

Certification Radio test report

According to the standard:
CFR 47 FCC PART 15

Equipment under test:
Industrial Smart Hub

FCC ID: 2APE2-CONNECT

Company:
ETS GEORGES RENAULT

Distribution: Mr GARIN

(Company: ETS GEORGES RENAULT)

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DESIGNATION OF PRODUCT: Industrial Smart Hub

Serial number (S/N): 08 01 18 00006

Internal code: 6159327230

Reference / model (P/N): CONNECT

Software version: System software: 2.0.0.4
CPU board: 2.0.0.4
CPU bootloader: 2016.01
OS version: 4.1.15-CP

Cards version: 8825-IND07
8868-IND0
8869-IND06
8870-IND
8949-IND01

MANUFACTURER: ETS GEORGES RENAULT

COMPANY SUBMITTING THE PRODUCT:

Company: ETS GEORGES RENAULT

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Responsible: Mr GARIN

DATES OF TEST: From 9-Mar-18 to 16-Mar-18

TESTING LOCATION: EMITECH ANGERS laboratory at JUIGNE SUR LOIRE (49) FRANCE
FCC Accredited under US-EU MRA Designation Number: FR0009
Test Firm Registration Number: 873677

TESTED BY: T. LEDRESSEUR

VISA:



WRITTEN BY: T. LEDRESSEUR

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1. INTRODUCTION

This report presents the results of radio test carried out on the following radio equipment: **Industrial Smart Hub - CONNECT**, in accordance with normative reference.

The device under test integrates a RFID part not certified and a WLAN (2.4 GHz and 5GHz) radio module already certified (FCC ID: 2AG87DLM168N).

The host device of certified module(s) shall be properly labeled to identify the module(s) within.

This radio test report concern only measure realized following CFR47 part 15.225 for certification procedure on the RFID.

For Verification and colocation measurements realized see radio test report RR051-18-100254-2-A.

2. PRODUCT DESCRIPTION

Class:	A
Utilization:	Industrial
Antenna type and gain:	PCB antenna, gain: 0dBi
Operating frequency range:	From 13.110 MHz to 14.010 MHz
Frequency tested	13.56 MHz
Number of channels:	1
Channel spacing:	Not concerned
Power source:	120 Vac – 60 Hz

Power level, frequency range and channels characteristics are not user adjustable.

The details pictures of the product and the circuit boards are joined with this file.

3. NORMATIVE REFERENCE

The standards and testing methods related throughout this report are those listed below.

They are applied on the whole test report even though the extensions (version, date and amendment) are not repeated.

CFR 47 FCC Part 15 (2018) Radio Frequency Devices

ANSI C63.10 2013
Procedures for Compliance Testing of Unlicensed Wireless Devices.

447498 D01 General RF RF Exposure procedures and equipment authorization policies for mobile and
Exposure Guidance v06 portable equipment

4. TEST METHODOLOGY

Radio performance tests procedures given in CFR 47 part 15:

Subpart C – Intentional Radiators

- Paragraph 203: Antenna requirement
- Paragraph 205: Restricted bands of operation
- Paragraph 207: Conducted limits
- Paragraph 209: Radiated emission limits; general requirements
- Paragraph 212: Modular transmitter
- Paragraph 215: Additional provisions to the general radiated emission limitations
- Paragraph 225: Operation within the band 13.110-14.010 MHz

5. TEST EQUIPMENT CALIBRATION DATES

Emitech Number	Model	Type	Last calibration	Calibration interval (years)	Next calibration due
0	BAT-EMC V3.16.0.64	Software	/	/	/
1211	HP 8901B	Modulation analyzer	08/11/2017	2	08/11/2019
1406	EMCO 6502	Loop antenna	13/04/2017	2	13/04/2019
4088	R&S FSP40	Spectrum Analyzer	21/02/2018	2	21/02/2020
7045	MPC F0-100	Climatic chamber	/	/	/
7190	R&S HL223	Antenna	15/03/2016	3	15/03/2019
7240	Emco 3110	Biconical antenna	15/03/2016	3	15/03/2019
8508	California instruments 1251RP	Power source	15/01/2018	1	15/01/2019
8528	Schwarzbeck VHA 9103	Biconical antenna	15/03/2016	3	15/03/2019
8578	2GHz	Cable	11/04/2016	2	11/04/2018
8590	RG214 N	Cable	11/04/2016	2	11/04/2018
8676	ISOTECH IDM106N	Multimeter	/	/	/
8707	R&S ESI7	Test receiver	07/06/2016	2	07/06/2018
8720	R&S ESH3-Z5	LISN	28/11/2016	2	28/11/2018
8732	Emitech	OATS	11/10/2016	3	11/10/2019
8749	La Crosse Technology WS-9232	Meteo station	23/09/2016	2	23/09/2018
8750	La Crosse Technology WS-9232	Meteo station	23/09/2016	2	23/09/2018
8783	EMCO 3147	Log periodic antenna	15/03/2016	3	15/03/2019
8893	Emitech	Outside room Hors cage	/	/	/
8896	ACQUISYS GPS8	Satellite synchronized frequency standard	/	/	/
9398	N-1.5m	cable	11/04/2016	2	11/04/2018
10523	Absorber sheath current	Emitech	06/06/2016	2	06/06/2018
10730	Mini-circuit ZFL-1000LN	Low-noise amplifier	12/02/2018	1	12/02/2019
10759	SIDT Cage 3	Anechoic chamber	/	/	/
11535	R&S EZ-25	High pass filter	13/12/2016	2	13/12/2018
14302	SUCOFLEX N-1m	cable	28/11/2016	2	28/11/2018
14303	SUCOFLEX N-2m	cable	28/11/2016	2	28/11/2018
14304	SUCOFLEX N-2.5m	cable	28/11/2016	2	28/11/2018
14305	SUCOFLEX N-4m	cable	28/11/2016	2	28/11/2018
-	GPIO Shot	Software	/	/	/

(2) The equipment is not verified; instead, the output voltage is checked before each measurement with the calibrated multimeter.

6. TESTS RESULTS SUMMARY

Test procedure	Description of test	Respected criteria?				Comment
		Yes	No	NAp	NAs	
FCC Part 15.203	ANTENNA REQUIREMENT	X				Note 1
FCC Part 15.205	RESTRICTED BANDS OF OPERATION	X				
FCC Part 15.207	CONDUCTED LIMITS	X				
FCC Part 15.209	RADIATED EMISSION LIMITS; general requirements	X				Note 2
FCC Part 15.212	MODULAR TRANSMITTERS	X				see certification documents
FCC part 15.215	ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS					
	(a) Alternative to general radiated emission limits	X				
	(b) Unwanted emissions outside of §15.225 frequency bands	X				Note 3
	(c) 20 dB bandwidth and band-edge compliance	X				
FCC Part 15.225	OPERATION WITHIN THE BAND 13.110-14.010 MHZ					
	(a) Field strength within the band 13.553-13.567 MHz	X				
	(b) Field strength within the bands 13.410-13.553 MHz and 13.567-13.710 MHz	X				
	(c) Field strength within the bands 13.110-13.410 MHz and 13.710-14.010 MHz	X				
	(d) Field strength outside the band 13.110-14.010 MHz	X				
	(e) Carrier frequency tolerance	X				
	(f) Powered tags			X		

NAp: Not Applicable NAs: Not Asked

Note 1: Integral antenna

Note 2: See FCC part 15.225 (d).

Note 3: See FCC part 15.209. Unwanted emissions levels are all below the fundamental emission field strength level.

7. MEASUREMENT UNCERTAINTY

To declare, or not, the compliance with the specifications, it was not explicitly taken into account of uncertainty associated with the result(s)

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for normal distribution corresponds to a coverage probability of approximately 95%.

Parameter	Emitech Uncertainty
RF power, conducted	$\pm 0.75\text{dB}$
Radiated emission valid to 26 GHz	
F < 62.5 MHz:	$\pm 5.14\text{ dB}$
62.5 MHz < F < 1 GHz:	$\pm 5.13\text{ dB}$
1 GHz < F < 26 GHz:	$\pm 5.16\text{ dB}$
AC Power Lines conducted emissions	$\pm 3.38\text{ dB}$
Temperature	$\pm 1\text{ }^{\circ}\text{C}$
Humidity	$\pm 5\%$

8. CONDUCTED LIMITS**Temperature (°C) :** 24**Humidity (%HR):** 36.6**Date :** March 15, 2018**Technician :** T. LEDRESSEUR**Standard:** FCC Part 15**Test procedure:** Paragraph 15.207**Software used:** BAT-EMC V3.6.0.32**Test set up:**

The EUT is isolated and placed on a wooden table, 0.8 m over an horizontal reference plane and 0.4 m from a vertical reference plane. It is powered by an artificial main network placed on the ground reference plane. The equipment is powered with the AC power operating voltage of 120 V / 60 Hz.

Frequency range: 150 kHz - 30 MHz**Detection mode:** Peak / Quasi-peak / Average**Bandwidth:** 10 kHz / 9 kHz**Equipment under test operating condition:**

The equipment under test is blocked in alternation of emission and reception mode without tag. During this measure the WLAN is also active, only the worst critical results for WLAN at 2.4 GHz or 5 GHz are reported below.

Results:

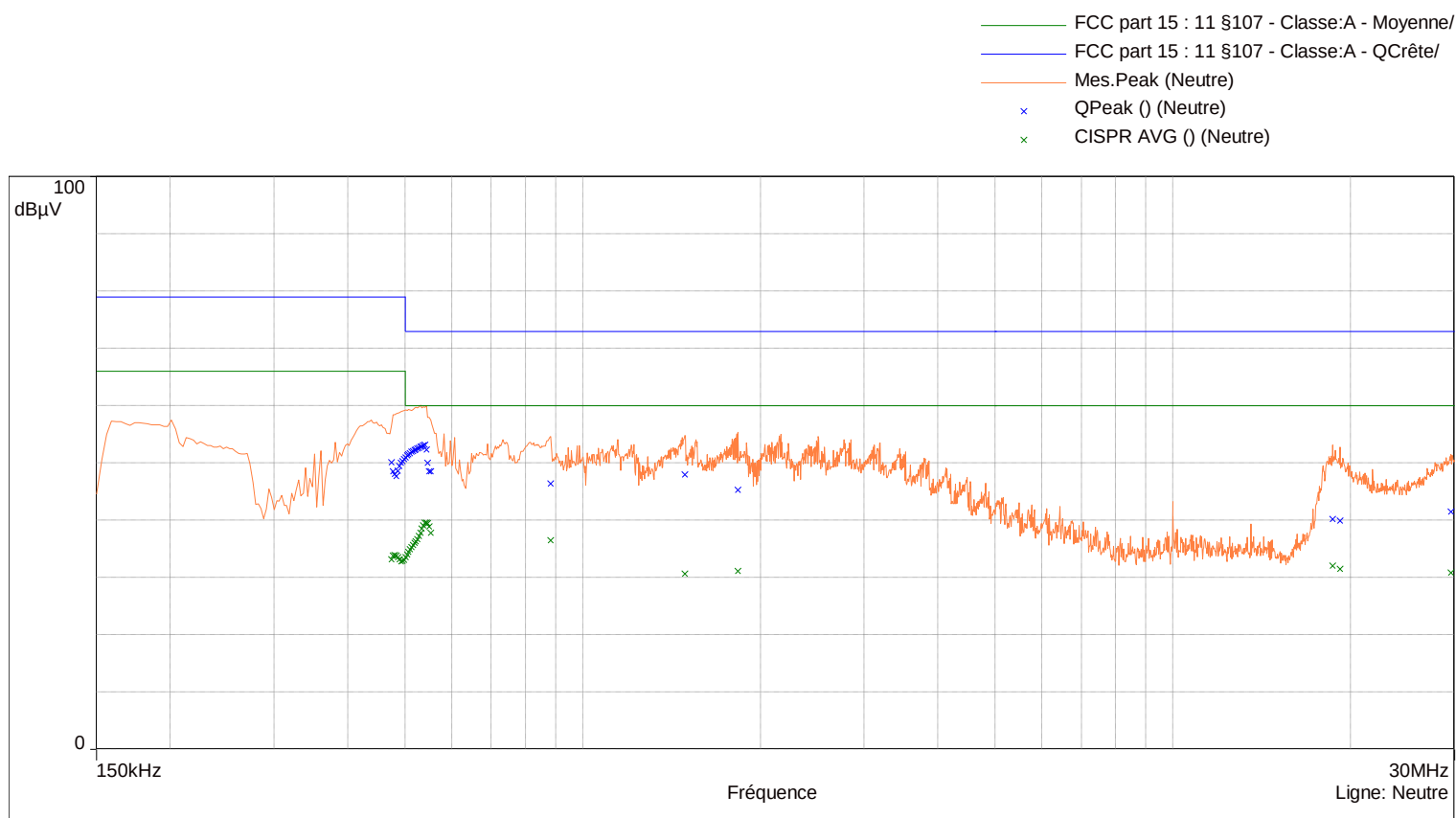
Sample N° 1:

Measurement on the mains power supply:

The measurement is first realized with peak detector.

The highest frequencies are then analyzed with Quasi-peak detector and Average detector

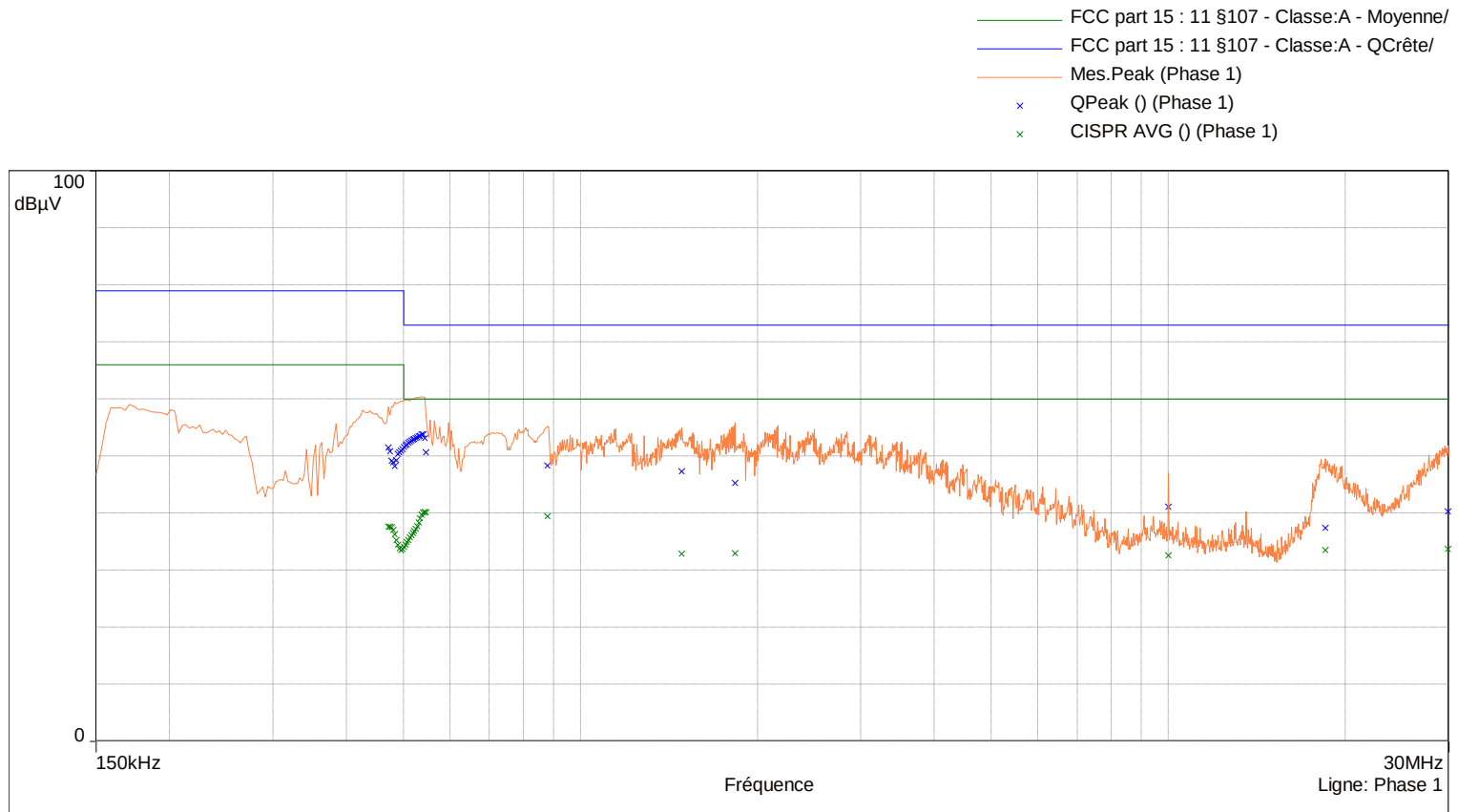
Curve N° 1: measurement on the Neutral



Frequency (MHz)	Quasi-peak (dBμV)	QP Limit (dBμV)	QP margin (dB)
0.54	53.12	73.000	19.880
0.882	46.39	73.000	26.610
1.489	47.93	73.000	25.070
1.831	45.27	73.000	27.730
18.649	40.22	73.000	32.780
29.575	41.47	73.000	31.530

Frequency (MHz)	Average (dBμV)	Average Limit (dBμV)	Average margin (dB)
0.54	39.51	60.000	20.490
0.882	36.49	60.000	23.510
1.489	30.66	60.000	29.340
1.831	31.15	60.000	28.850
18.649	32.08	60.000	27.920
29.575	30.87	60.000	29.130

Curve N° 2: measurement on the Line



Frequency (MHz)	Quasi-peak (dBμV)	QP Limit (dBμV)	QP margin (dB)
0.537	53.77	73.000	19.230
0.879	48.36	73.000	24.640
1.486	47.28	73.000	25.720
1.831	45.32	73.000	27.680
10	41.11	73.000	31.890
18.493	37.44	73.000	35.560
29.908	40.33	73.000	32.670

Frequency (MHz)	Average (dBμV)	Average Limit (dBμV)	Average margin (dB)
0.537	39.73	60.000	20.270
0.879	39.49	60.000	20.510
1.486	32.88	60.000	27.120
1.831	32.99	60.000	27.010
10	32.57	60.000	27.430
18.493	33.53	60.000	26.470
29.908	33.75	60.000	26.250

Test conclusion:

RESPECTED STANDARD

9. ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS

Temperature (°C) : 24

Humidity (%HR): 36

Date : March 15, 2018

Technician : T. LEDRESSEUR

Standard: FCC Part 15

Test procedure: Paragraph 15.215

Test set up:

Test realized in near field. All field strength measurements are correlated with the radiated maximum peak output power

Test operating condition of the equipment:

The equipment under test is blocked in alternation of emission and reception.

Power source: 120 Vac – 60 Hz through a variac

Percentage of voltage variation during the test (%):

± 1

Results:

Lower Band Edge: From 13.090 MHz to 13.110 MHz

Upper Band Edge: From 14.010 MHz to 14.030 MHz

Sample N° 1:

Fundamental frequency (MHz)	Field Strength Level of fundamental (dBμV/m)	Detector (Peak or Average)	Frequency of maximum Band-edges Emission (MHz)	Delta Marker (dB) (1)	Calculated Max Out-of-Band Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
13.56	44.17	Peak	13.0866375	-38.68	5.49	48.58	43.09
13.56	44.17	Peak	14.0317375	-38.67	5.5	48.58	43.08

(1) Marker-Delta method

band-edge curves are given in appendix 4.

Test conclusion:

RESPECTED STANDARD

10. OPERATION WITHIN THE BAND 13.110 – 14.010 MHZ**Temperature (°C) :** 21.8**Humidity (%HR):** 40.2**Date :** March 16, 2018**Technician :** T. LEDRESSEUR**Standard:** FCC Part 15**Test procedure:** paragraph 15.225 (a), (b), (c), (e)**Test set up:**

First an exploratory radiated measurement was performed. During this phase the product is oriented in two orthogonal planes.

Then the final measurement is realized with the product on the most critical orientation.

The system is tested in an open area test site (OATS). The EUT is placed on a rotating table, 0.8 m from a ground plane. Zero degree azimuth corresponds to the front of the equipment under test.

The frequency tolerance and the spectral mask between 13.010 MHz and 14.110 MHz measures are realized in near-field.

Detection mode: Quasi-peak ($F < 1$ GHz)**Bandwidth:** 9 kHz ($150 \text{ kHz} < F < 30\text{MHz}$)**Distance of antenna:** 10 meters**Antenna height:** 1 meter**Antenna polarization:** oriented in the vertical plane. The lowest point of the loop is 1m above ground level.**Equipment under test operating condition:**

The equipment under test is blocked in alternation of emission and reception mode.

A passive tag is used for the spectral mask

Power source: 120 Vac – 60 Hz through a variac**Percentage of voltage variation during the test (%):** ± 1

Results:

Sample N° 1:

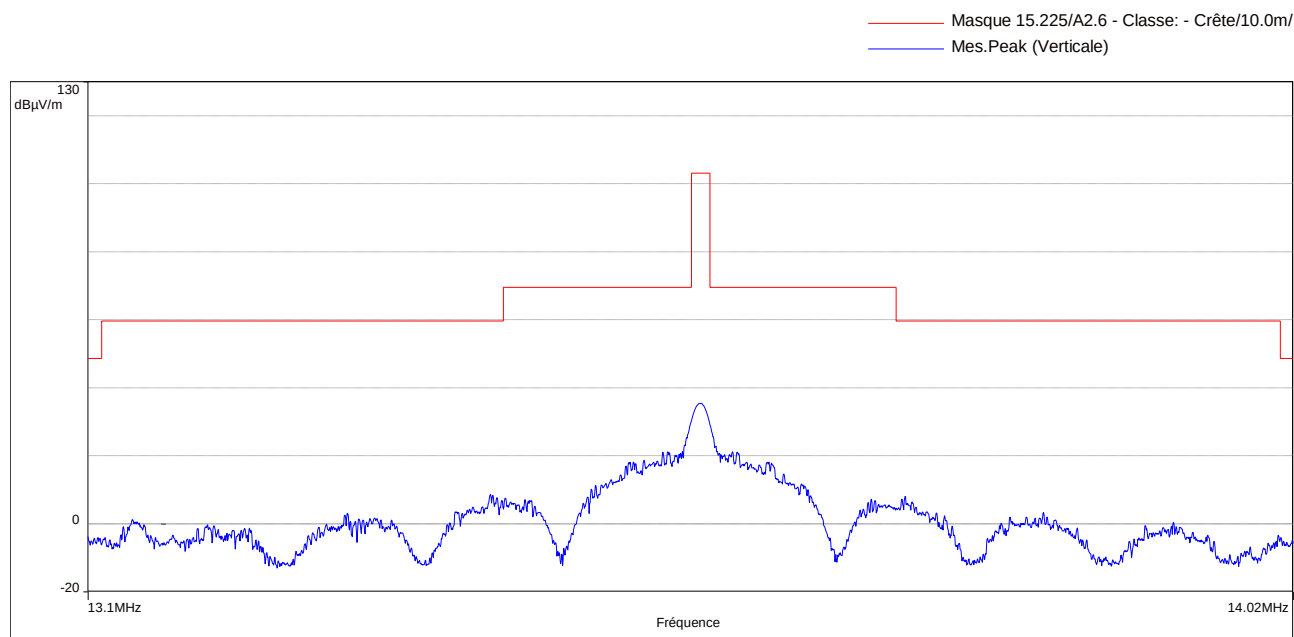
Carrier field strength

	Field strength (dB μ V/m) at frequency: 13.56 MHz
Normal test conditions measure at 10 m	44.17
Normal test conditions correlated at 30 m	25.09
Limits at 30m (dB μ V/m)	84
Margin (dB)	58.91

Polarization of test antenna: 45° at the equipment at 0 degree.

Position of equipment: see photos in "Test setup" document (azimuth: 240°)

Field strength within the band 13.110-14.010 MHz



Frequency stability

Results for temperature variation

Realized with a power source at 120 Vac – 60 Hz through a variac

Temperature (°C)	Mesure at startup		Measure at 2 min		Measure at 5 min		Measure at 10 min		Drift limit (kHz)
	Frequency measured (MHz)	Frequency drift (kHz)	Frequency measured (MHz)	Frequency drift (kHz)	Frequency measured (MHz)	Frequency drift (kHz)	Frequency measured (MHz)	Frequency drift (kHz)	
50	13.559638	-0.362	13.559627	-0.373	13.559624	-0.376	13.559623	-0.377	± 1.356 (a)
40	13.559636	-0.364	13.559625	-0.375	13.559624	-0.376	13.559624	-0.376	
30	13.559648	-0.352	13.559634	-0.366	13.559630	-0.37	13.559628	-0.372	
20	13.559668	-0.332	13.559648	-0.352	13.559643	-0.357	13.559642	-0.358	
10	13.559681	-0.319	13.559663	-0.337	13.559661	-0.339	13.559660	-0.34	
0	13.559717	-0.283	13.559706	-0.294	13.559701	-0.299	13.559697	-0.303	
-10	13.559710	-0.29	13.559722	-0.278	13.559721	-0.279	13.559718	-0.282	
-20	13.559677	-0.323	13.559714	-0.286	13.559719	-0.281	13.559722	-0.278	

(a) ±0.01% of the operating frequency

Results for power supply variation

Realized at +20 °C

Power supply (Vac)	Frequency measured (MHz)	Frequency drift (kHz)	Drift limit (kHz)
102	13.559632	-0.368	± 1.356 (a)
120	13.559668	-0.332	
138	13.559724	-0.276	

(a) ±0.01% of the operating frequency

Test conclusion:

RESPECTED STANDARD

11. FIELD STRENGTH OUTSIDE THE BAND 13.110-14.01 MHZ**Temperature (°C) :** 23**Humidity (%HR):** 35**Date :** March 15, 2018**Technician :** T. LEDRESSEUR**Standard:** FCC Part 15**Test procedure:** paragraph 209
paragraph 15.225 (d)**Test set up:**

First an exploratory radiated measurement was performed. During this phase the product is oriented in two orthogonal planes.

Then the final measurement is realized with the product on the most critical orientation.

The exploratory measurement is realized in anechoic chamber and the final measure is realized on open area test site.

When the system is tested in an open area test site (OATS), the EUT is placed on a rotating table, 0.8m from a ground plane.

When the system is tested in anechoic chamber, the EUT is placed on a rotating table, 1.65 m from a ground plane.

Zero degree azimuths correspond to the front of the device under test.

See photos in appendix 2.

Frequency range: From 9 kHz to 1GHz.**Detection mode:** Quasi-peak ($F < 1$ GHz)**Bandwidth:** 200Hz ($9 \text{ kHz} < F < 150\text{kHz}$)
9 kHz ($150 \text{ kHz} < F < 30\text{MHz}$)
120 kHz ($30 \text{ MHz} < F < 1 \text{ GHz}$)**Distance of antenna:** 10 meters (in open area test site) / 3 meters (in anechoic room)**Antenna height:** 1 to 4 meters (in open area test site) / 1.65 meter (in anechoic room)**Antenna polarization:** vertical and horizontal (only the highest level is recorded)**Equipment under test operating condition:**

The equipment under test is blocked in alternation of emission and reception mode

Power source: 120 Vac – 60 Hz through a variac**Percentage of voltage variation during the test (%):** ± 1

Results:
Sample N° 1:

Below 30 MHz

Frequencies (MHz)	Detector P QP Av	RBW (kHz)	Polarization (Parallel Perpendicular Horizontal)	Position of the product (b)	Field strength Measured at 10 m (dB μ V/m)	Field strength Computed at 30 m (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
27.12	QP	9	/	2	18 (a)	-1.09	29.5	30.59

(a) Noise floor

(b) see document test setup

Above 30 MHz

Frequencies (MHz)	Detector P QP Av	RBW (kHz)	Polarization H: Horizontal V: Vertical	Position of the product (a)	Field strength Measured at 10 m (dB μ V/m)	Field strength Computed at 3 m (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
37.786	P	100	V	2	28.98	38.58	40	1.42
40.37	P	100	V	1	29.97	39.57	40	0.43
52.355	QP	120	V	1	28.25	37.85	40	2.15
65.734	P	100	V	1	19.91	29.51	40	10.49
74.795	P	100	V	1	27.29	36.89	40	3.11
81.493	P	100	V	1	22.11	31.71	40	8.29
245.12	P	100	H	2	26.61	36.21	46	9.79
247.52	P	100	H	1	25.72	35.32	46	10.68
250	P	100	H	1	23.75	33.35	46	12.65
264	P	100	H	1	31.52	41.12	46	4.88
346.56	P	100	H	1	26.84	36.44	46	9.56
375.04	P	100	H	1	25.88	35.48	46	10.52
396	P	100	H	2	36.32	45.92	46	0.08
400	P	100	H	1	26.03	35.63	46	10.37
414.96	P	100	H	1	25.69	35.29	46	10.71
425.04	P	100	H	1	28.65	38.25	46	7.75
717.04	P	100	V	2	33.36	42.96	46	3.04

P= Peak, QP=Quasi-peak, Av=Average

(a) see document test setup

Not any harmonics has been observed

Applicable limits: for 9 kHz $\leq$ F $\leq$ 490 kHz : 2400/F(kHz) at 300 meters
for 490 kHz < F $\leq$ 1.705 MHz : 24000/F(kHz) at 30 meters
for 1.705 MHz < F $\leq$ 30 MHz : 29.5 dB μ V/m at 30 meters
for 30 MHz < F $\leq$ 88 MHz : 40 dB μ V/m at 3 meters
for 88 MHz < F $\leq$ 216 MHz : 43.5 dB μ V/m at 3 meters
for 216 MHz < F $\leq$ 960 MHz : 46 dB μ V/m at 3 meters
Above 960 MHz : 54 dB μ V/m at 3 meters

Test conclusion:

RESPECTED STANDARD

End of report, (4) appendixes to be forwarded

APPENDIX 1: Photos of the equipment under test





APPENDIX 2: Test equipment list

Conducted limits

TYPE	MANUFACTURER	EMITECH NUMBER
Outside room Hors cage	Emitech	8893
Test receiver ESI7	Rohde & Schwarz	8707
Absorber sheath current	Emitech	10523
High pass filter EZ-25	Rohde & Schwarz	11535
LISN ESH3-Z5	Rohde & Schwarz	8720
Cable N-5m	-	8590
Power source 1251RP	California instruments	8508
Multimeter IDM106N	ISOTECH	8676
Meteo station WS-9232	La Crosse Technology	8750
Software	GPIBShot V2.4	-

Additional provisions to the general radiated emission limitations

TYPE	MANUFACTURER	EMITECH NUMBER
Full anechoic chamber	EMITECH	10759
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Loop antenna 6502	EMCO	1406
Cable N-1m	SUCOFLEX	14302
Cable N-2m	SUCOFLEX	14303
Cable N-2.5m	SUCOFLEX	14304
Cable N-4m	SUCOFLEX	14305
Cable N-1.5m	-	9398
Power source 1251RP	California instruments	8508
Multimeter IDM106N	ISOTECH	8676
Meteo station WS-9232	La Crosse Technology	8750
Software	GPIBShot V2.4	-

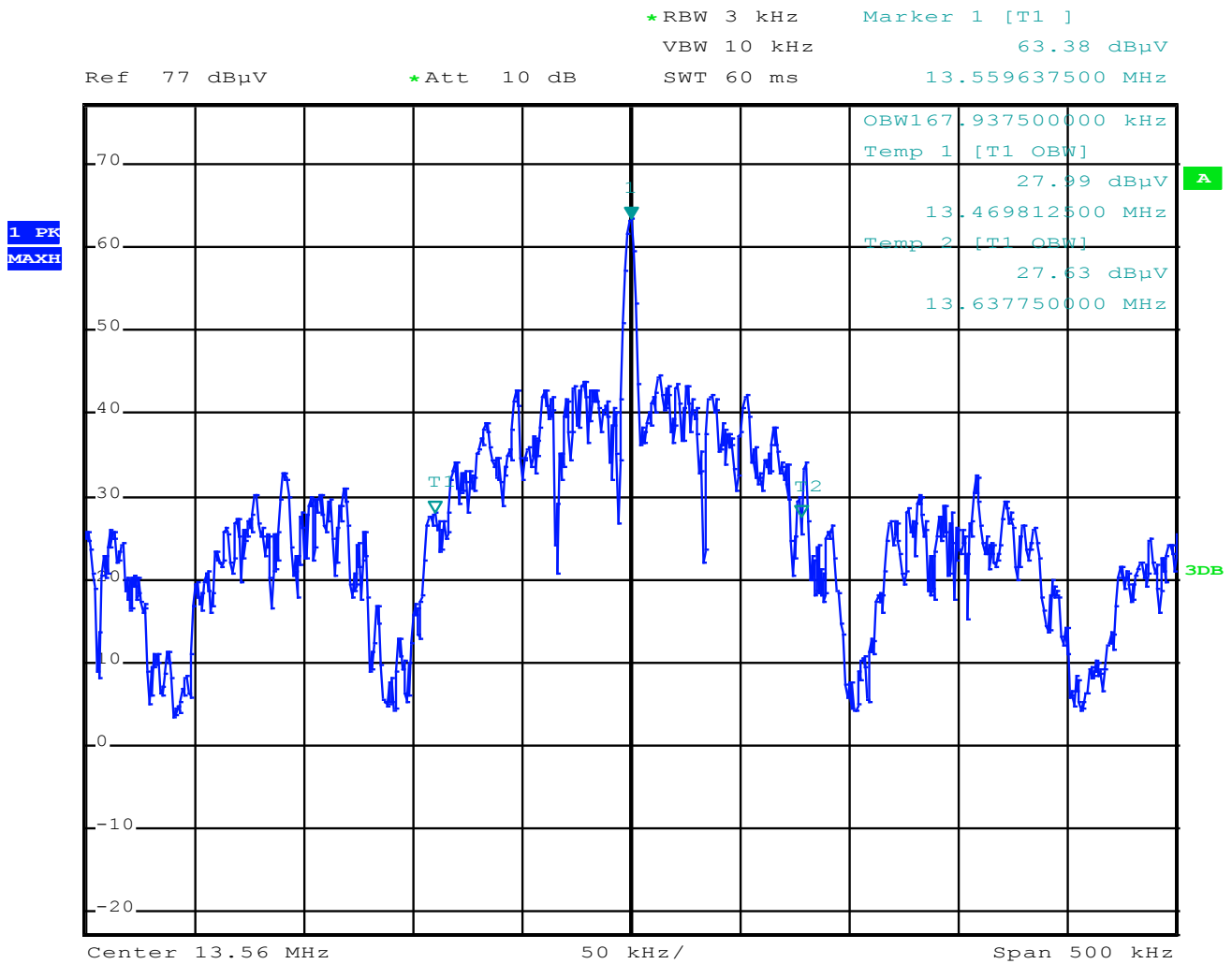
Operation within the band 13.110 – 14.010 MHz

TYPE	MANUFACTURER	EMITECH NUMBER
Open test site	EMITECH	8732
Full anechoic chamber	EMITECH	10759
Modulation analyzer HP 8901B	Hewlett Packard	1211
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Test receiver ESI7	Rohde & Schwarz	8707
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Loop antenna 6502	EMCO	1406
Cable N-1m	SUCOFLEX	14302
Cable N-2m	SUCOFLEX	14303
Cable N-2.5m	SUCOFLEX	14304
Cable N-4m	SUCOFLEX	14305
Cable N-1.5m	-	9398
Cable N-1m	-	8572
Cable N-10m	-	8578
Climatic chamber F0-100	MPC	7045
Power source 1251RP	California instruments	8508
Multimeter IDM106N	ISOTECH	8676
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.6.0.32	0000

Field strength outside the band 13.110-14.010 MHz

TYPE	MANUFACTURER	EMITECH NUMBER
Open test site	EMITECH	8732
Full anechoic chamber	EMITECH	10759
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Test receiver ESI7	Rohde & Schwarz	8707
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Loop antenna 6502	EMCO	1406
Cable N-1m	SUCOFLEX	14302
Cable N-2m	SUCOFLEX	14303
Cable N-2.5m	SUCOFLEX	14304
Cable N-4m	SUCOFLEX	14305
Cable N-1.5m	-	9398
Cable N-1m	-	8572
Cable N-10m	-	8578
Biconical antenna 3110	Emco	7240
Biconical antenna VHA 9103	Schwarzbeck	8528
Log periodic antenna HL223	Rohde & Schwarz	7190
Log periodic antenna 3147	EMCO	8783
Low-noise amplifier ZFL-1000LN	Mini-circuit	10730
Power source 1251RP	California instruments	8508
Multimeter IDM106N	ISOTECH	8676
Meteo station WS-9232	La Crosse Technology	8749
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.6.0.32	0000

APPENDIX 3: 99% bandwidth



APPENDIX 4: Band edge

