2019	29/03/2021
Preamplifier	Agilent Technologies	8449B	10262	11/05/2020	11/07/2021
Spectrum Analyzer	Agilent Technologies	N9010A	11316	14/05/2020	14/07/2021
Filter	Micro-Tronics	High pass	14038	04/10/2018	04/12/2021
Cable	H&S	N-5m	15909	04/12/2018	04/02/2021
Horn Antenna	Schwarzbeck	9120B	6970	17/01/2018	17/03/2021
Cable	HYTEM	N-6m	7695	04/10/2018	04/12/2020
Log periodic antenna	Emco	3146A	5609	26/08/2020	26/10/2023
Biconic antenna	Rohde & Schwarz	HK116	6118	26/08/2020	26/10/2023
Preamplifier	RFPA	RF30400-27-LNA	6136	04/05/2020	04/07/2021
Cable	/	N-10m	7537	20/09/2018	20/11/2020
Cable	HYTEM	N-10.5m	7655	21/09/2018	21/11/2020
Attenuator	Weinschel Associated	WA1W/6-3-34	14006	21/09/2018	21/11/2021
Cable	H&S	N-3m	15202	05/05/2020	05/07/2022
Antenna	Emco	6502	6155	25/01/2019	25/03/2021
Cable	H&S	BNC	16008	14/01/2019	14/03/2021
Cable	H&S	BNC	16009	14/01/2019	14/03/2021
Cable	H&S	BNC	16016	14/01/2019	14/03/2021
Converter		-51.5dB	9997		
Receiver	Rohde & Schwarz	FSV40	15776	23/12/2019	23/02/2021
Software	Nexio		0000		

Blank cells = Permanent validity

RADIATED SPURIOUS EMISSIONS - TABULATED RESULTS				
TX MODE / LOW, CENTRAL & HIGHEST CHANNEL				
Frequency (MHz)	Position / Polarization	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
30.9	Pos 1 / Vertical	34.7	40.0	5.3
48.0	Pos 1 / Vertical	32.3	40.0	7.7
72.0	Pos 1 / Vertical	28.8	40.0	11.2
120.0	Pos 1 / Vertical	38.0	43.5	5.5
240.0	Pos 1 / Vertical	35.3	46.0	10.7
300.0	Pos 1 / Vertical	33.9	46.0	12.1
480.0	Pos 1 / Vertical	40.4	46.0	5.6
960.1	Pos 1 / Vertical	36.4 (QP)	54.0	17.6
120.0	Pos 1 / Horizontal	37.4	43.5	6.1
300.0	Pos 1 / Horizontal	38.0	46.0	8.0
480.0	Pos 1 / Horizontal	36.8	46.0	9.2
717.6	Pos 1 / Horizontal	40.1	46.0	5.9
847.0	Pos 1 / Horizontal	32.6 (QP)	46.0	13.4
870.3	Pos 1 / Horizontal	39.2 (QP)	46.0	6.8
882.9	Pos 1 / Horizontal	39.5 (QP)	46.0	6.5
960.1	Pos 1 / Horizontal	38.2(QP)	54.0	25.8
2744	Pos 1 / Vertical	51.4	73.8 (1)	23.4

RADIATED SPURIOUS EMISSIONS - TABULATED RESULTS				
TX MODE / LOW, CENTRAL & HIGHEST CHANNEL				
Frequency (MHz)	Position / Polarization	Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)
5489	Pos 1 / Vertical	56.0	73.8 (1)	17.8
6404	Pos 1 / Vertical	58.9	73.8 (1)	14.9
1739	Pos 1 / Horizontal	51.7	73.8 (1)	22.1
5489	Pos 1 / Horizontal	56.8	73.8 (1)	17.0
6404	Pos 1 / Horizontal	59.9	73.8 (1)	13.9
7319	Pos 1 / Horizontal	53.7 (Av)	54.0	0.3
30.5	Pos 2 / Vertical	32.8	40.0	7.2
48.1	Pos 2 / Vertical	32.8	40.0	7.2
72.0	Pos 2 / Vertical	28.4	40.0	21.6
120.0	Pos 2 / Vertical	36.3	43.5	7.2
240.0	Pos 2 / Vertical	35.0	46.0	11.0
480.0	Pos 2 / Vertical	40.9	46.0	5.1
870.3	Pos 2 / Vertical	36.8 (QP)	46.0	9.2
960.1	Pos 2 / Vertical	39.2 (QP)	54.0	14.8
120.0	Pos 2 / Horizontal	37.3	43.5	6.2
300.0	Pos 2 / Horizontal	38.7	46.0	7.3
724.4	Pos 2 / Horizontal	40.2	46.0	5.8
870.3	Pos 2 / Horizontal	41.2 (QP)	46.0	4.8
960.1	Pos 2 / Horizontal	36.9 (QP)	54.0	14.1
1732	Pos 2 / Vertical	52.8	54.0	1.2
2745	Pos 2 / Vertical	51.8	54.0	2.2
1897	Pos 2 / Horizontal	55.7	73.8 (1)	18.1
1924	Pos 2 / Horizontal	56.2	73.8 (1)	17.6
2477	Pos 2 / Horizontal	54.7	73.8 (1)	19.1
32.5	Pos 3 / Vertical	29.9 (QP)	40.0	10.1
46.7	Pos 3 / Vertical	37.7	40.0	2.3
72.0	Pos 3 / Vertical	26.9	40.0	13.1
120.0	Pos 3 / Vertical	38.5	43.5	5.0
240.0	Pos 3 / Vertical	34.4	46.0	11.6
300.0	Pos 3 / Vertical	35.9	46.0	10.1
480.0	Pos 3 / Vertical	41.8	46.0	4.2
870.3	Pos 3 / Vertical	43.6	46.0	2.4
960.1	Pos 3 / Vertical	36.9	54.0	17.1
120.0	Pos 3 / Horizontal	36.7	43.5	6.8
300.0	Pos 3 / Horizontal	38.8	46.0	7.2
480.0	Pos 3 / Horizontal	39.0	46.0	7.0
719.4	Pos 3 / Horizontal	41.2	46.0	4.8
834.1	Pos 3 / Horizontal	29.0 (QP)	46.0	17.0
870.3	Pos 3 / Horizontal	32.4 (QP)	46.0	13.6
882.9	Pos 3 / Horizontal	32.1 (QP)	46.0	13.9
960.1	Pos 3 / Horizontal	37.7 (QP)	54.0	16.3
1738	Pos 3 / Vertical	58.4	73.8 (1)	15.4
1884	Pos 3 / Vertical	58.1	73.8 (1)	15.7
1922	Pos 3 / Vertical	56.5	73.8 (1)	17.3
2514	Pos 3 / Vertical	53.6	73.8 (1)	20.2
2744	Pos 3 / Vertical	53.9	73.8 (1)	19.9
7319	Pos 3 / Vertical	53.2 (Av)	54.0	0.8

RADIATED SPURIOUS EMISSIONS - TABULATED RESULTS				
TX MODE / LOW, CENTRAL & HIGHEST CHANNEL				
Frequency (MHz)	Position / Polarization	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)
1731	Pos 3 / Horizontal	52.3	73.8 (1)	21.5
1882	Pos 3 / Horizontal	60.7	73.8 (1)	13.1
2510	Pos 3 / Horizontal	59.0	73.8 (1)	14.8
2745	Pos 3 / Horizontal	49.5	73.8 (1)	24.3

V= Vertical H=Horizontal

Spurious which has more than 20 dB of margin compared to the applicable limit is not necessarily reported

Note 1 : The limit outside the restricted bands are 30 dB below the carrier power.

The lowest power of the carrier is 103.8 dB μ V/m, so limit is 73.8 dB μ V/m.

TEST SETUP PHOTO(S) RADIATED EMISSIONS ($F < 30\text{MHz}$)



TEST SETUP PHOTO(S) RADIATED EMISSIONS ($F < 1\text{GHz}$)



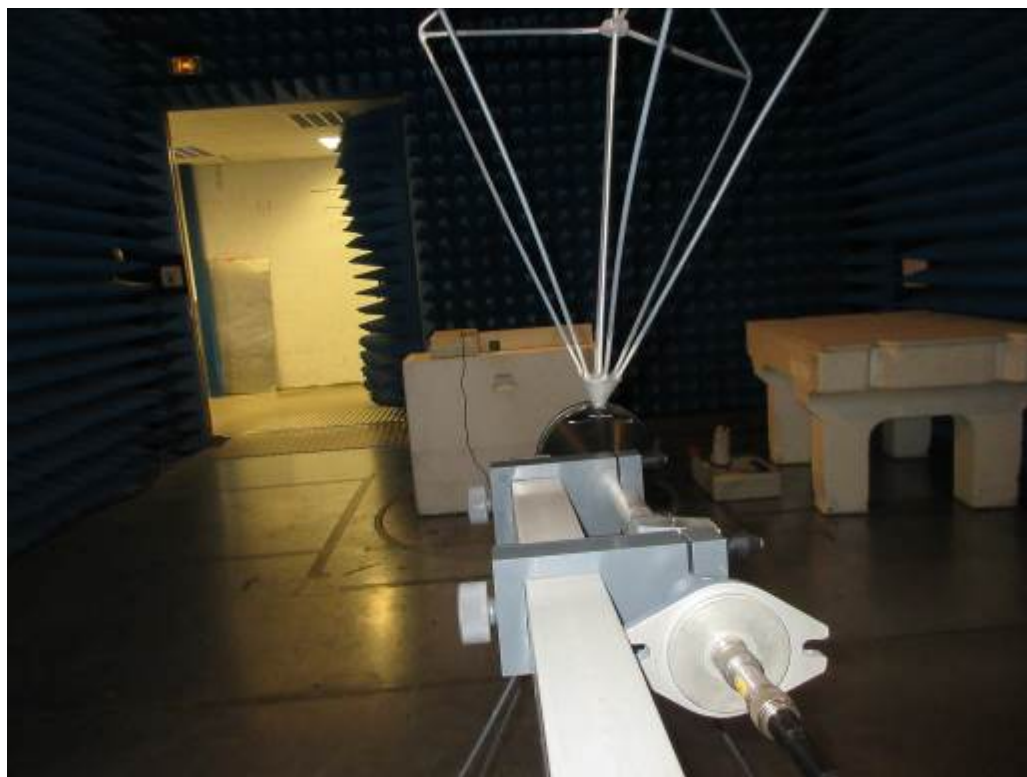
TEST SETUP PHOTO(S) RADIATED EMISSIONS ($F > 30\text{MHz}$)



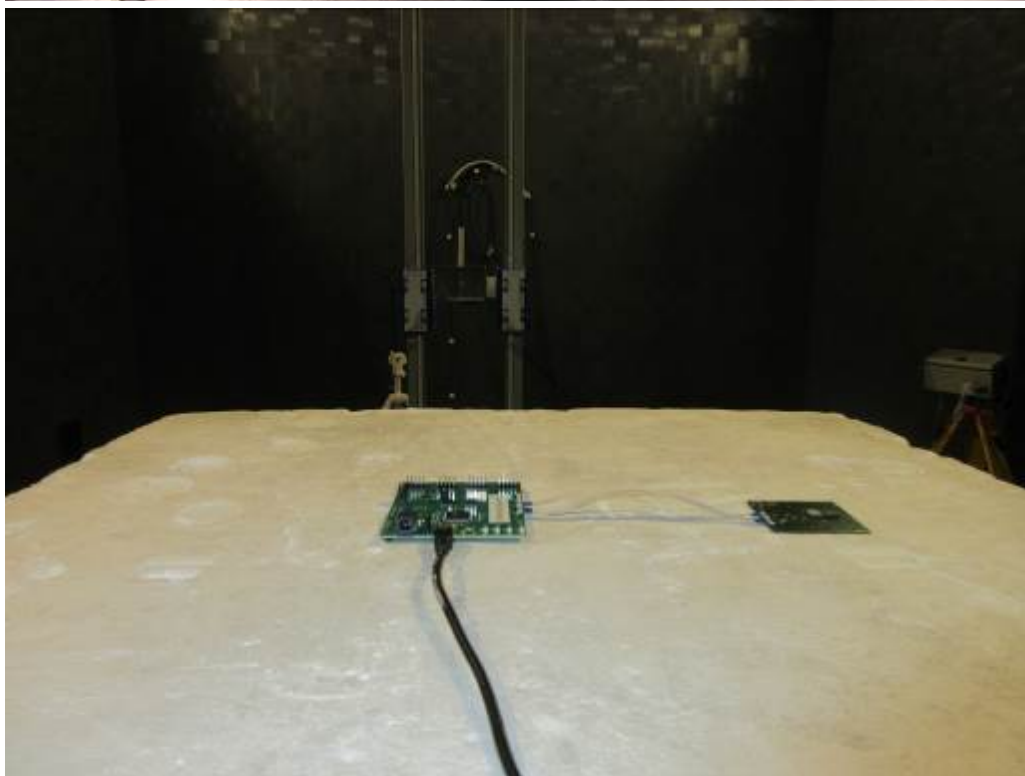
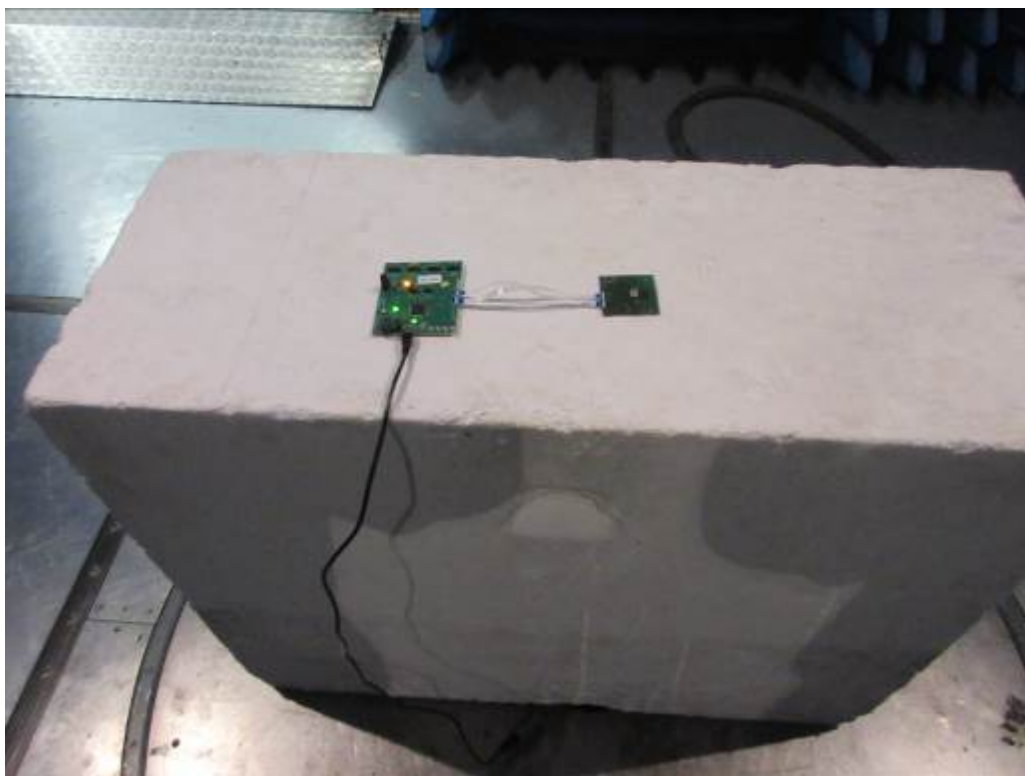
TEST SETUP PHOTO(S) RADIATED EMISSIONS (300MHz>F>1GHz)



TEST SETUP PHOTO(S) RADIATED EMISSIONS (30MHz>F>300MHz)



TEST SETUP PHOTO(S) RADIATED EMISSIONS – POSITION 1

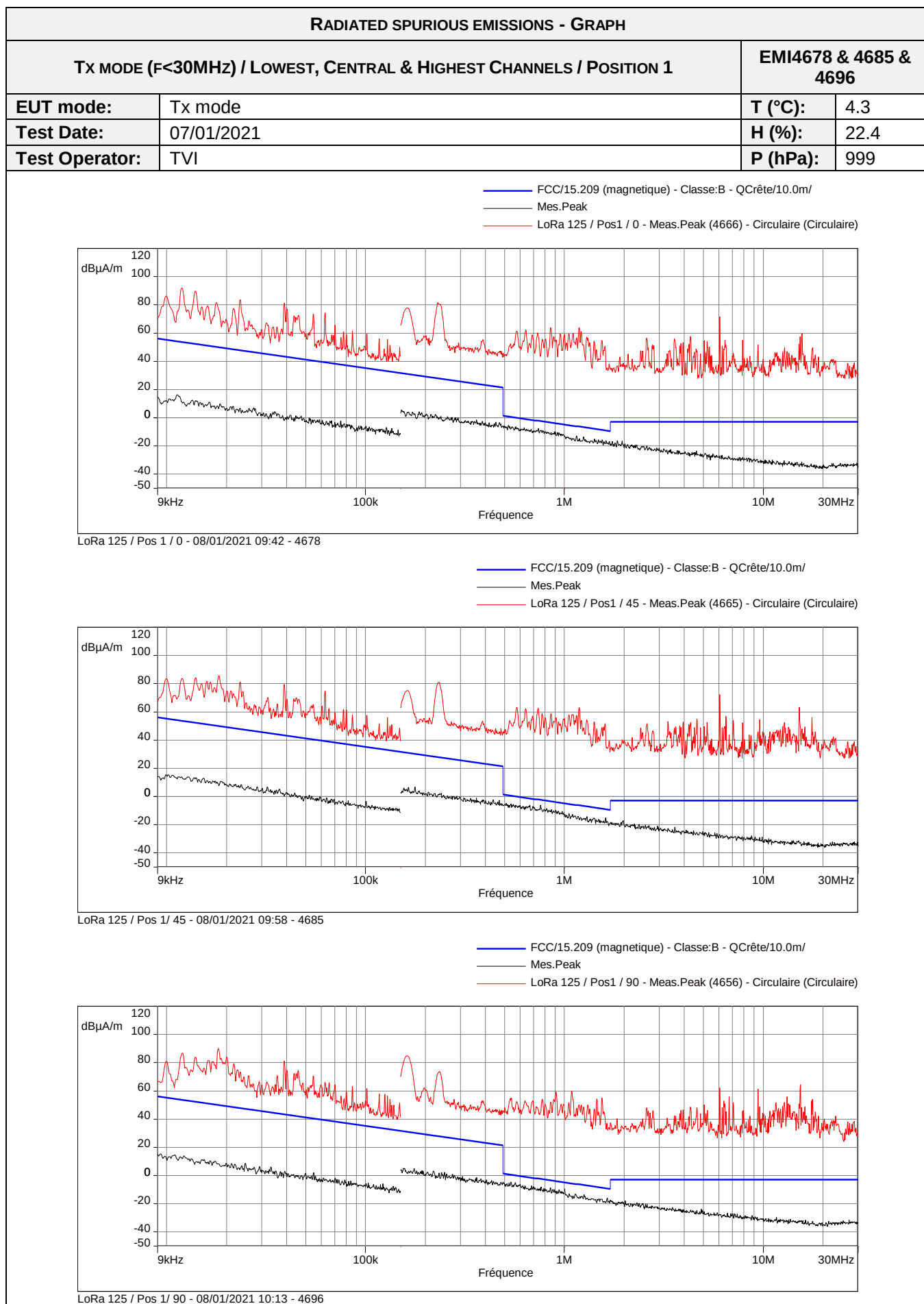


TEST SETUP PHOTO(S) RADIATED EMISSIONS – POSITION 2

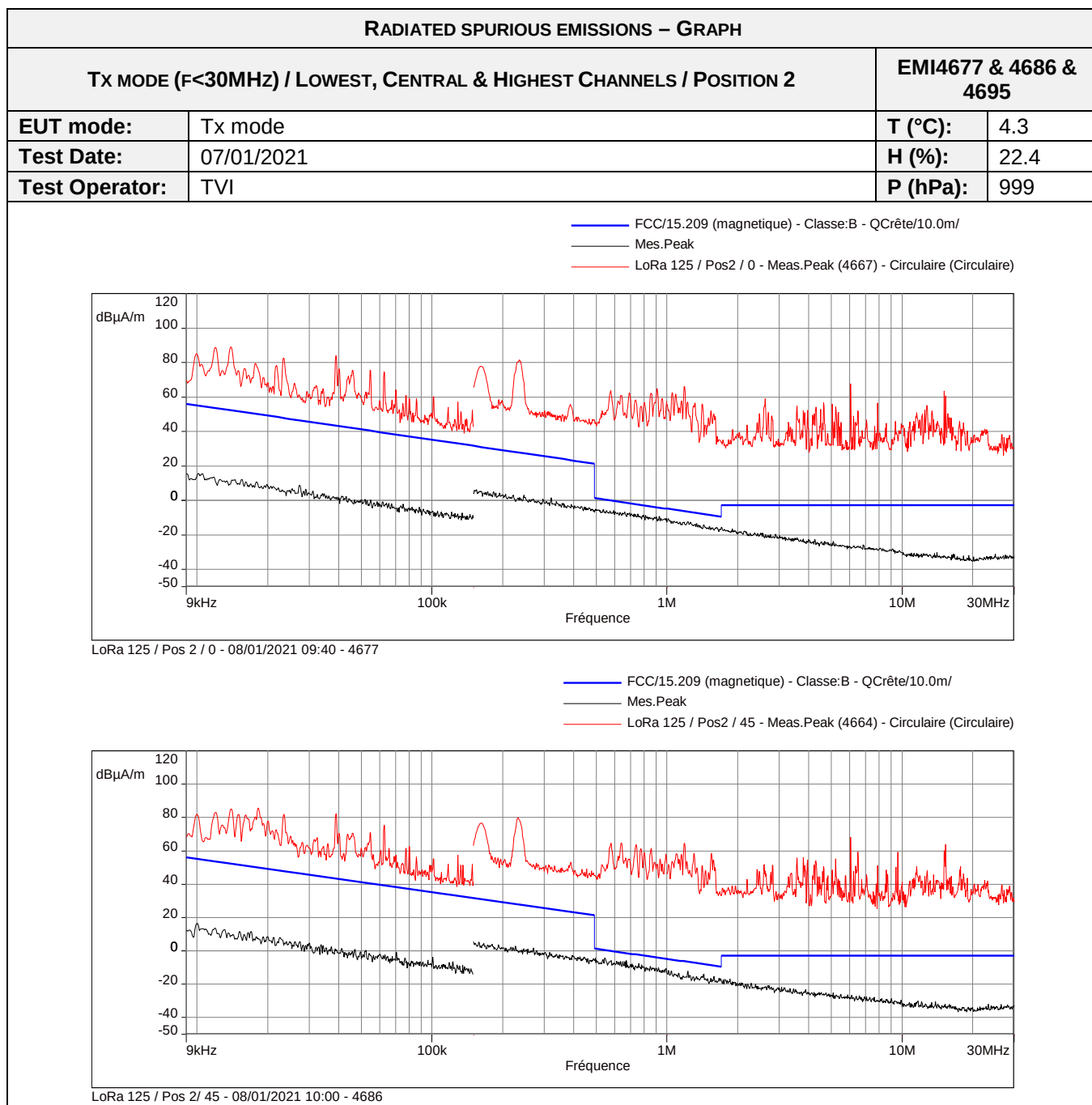


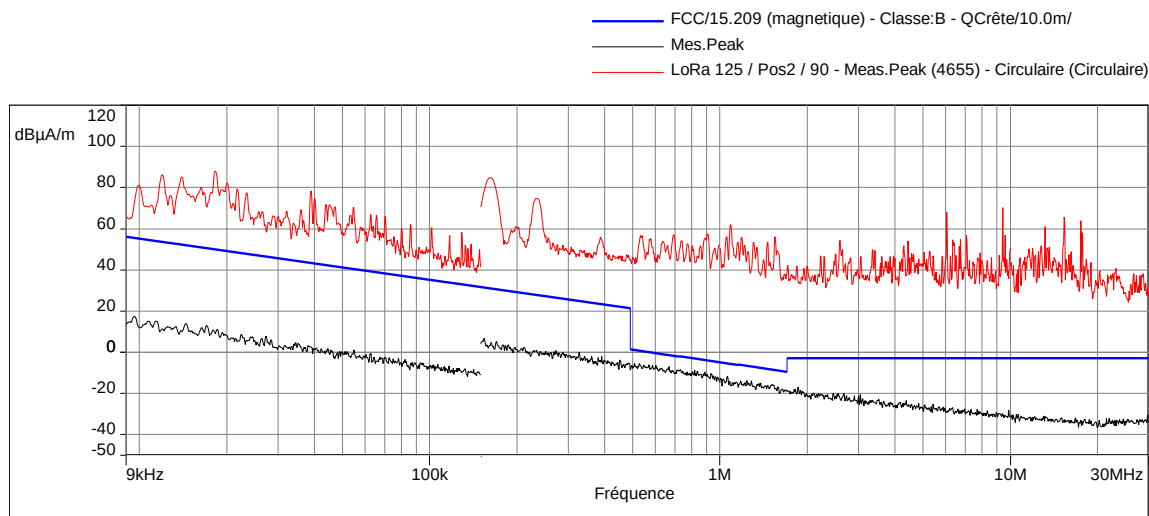
TEST SETUP PHOTO(S) RADIATED EMISSIONS – POSITION 3





RADIATED SPURIOUS EMISSIONS - GRAPH				
TX MODE (F<30MHz) / LOWEST, CENTRAL & HIGHEST CHANNELS / POSITION 1				EMI4678 & 4685 & 4696
POSITION	FREQUENCIES	RBW	VBW	DETECTOR
0°	9kHz-150kHz	200Hz	1kHz	Peak
0°	150kHz-1MHz	9kHz	30kHz	Peak
0°	200MHz-1GHz	9kHz	30kHz	Peak
45°	9kHz-150kHz	200Hz	1kHz	Peak
45°	150kHz-1MHz	9kHz	30kHz	Peak
45°	200MHz-1GHz	9kHz	30kHz	Peak
90°	9kHz-150kHz	200Hz	1kHz	Peak
90°	150kHz-1MHz	9kHz	30kHz	Peak
90°	200MHz-1GHz	9kHz	30kHz	Peak
Configuration:	N/A			
Comments:	The EUT was placed in sweep mode, from the first to the last. The black graphs represent the level measured in FAR, used to know which peak come from the EUT and which come from the environment. No spurious detected			
EUT modification(s): N/A				

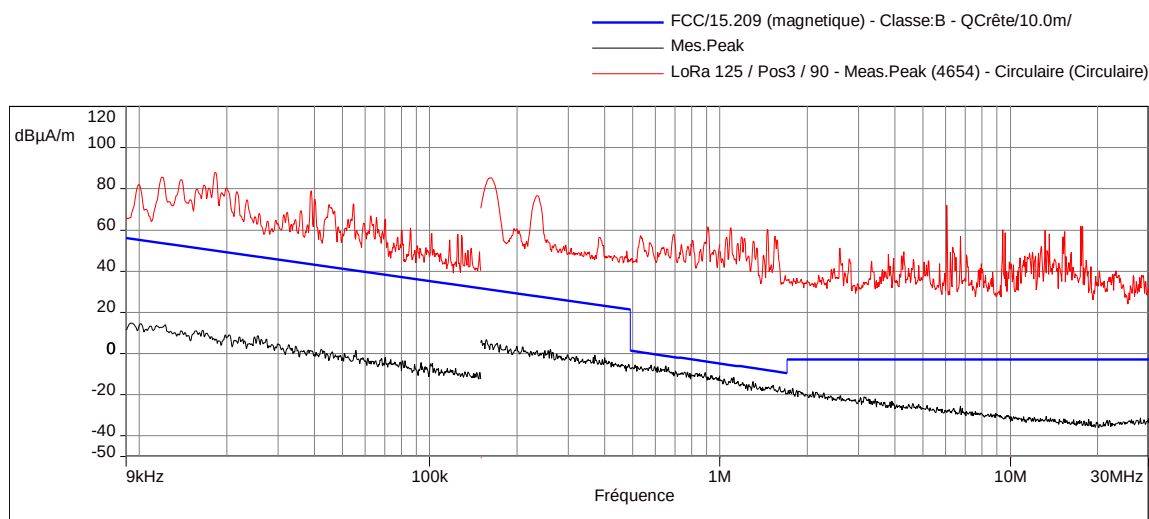
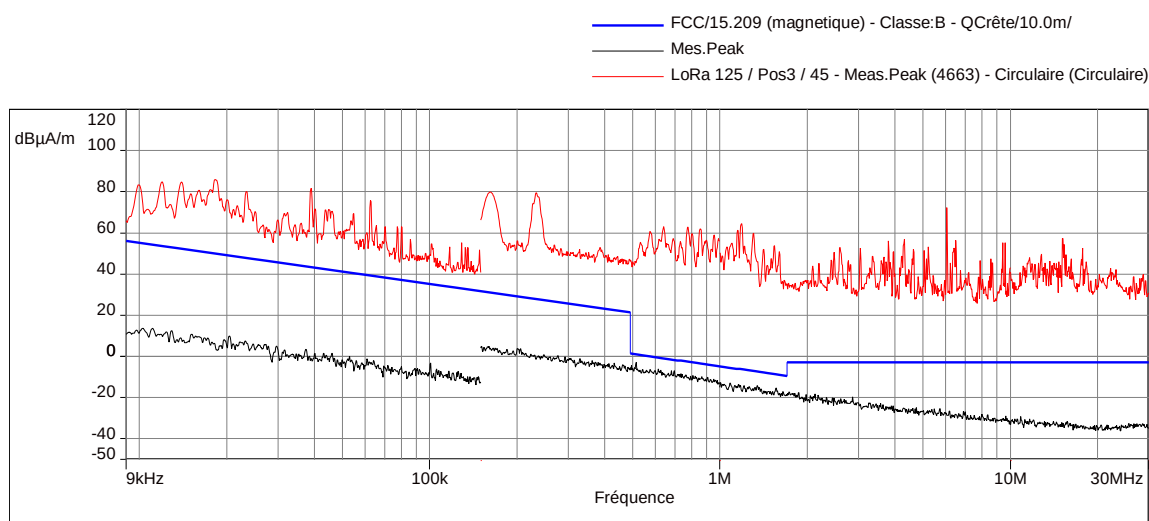
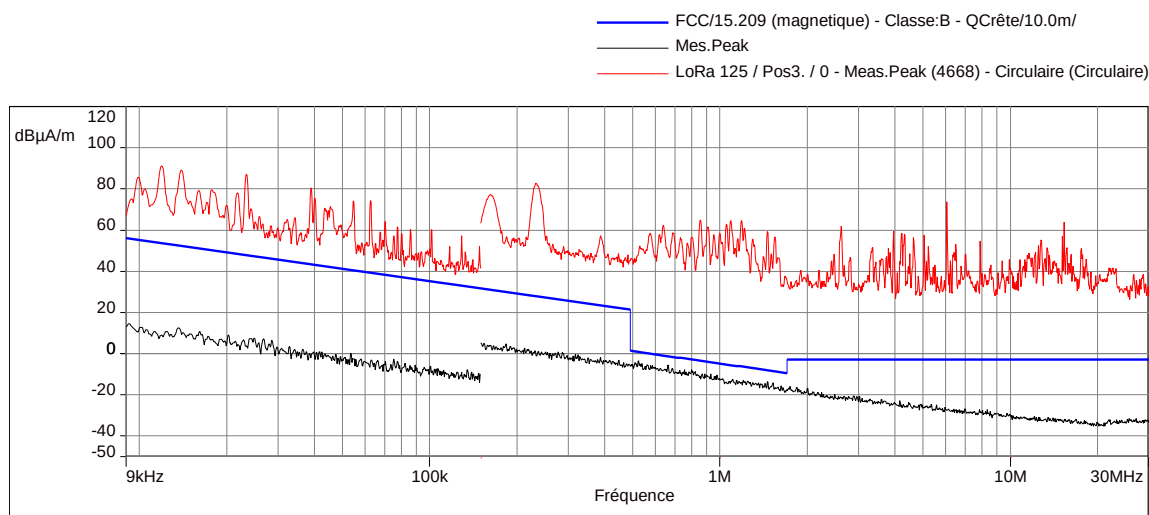


RADIATED SPURIOUS EMISSIONS – GRAPH
TX MODE (F<30MHz) / LOWEST, CENTRAL & HIGHEST CHANNELS / POSITION 2
**EMI4677 & 4686 &
4695**


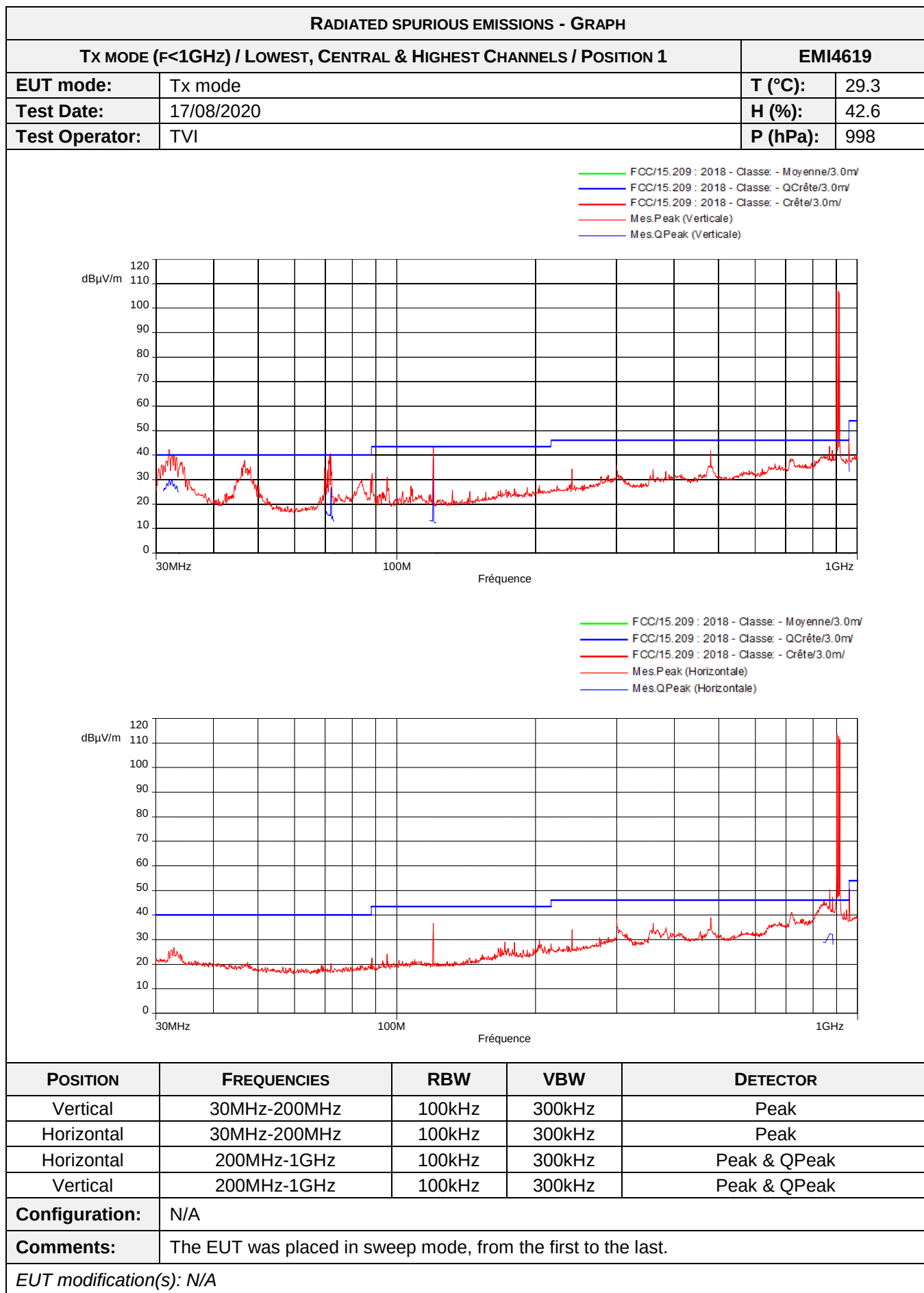
POSITION	FREQUENCIES	RBW	VBW	DETECTOR
0°	9kHz-150kHz	200Hz	1kHz	Peak
0°	150kHz-1MHz	9kHz	30kHz	Peak
0°	200MHz-1GHz	9kHz	30kHz	Peak
45°	9kHz-150kHz	200Hz	1kHz	Peak
45°	150kHz-1MHz	9kHz	30kHz	Peak
45°	200MHz-1GHz	9kHz	30kHz	Peak
90°	9kHz-150kHz	200Hz	1kHz	Peak
90°	150kHz-1MHz	9kHz	30kHz	Peak
90°	200MHz-1GHz	9kHz	30kHz	Peak
Configuration:	N/A			
Comments:	The EUT was placed in sweep mode, from the first to the last. The black graphs represent the level measured in FAR, used to know which peak come from the EUT and which come from the environment. No spurious detected			
EUT modification(s): N/A				

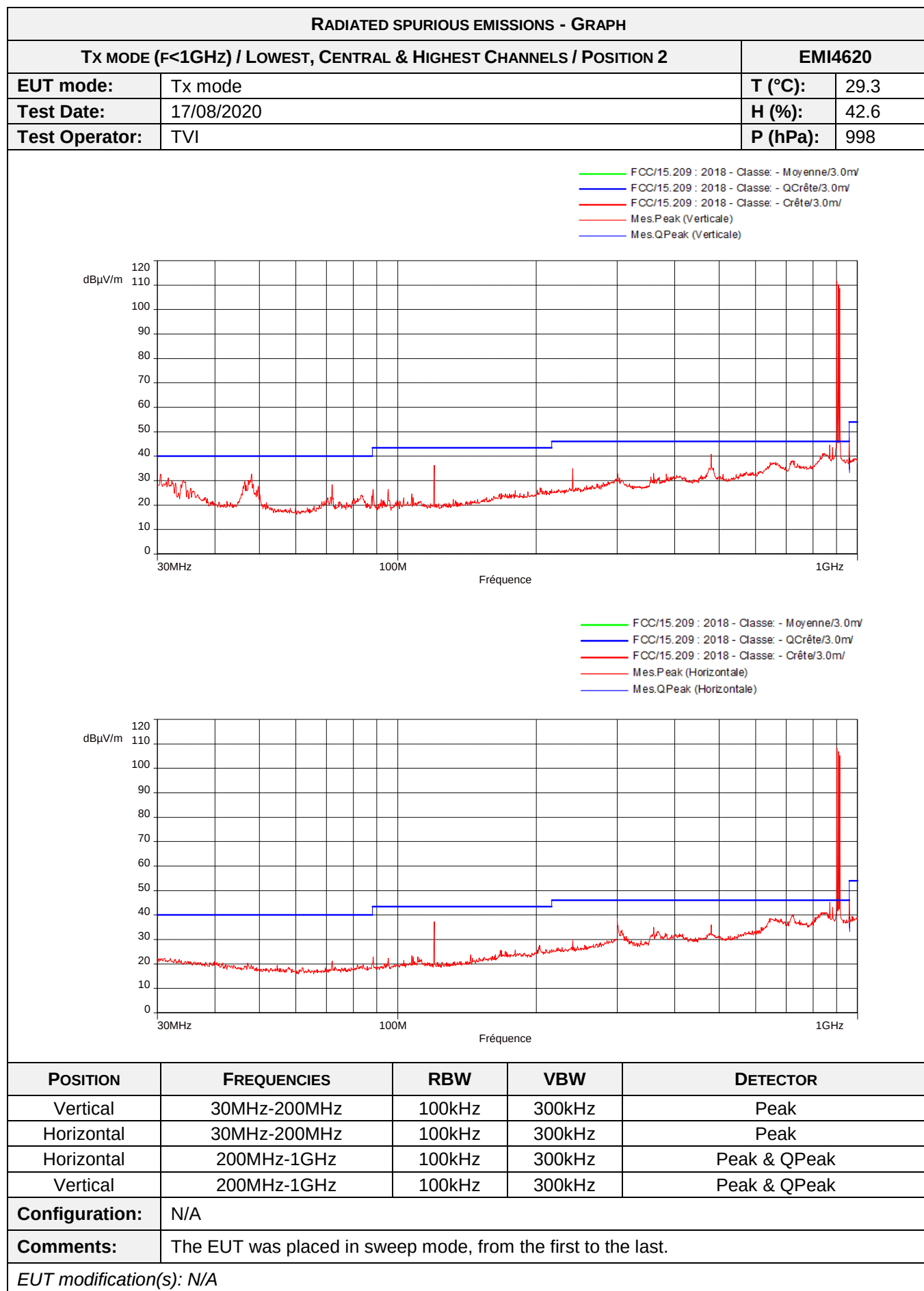
RADIATED SPURIOUS EMISSIONS - GRAPH

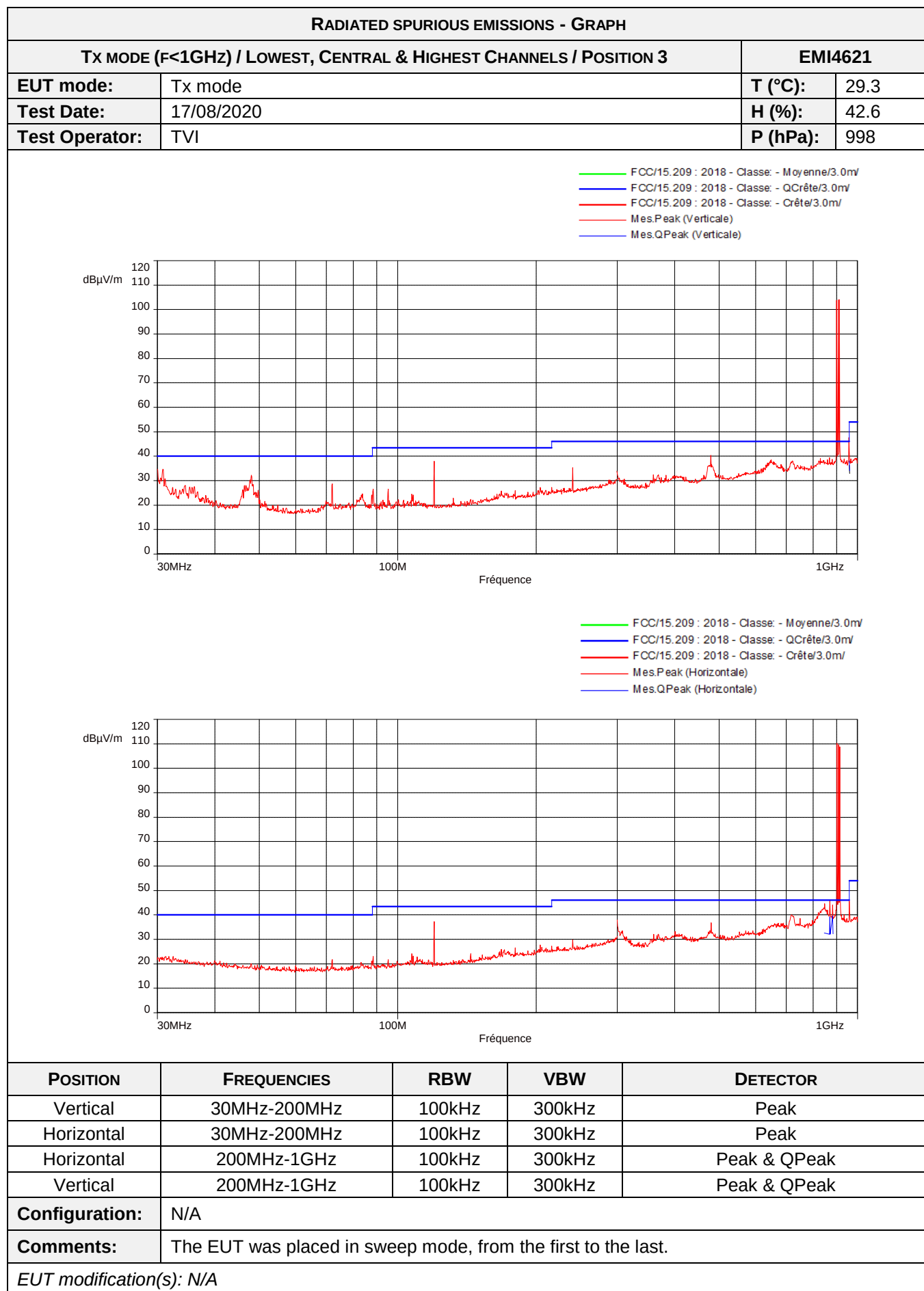
TX MODE (F<30MHz) / LOWEST, CENTRAL & HIGHEST CHANNELS / POSITION 3		EMI4676 & 4687 & 4694	
EUT mode:	Tx mode	T (°C):	4.3
Test Date:	07/01/2021	H (%):	22.4
Test Operator:	TVI	P (hPa):	999

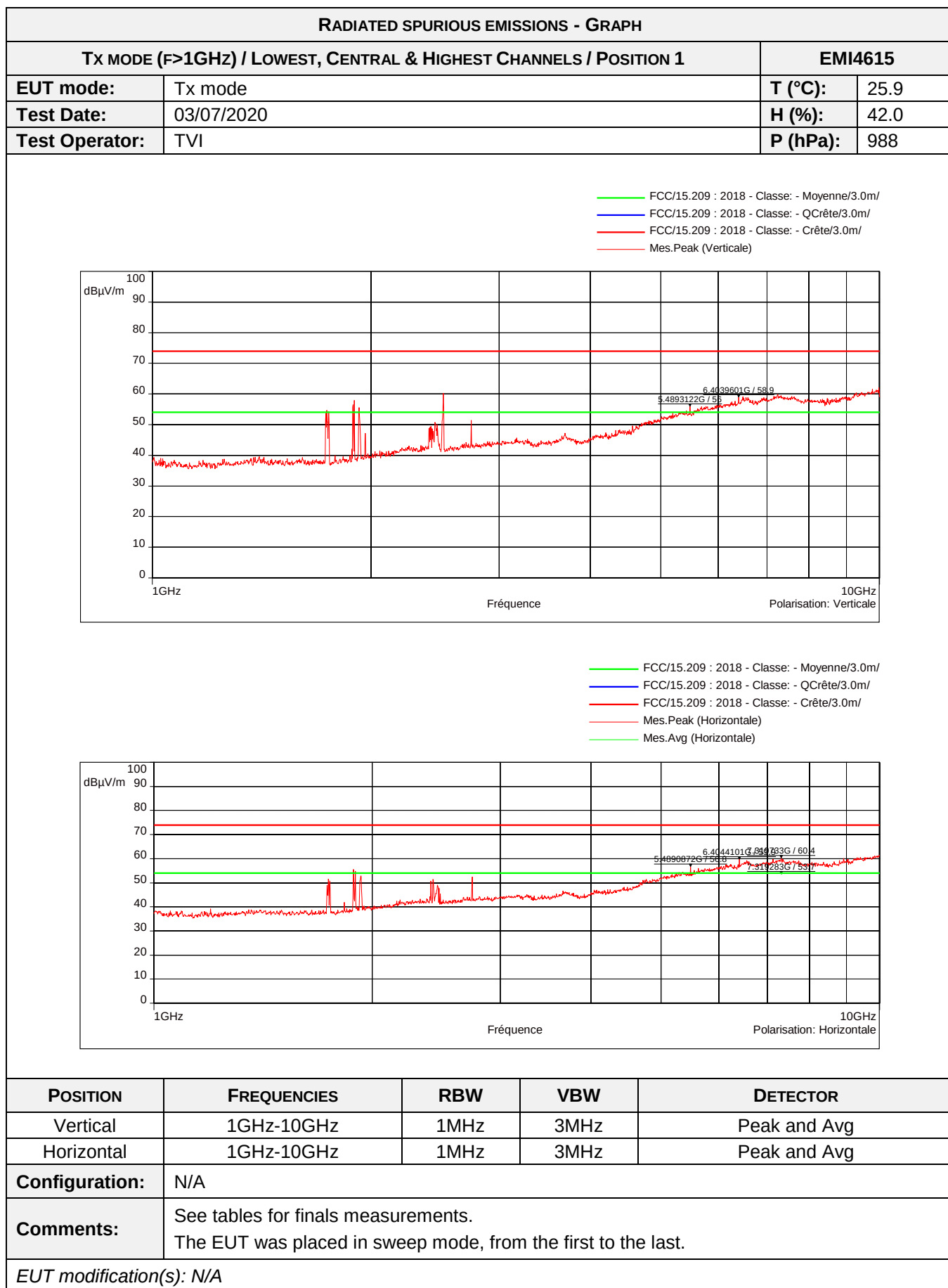


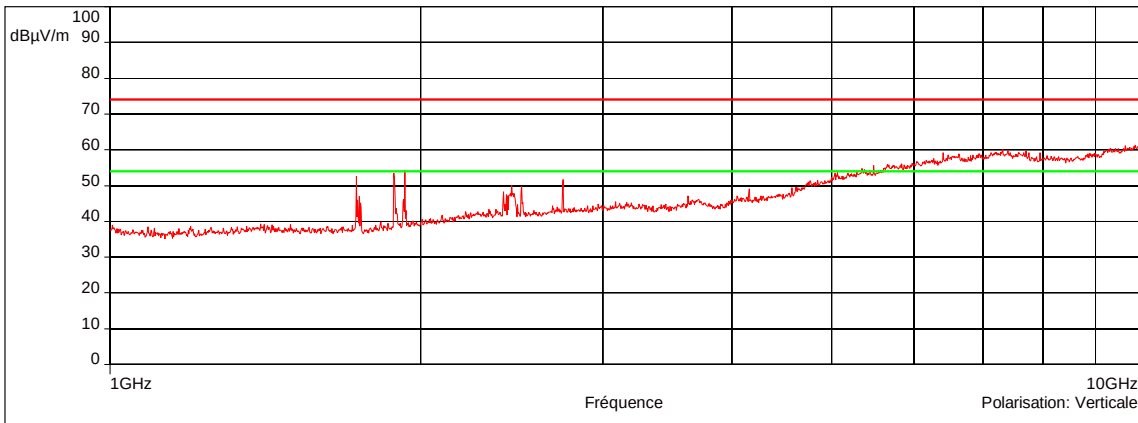
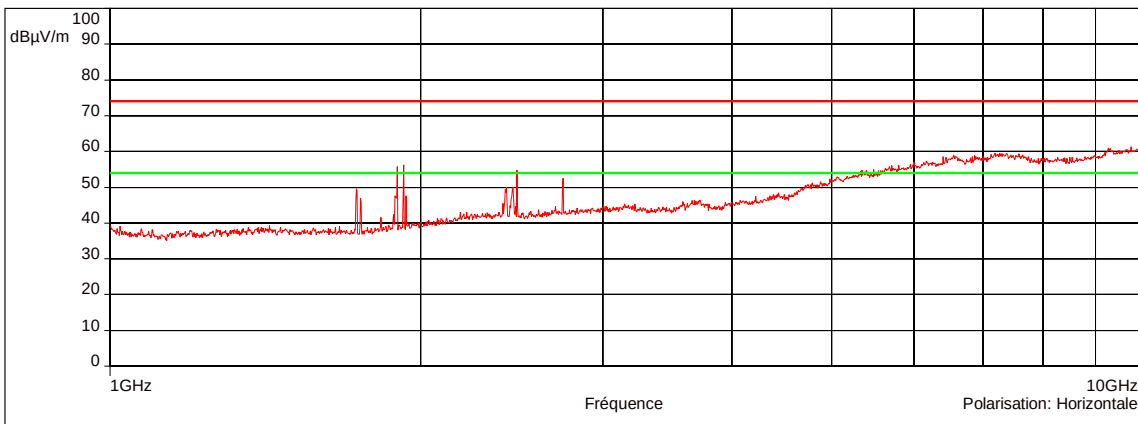
RADIATED SPURIOUS EMISSIONS - GRAPH				
TX MODE (F<30MHz) / LOWEST, CENTRAL & HIGHEST CHANNELS / POSITION 3				EMI4676 & 4687 & 4694
POSITION	FREQUENCIES	RBW	VBW	DETECTOR
0°	9kHz-150kHz	200Hz	1kHz	Peak
0°	150kHz-1MHz	9kHz	30kHz	Peak
0°	200MHz-1GHz	9kHz	30kHz	Peak
45°	9kHz-150kHz	200Hz	1kHz	Peak
45°	150kHz-1MHz	9kHz	30kHz	Peak
45°	200MHz-1GHz	9kHz	30kHz	Peak
90°	9kHz-150kHz	200Hz	1kHz	Peak
90°	150kHz-1MHz	9kHz	30kHz	Peak
90°	200MHz-1GHz	9kHz	30kHz	Peak
Configuration:	N/A			
Comments:	The EUT was placed in sweep mode, from the first to the last. The black graphs represent the level measured in FAR, used to know which peak come from the EUT and which come from the environment. No spurious detected			
EUT modification(s): N/A				

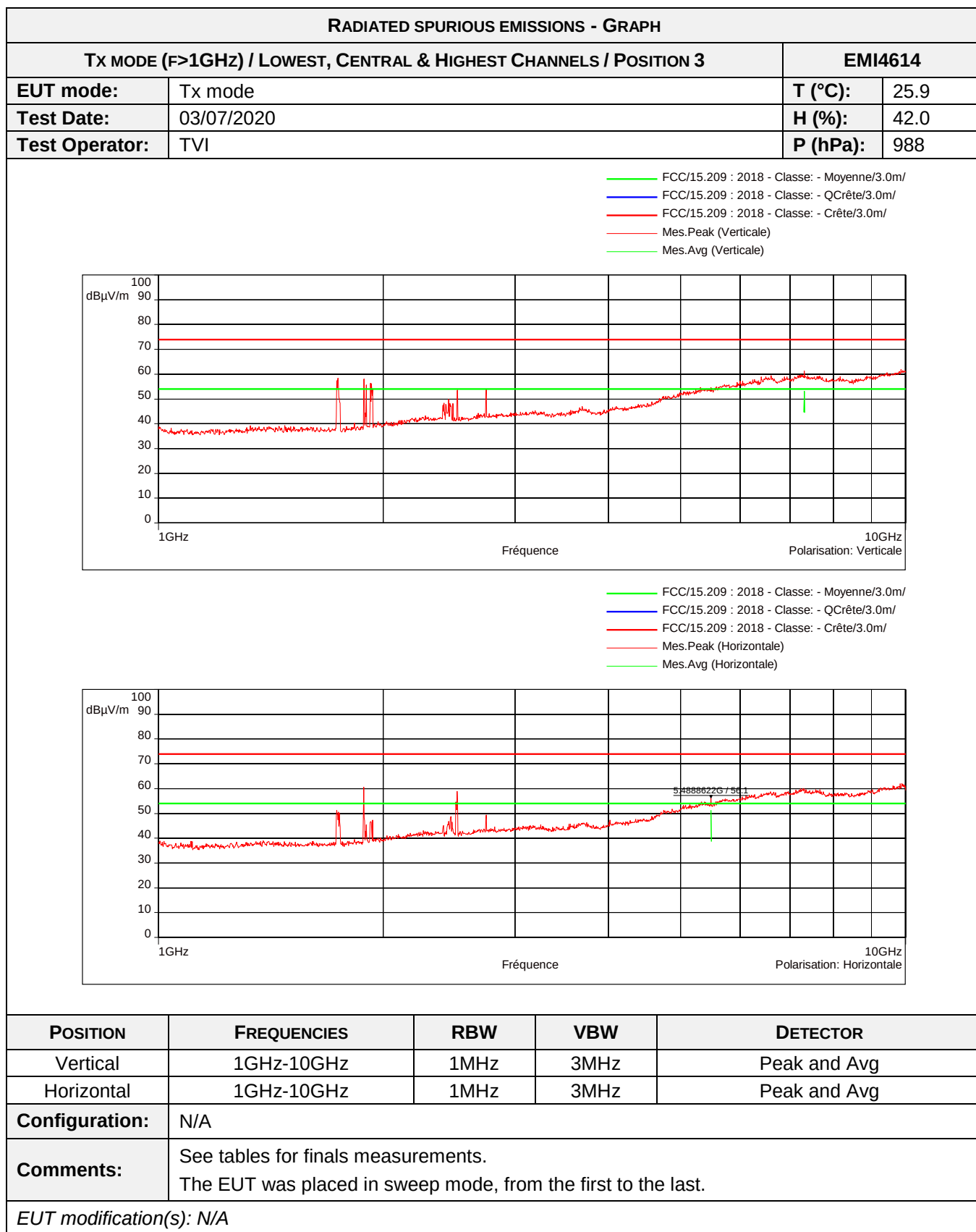








RADIATED SPURIOUS EMISSIONS - GRAPH				
TX MODE (F>1GHz) / LOWEST, CENTRAL & HIGHEST CHANNELS / POSITION 2			EMI4613	
EUT mode:	Tx mode		T (°C):	25.9
Test Date:	03/07/2020		H (%):	42.0
Test Operator:	TVI		P (hPa):	988
FCC/15.209 : 2018 - Classe: - Moyenne/3.0m/ FCC/15.209 : 2018 - Classe: - QCrête/3.0m/ FCC/15.209 : 2018 - Classe: - Crête/3.0m/ Mes.Peak (Verticale)  FCC/15.209 : 2018 - Classe: - Moyenne/3.0m/ FCC/15.209 : 2018 - Classe: - QCrête/3.0m/ FCC/15.209 : 2018 - Classe: - Crête/3.0m/ Mes.Peak (Horizontale) 				
POSITION	FREQUENCIES	RBW	VBW	DETECTOR
Vertical	1GHz-10GHz	1MHz	3MHz	Peak and Avg
Horizontal	1GHz-10GHz	1MHz	3MHz	Peak and Avg
Configuration:	N/A			
Comments:	See tables for finals measurements. The EUT was placed in sweep mode, from the first to the last.			
EUT modification(s): N/A				



7.6. Measurement of Frequency Stability §15.215 (C) And RSS-GEN

Reference standard:	FCC part 15 Radio part 15.215 c)
Test method:	FCC part 15 Radio part 15.215 c) and RSS Gen
General test setup: The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation. EUT is set inside the climatic enclosure. EUT is connected to the measuring receiver via 50Ω attenuator(s).	

TEST CASE	EUT MODE	SEVERITY	RESULT TAB.	VERDICT
Tx mode	Permanent emission mode	902-928 MHz	-	PASS

LABORATORY PARAMETERS:	REQUIRED PRIOR TO THE TEST	DURING THE TEST
Ambient Temperature	15 to 35 °C	N/A
Relative Humidity	20 to 75 %	N/A
Atmospheric pressure	N/A	N/A
Test method deviation: N/A		
Supplementary information: EUT power supply is replaced by a stabilized power supply.		

TEST EQUIPMENT USED					
CATEGORY	BRAND	TYPE	IDENTIFIER	CAL. DATE	CAL. DUE
Spectrum Analyzer	Agilent Technologies	N9010A	11316	14/05/2019	14/07/2020
Cable	H&S	N-1m	15931	04/12/2018	04/02/2021
Software	Nexio		0000		
Thermohygrometer	Testo	608-H1	15790	12/11/2018	12/01/2021
Climatic chamber	CLIMATIS	EXCAL 4014-TA	12398	04/03/2020	04/05/2022

BAT-EMC software version: V3.18.0.26
Blank cells = Permanent validity

TEST SETUP PHOTO(S)



EFFECTIVE RADIATED POWER - TABULATED RESULTS

Test Case	Temperature (°C)	Power supply (Vdc)	Frequency (MHz)	Frequency error (kHz)
Normal conditions / Low channel	25	3.3 (1)	902.301724	-
Extremes tests conditions / Low channel	-30	3.3 (1)	902.301723	-0.001
Extremes tests conditions / Low channel	85	3.3 (1)	902.300971	-0.753
Normal conditions / Central channel	25	3.3 (1)	908.500972	-
Extremes tests conditions / Central channel	-30	3.3 (1)	908.500894	-0.078
Extremes tests conditions / Central channel	85	3.3 (1)	908.501237	0.265
Normal conditions / High channel	25	3.3 (1)	914.899973	-
Extremes tests conditions / High channel	-30	3.3 (1)	914.899718	-0.255
Extremes tests conditions / High channel	85	3.3 (1)	914.902513	2.540

Note 1 : The voltage of the EUT is provided by an EA, which regulate the voltage of the EUT. Modifying the voltage of provided would only modify the voltage of the EA, and not the EUT.

EUT MODIFICATIONS	OPERATOR	TEST DATE	RESULT TAB.
N/A	TVI	03/04/2020	-

End of test report