AT4 wireless, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
www.at4wireless.com · C.I.F. A29 507 456

FCC LISTED, REGISTRATION NUMBER: 720267

Informe de ensayo nº:
Test report No:

NIE: 51748RRF.001

Test report

USA FCC Part 15.247, 15.209

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.
Radiated emission limits; general requirements.

Identificación del objeto ensayado.....: Identification of item tested	Wireless sensor node for the Internet of Things
Marca .....: Trademark	Libelium
Modelo y/o referencia tipo .....: Model and /or type reference	Waspmote Plug & Sense! Sigfox US
Other identification of the product .....:	FCC ID: XKM-WPS-SFX-V1
Final HW version .....:	1.0
Final SW version .....:	1.0
Características .....: Features	Can communicate with Sigfox networks. USA version. Contains a TD1508 chipset.
Fabricante .....: Manufacturer	LIBELIUM COMUNICACIONES DISTRIBUIDAS SL C/ Escatrón 16 (Edificio Libelium), CP: 50014, Zaragoza (SPAIN)
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.247 10-1-15 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-15 Edition: Radiated emission limits; general requirements. Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r05 dated 04/08/2016. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Resultado.....: Summary	IN COMPLIANCE
Aprobado por (nombre / cargo y firma) .....: Approved by (name / position & signature)	A. Llamas RF Lab. Manager Firmado digitalmente por ALEJANDRO LLAMAS RODRIGUEZ Fecha: 2017.03.15 14:12:15 +01'00'
Fecha de realización .....: Date of issue	2017-03-15
Formato de informe No. .....: Report template No	FDT08_17

Index

Competences and guarantees

AT4 wireless is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

AT4 wireless is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjuction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

In order to assure the traceability to other national and international laboratories, AT4 wireless has a calibration and maintenance program for its measurement equipment.

AT4 wireless guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at AT4 wireless at the time of performance of the test.

AT4 wireless is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the AT4 wireless internal document PODT000.

Usage of samples

Samples undergoing test have been selected by: **the client**

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
51748/001	Sensor node with wireless communication	Waspmote Plug & Sense! Sigfox US	---	2016-11-23
51748/012	Antenna RF 900MHz	---	---	2016-11-24
51748/009	Power supply connector	---	---	2016-11-21
51748/008	Luminosity probe	Plug&Sense	---	2016-11-21

1. Sample S/01 has undergone following test(s).

   All radiated tests indicated in appendix A.

Test sample description

The test sample consists of a device that receives data from sensors and sends information with its wireless radio. It is battery powered and can be easily programmed.

Identification of the client

LIBELIUM COMUNICACIONES DISTRIBUIDAS SL

C/ Escatrón 16 (Edificio Libelium), CP: 50014, Zaragoza (SPAIN)

Testing period

The performed test started on 2016-12-01 and finished on 2016-12-15.

The tests have been performed at AT4 wireless.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

Remarks and comments

1: Test not requested. Only radiated radiated spurious emissions tests were requested.

2: Used instrumentation:

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	BiconicalLog antenna ETS LINDGREN 3142E	2014/03	2017/03
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
5.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2014/03	2017/03
6.	EMI Test Receiver R&S ESU 40	2016/03	2018/03
7.	Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
8.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2016/04	2017/04
9.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2016/02	2018/02

Testing verdicts

Not applicable ..... :	N/A
Pass ..... :	P
Fail ..... :	F
Not measured ..... :	N/M

FCC PART 15 PARAGRAPH		VERDICT			
		NA	**P**	**F**	**NM**
FCC 15.247 Subclause (a) (1)	20 dB Bandwidth and Carrier frequency separation				NM[1]
FCC 15.247 Subclause (a)(1)(iii)	Number of hopping channels				NM[1]
FCC 15.247 Subclause (a)(1)(iii)	Time of occupancy (Dwell Time)				NM[1]
FCC 15.247 Subclause (b)	Maximum peak output power and antenna gain				NM[1]
FCC 15.247 Subclause (d)	Emission limitations conducted (Transmitter)				NM[1]
FCC 15.247 Subclause (d)	Emission limitations radiated (Transmitter)		P		

1: see section “Remarks and Comments”.

Appendix A – Test result

INDEX

TEST CONDITIONS

$V_{nominal}$ = 6.0 Vdc

Type of antenna = External attachable antenna.

Temperature (ºC):

T_n = +15 to + 35

T_{min} = N/A

T_{max} = N/A

The subscript n indicates normal test conditions.

N/A: Not Applicable.

TEST FREQUENCIES:

Lowest channel: 902.2 MHz

Highest channel: 904.6 MHz

The Software of EUT was used to configure to transmit continuously at an output power of 23 dBm in all tested channels.

RADIATED MEASUREMENTS

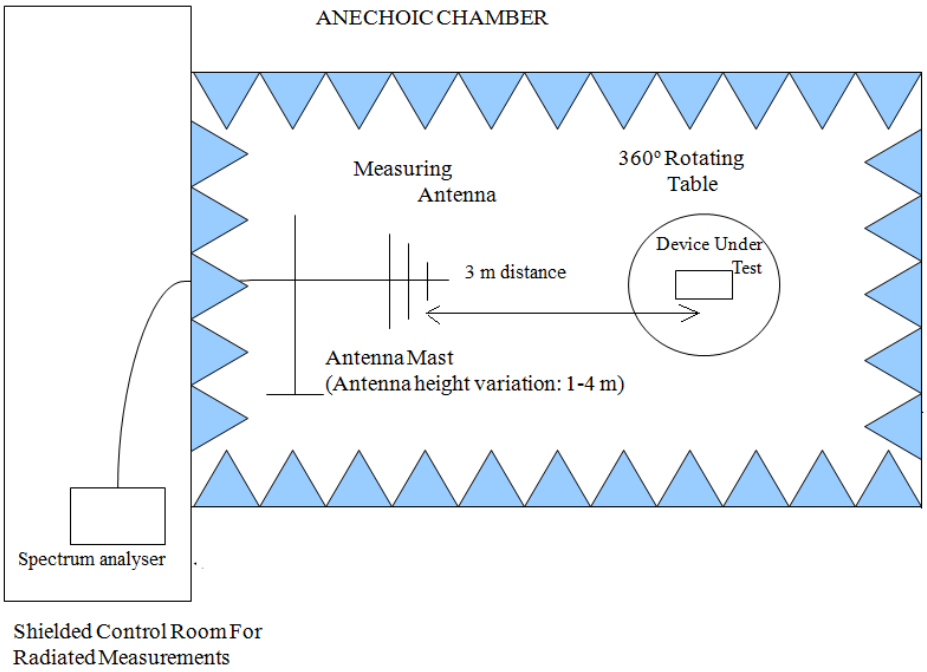
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-10 GHz (1 GHz-18 GHz Double ridge horn antenna).

For radiated emissions in the range 1 GHz-10 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

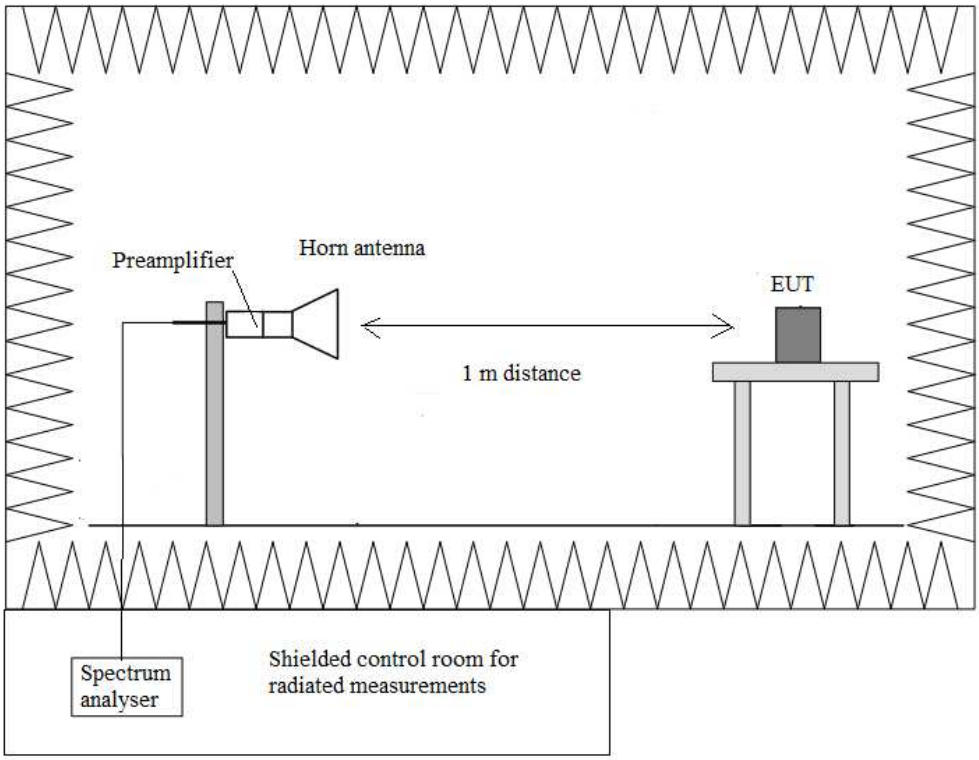
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



FCC Section 15.247 Subclause (d). Emission limitations radiated (Transmitter)

SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-10 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz-1000 MHz.

1. CHANNEL: LOWEST (902.2 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
187.625	V	Quasi-Peak	29.76	± 3.88
195.191	V	Quasi-Peak	29.01	± 3.88
207.801	V	Quasi-Peak	31.42	± 3.88
215.658	V	Quasi-Peak	30.21	± 3.88
229.044	H	Quasi-Peak	29.54	± 3.88
310.912	H	Quasi-Peak	29.98	± 3.88
876.034	V	Quasi-Peak	37.12	± 3.88
928.026	V	Quasi-Peak	35.62	± 3.88
952.955	V	Quasi-Peak	31.59	± 3.88

2. CHANNEL: HIGHEST (904.6 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
58.971	V	Quasi-Peak	30.62	± 3.88
147.467	H	Quasi-Peak	20.26	± 3.88
176.923	V	Quasi-Peak	23.75	± 3.88
191.667	V	Quasi-Peak	24.21	± 3.88
221.187	H	Quasi-Peak	23.79	± 3.88
250.675	H	Quasi-Peak	29.67	± 3.88
802.637	H	Quasi-Peak	29.46	± 3.88
853.724	V	Quasi-Peak	32.55	± 3.88

Frequency range 1 GHz-10 GHz

1. CHANNEL: LOWEST (902.2 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.80415 (*)	V	Peak	64.27	± 4.69
		AVG	63.84	± 4.69
2.40175	V	Peak	48.60	± 4.69
2.70595	V	Peak	53.33	± 4.69
3.60805	V	Peak	40.62	± 4.69
4.51015	V	Peak	40.60	± 4.69
5.41195	V	Peak	38.75	± 4.69
6.31405	V	Peak	44.66	± 4.69
7.21615	V	Peak	52.09	± 4.69

(*): This spurious frequency is outside the restricted bands as defined in §15.205(a). The measured maximum carrier level at 3 m was 120.12 dBµV/m (Peak) so the spurious level is more than 30 dB below the carrier level.

2. CHANNEL: HIGHEST (904.6 MHz).

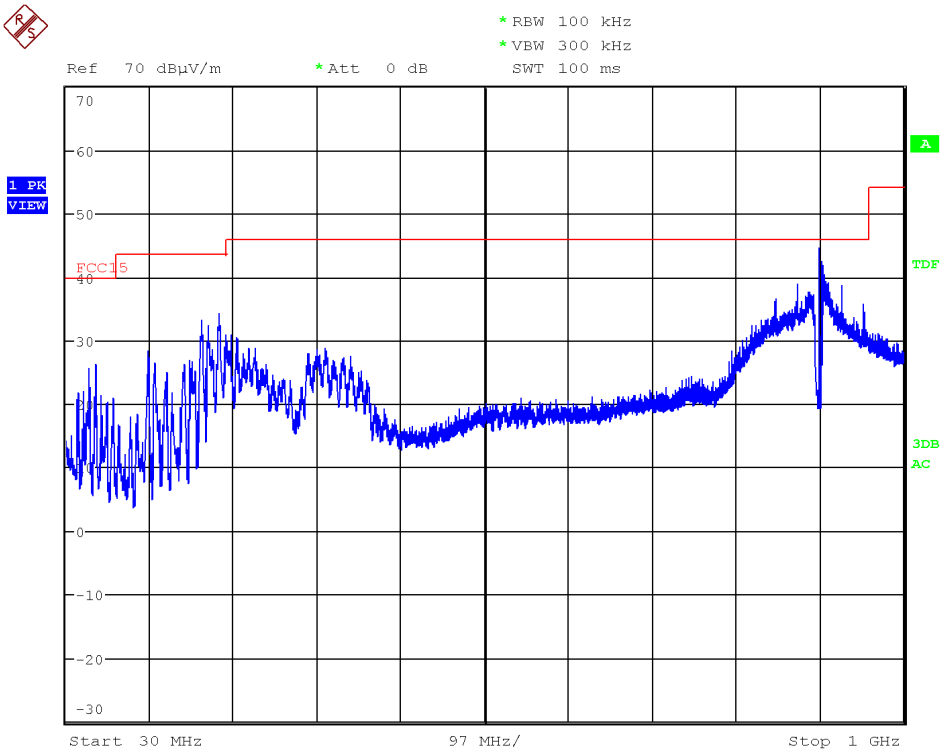
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
1.80925 (*)	H	Peak	60.69	± 4.69
		AVG	60.47	± 4.69
2.71375	V	Peak	53.64	± 4.69
3.61825	V	Peak	41.48	± 4.69
6.33235	V	Peak	42.03	± 4.69
7.23685	V	Peak	47.44	± 4.69

(*): This spurious frequency is outside the restricted bands as defined in §15.205(a). The measured maximum carrier level at 3 m was 120.96 dBµV/m (Peak) so the spurious level is more than 30 dB below the carrier level.

Verdict: PASS

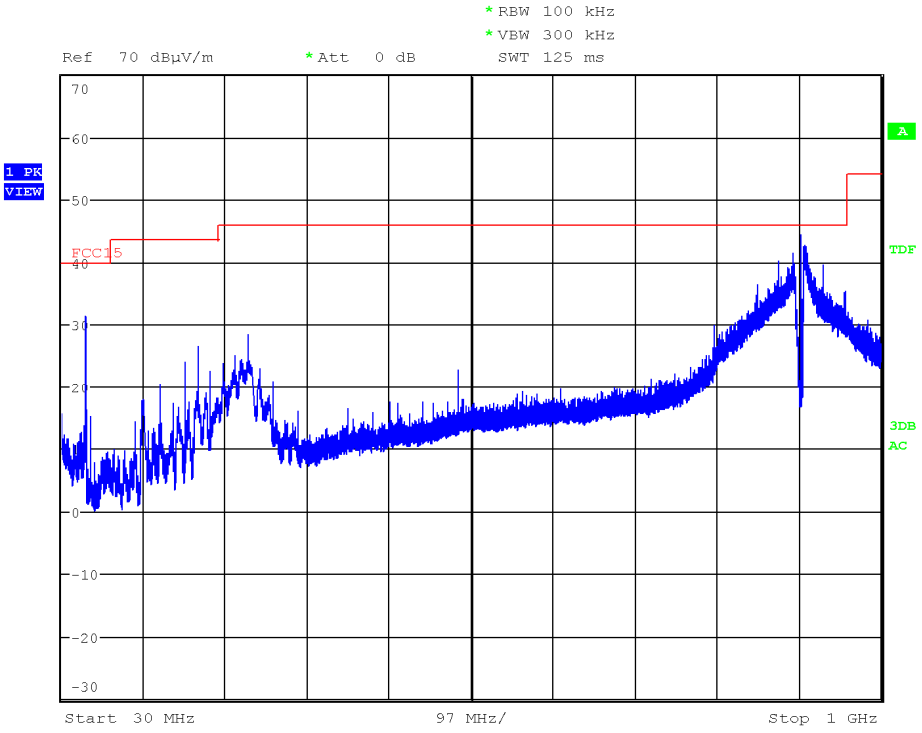
FREQUENCY RANGE 30 MHz-1000 MHz.

CHANNEL: Lowest (902.2 MHz).



Note: The carrier was attenuated using a Notch filter.

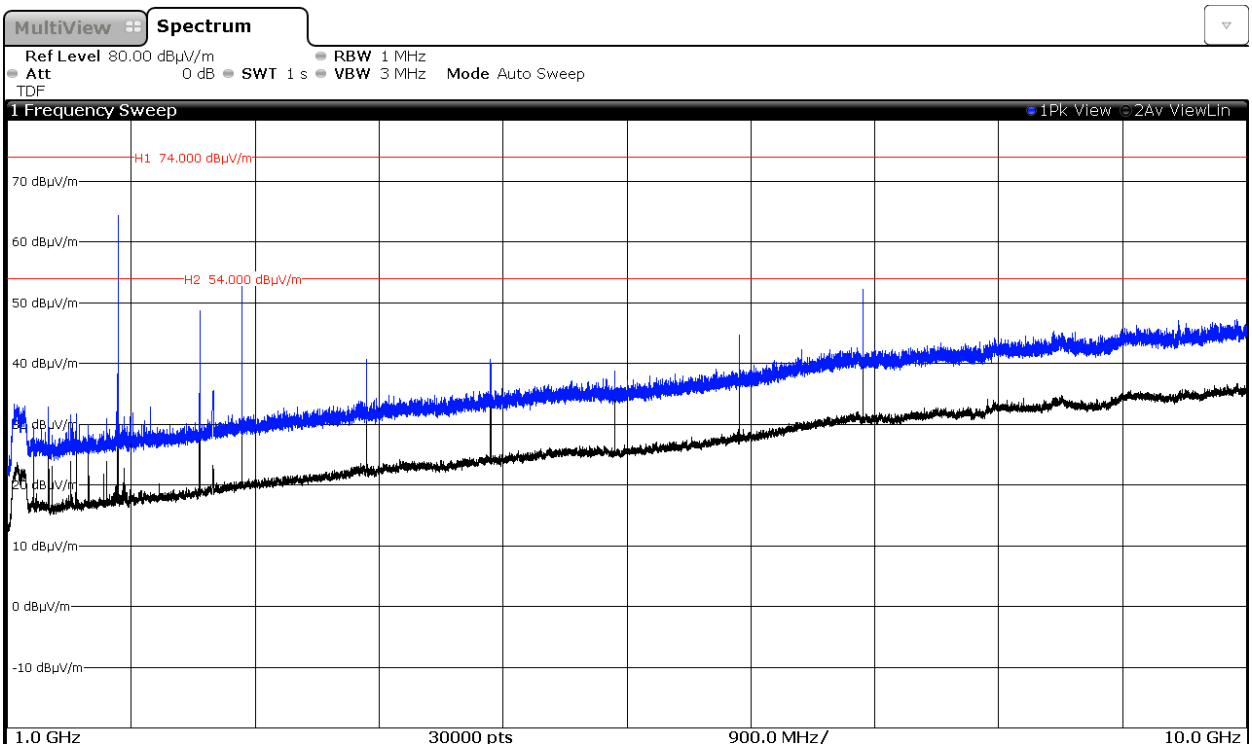
CHANNEL: Highest (904.6 MHz).



Note: The carrier was attenuated using a Notch filter.

FREQUENCY RANGE 1 GHz to 10 GHz.

CHANNEL: Lowest (902.2 MHz).



CHANNEL: Highest (904.6 MHz).