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

Test report No:

NIE: 48668REM.006A1

Test report (Modification 1)

FCC Rules and Regulations 47 CFR Chapter I Part 15 Subpart B (10-01-13 Edition); ICES-003 ISSUE 5 (2012)

Identification of item tested:	Multiprotocol router for the Internet of Things
Trademark:	Libelium
Model and/or type reference:	Meshlium 4G 802.15.4 AP 900 US
Other identification of the product:	S/N: Prototype
Final HW version:	1.0
Final SW version:	1.0
FCC ID:	Libelium's product FCC ID: XKM-MESHLIUM-V1 Chipsets FCC ID: RI7LE910NA, OUR-XBEEPRO, MCQ-XB900HP and TK4WLE600VX
IC:	Libelium's product IC: 8472A-MESHLIUMV1 Chipsets IC: 5131A-LE910NA, 4214A-XBEEPRO and 1846A-XB900HP.
IMEI TAC:	35894205
Features:	Can communicate with 2G, 3G and 4G/LTE networks. Also equipped with a short-range 802.15.4 module (2.4 GHz ISM band), a long-range RF 900 radio (900 MHz ISM band) and a 802.11a/b/g/n/ac module (2.4 GHz ISM bands). Includes a GNSS (A-GPS) receiver. USA and Canada version, AT&T. Includes 2 cellular antennas for diversity gain. Contains these radios: WLE600VX, XBee-PRO 802.15.4, LE910 NAG and XBee-PRO 900HP.
Manufacturer:	LIBELIUM COMUNICACIONES DISTRIBUIDAS, S.L. C/ Escatrón 16 (Edificio Libelium). 50014. Zaragoza. Spain.
Test method requested, standard:	FCC Rules and Regulations 47 CFR Chapter I Part 15 Subpart B (10-01-13 Edition); ICES-003 ISSUE 5 (2012)
Summary:	IN COMPLIANCE
Approved by (name / position & signature):	Francisco Cañas Regulatory Lab Director FRANCISCO CAÑAS ESCRIBANO 2016.11.15 09:04:48 +01'00'
Date of issue:	2016-11-10
Report template No.:	FDT11_18

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.

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 under test have been selected by: the Client.

Sample S/03 is composed of the following elements:

Control Nº	Description	Model	Serial number	Reception date
48668/010	Multiprotocol router for the Internet of Things	Meshlium 4G 802.15.4 AP 900 US	---	2016-06-06
48668/017	AC/DC Adapter	---	---	2016-06-06
48668/022	POE Inyector	---	---	2016-06-06
48668/025	RS232 Cable	---	---	2016-06-06
48668/027	RS232 Cable	---	---	2016-06-06
48668/033	Ethernet cable	---	---	2016-06-06
48668/041	2,4 GHz Antenna	---	---	2016-06-06
48668/046	2,4 GHz Antenna	---	---	2016-06-06
48668/051	900 MHz Antenna	---	---	2016-06-06
48668/054	4G GPS Antenna	---	---	2016-06-06
48668/055	4G GPS Antenna	---	---	2016-06-06
48668/066	4G GPS Antenna	---	---	2016-06-06

Modifications on sample S/03:
A ferrite 742 712 22 WÜRTH is installed in the POE DC cable with two turns.
A ferrite 742 712 22 WÜRTH is installed in the POE Ethernet cable with two turns close to the equipment. The maintenance LAN cable is removed.
The internal Ethernet cable is replaced by a shielded one.

Auxiliary PC for Operation Mode 03: Dell Latitude E6440 (CTC-1230-D)

Test sample description

This device is the central node of a Waspmote Plug & Sense! network. It gathers all the data and sends it to the cloud. Meshlium can be deployed outdoors and is quickly configured with its graphic interface.

Identification of the client

LIBELIUM COMUNICACIONES DISTRIBUIDAS, S.L.
C/ Escatrón 16 (Edificio Libelium). 50014. Zaragoza. Spain.

Testing period

The performed test started on 2016-06-07 and finished on 2016-06-09.

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. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the semianechoic chamber (21 meters x 11 meters x 8 meters), the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 60 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Modifications to the reference test report

The following modifications in respect to the test report number 48668REM.006 were included in the next clauses and sub-clauses:

- The Operation Mode 03 defined as “programming mode connected to an auxiliary PC” is included in the report. The measurement results for this mode are added.

This modification test report cancels and replaces the test report 48668REM.006.

Remarks and comments

The tests have been performed by the technical personnel: Eduardo del Nogal & Daniel López.

The total uncertainty of the measurement system for the measured radio disturbance characteristics of EUT from 30 MHz to 1000 MHz is I = ± 4,9 dB for quasi-peak measurements, I = ± 4,6 dB for peak measurements (k = 2)

The total uncertainty of the measurement system for the measured radio disturbance characteristics of EUT from 1000 MHz to 26GHz is I = ± 2,6 dB for peaks and average measurements (k = 2)

Testing verdicts (Legend)

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

List of equipment used during the test					
CONTROL NUMBER	**DESCRIPTION**	**MANUFACTURER**	**MODEL**	**LAST CALIBRATION**	**NEXT CALIBRATION**
1999	EMI Receptor	ROHDE & SCHWARZ	ESIB 26	2015-06-16	2017-06-16
2932	Bilog Hybrid Antenna	SUNOL	JB6	2014-05-11	2017-05-11
4612	Horn Antenna	SCHWARZBECK MESS- ELEKTRONIK	BBHA 9120D	2013-12-29	2016-12-29
4658	RF Amplifier	SCHWARZBECK	BBV9743	2015-03-19	2016-03-19
4662	Transient limiter	SCHWARZBECK	VTSD 9561-D	2014-02-12	2016-02-12
4659	RF Amplifier	SCHWARZBECK	BBV 9718	2015-09-29	2016-09-29
4729	RF Amplifier	BONN ELEKTRONIK	BLMA 1840-1M	2015-12-02	2017-12-02
3545	Temperature and humidity probe	PICO TECHNOLOGY	HUMIDIPROBE	2015-03-04	2016-03-04
3556	Digital termohigrometer	T&D	TR-72W	2015-04-16	2016-04-16
4657	Horn Antenna	SCHWARZBECK	BBHA 9170	2014-03-28	2017-03-28
0224	Artificial network	ROHDE & SCHWARZ	ESH2-Z5	2015-02-06	2017-02-06

Appendix A – Test result

CONTENT

DESCRIPTION OF THE OPERATION MODES

The operation modes described in this paragraph constitute a functionality of the sample under test for itself. Every operation mode takes a failure criteria for the immunity test that they were applying to it and a monitoring to guarantee performance of the same ones.

The operation modes used by the samples to which the present report refers, are shown in the following table:

OPERATION MODE	DESCRIPTION
OM#01	EUT ON. IDLE LTE Band 2. WiFi in IDLE mode. RF 900MHz in IDLE mode. RF 2.4GHz in IDLE mode. GPS ON. Power supply: 115Vac + POE (Worst case)
OM#02	EUT ON. TCH LTE Band 2. WiFi in Tx mode. RF 900MHz in TX mode. RF 2.4GHz in Tx mode. GPS ON. Power supply: 115Vac + POE (Worst case)
OM#03	EUT ON. Equipment in programming mode connected by serial cable to an auxiliary PC and USB port with a Pendrive. Power supply: 115Vac.

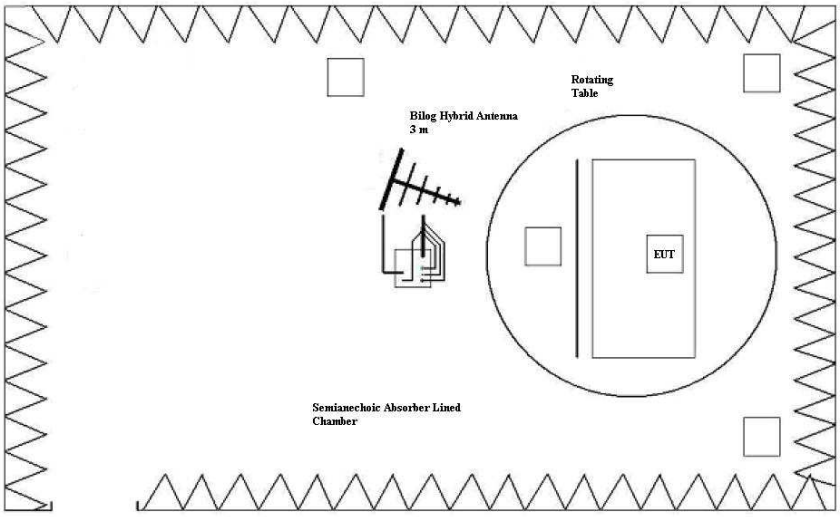
RADIATED EMISSION. ELECTROMAGNETIC FIELD MEASURE

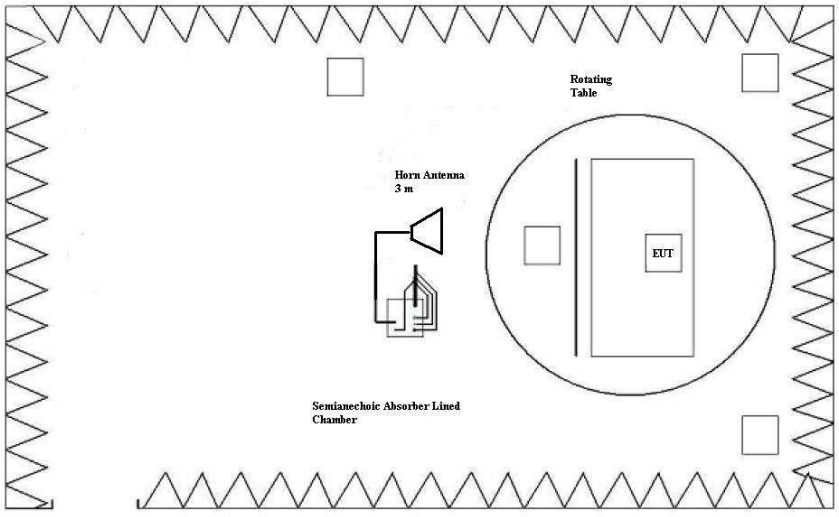
LIMITS:	Product standard:	FCC RULES AND REGULATIONS 47 CFR PART 15, SUBPART B (10-01-13 Edition); ICES-003 ISSUE 5 (2012)
	Test standard:	FCC RULES AND REGULATIONS 47 CFR PART 15, SUBPART B (10-01-13 Edition); ICES-003 ISSUE 5 (2012)

Limits of interference Class B

The applied limit for radiated emissions, 3 m distance, according with the requirements of FCC Rules and Regulations 47 CFR Part 15.109, Subpart B (10-01-13 Edition); ICES-003 ISSUE 5 (2012) & ANSI C63.4-2009 in the frequency range 30 MHz to 26 GHz, for Class B equipment, which is a transmitter in a band over 500 MHz, was:

Frequency range (MHz)	QP Limit for 3 m (µV/m)	QP Limit for 3 m (dBµV/m)
30 to 88	100	40
88 to 216	150	43.52
216 to 960	200	46.02
Above 960	500	53.98
Above 1000	Limit for 3m AVG	Limit for 3m PK
	53.98 dBµV/m	73.98 dBµV/m





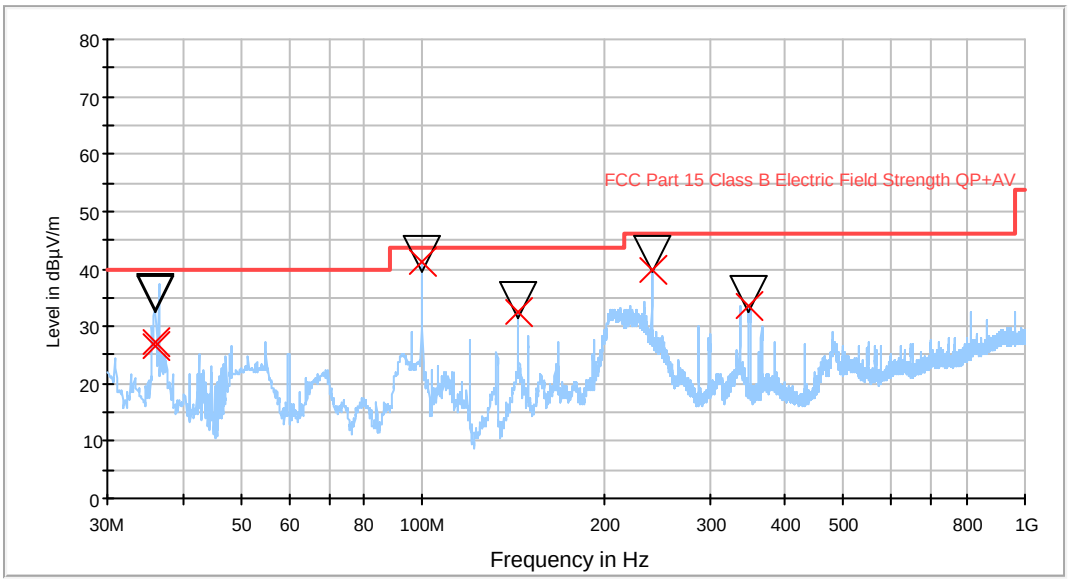
TESTED SAMPLES:	S/03
TESTED OPERATION MODES:	OM#01 & OM#03
TEST RESULTS:	CRmmnnRRPP: CR, Radiation Condition; mm: Sample number; nn: Operation mode; RR: Range; PP: Polarization.

CRmmnnRRPP	Description	Result
CR0301LR	Range: 30 MHz - 1000 MHz.	P
CR0301HR1_PH	Range: 1 GHz - 18 GHz. Horizontal Polarization.	P
CR0301HR1_PV	Range: 1 GHz - 18 GHz. Vertical Polarization.	P
CR0301HR2_PH	Range: 18 GHz - 26 GHz. Horizontal Polarization.	P
CR0301HR2_PV	Range: 18 GHz - 26 GHz. Vertical Polarization.	P
CR0303	The programming mode (03) is previewed and compared with normal mode (01). It is checked that the normal operation mode is the worst case, so the final measurements are performed on operation mode 01.	P

Radiated Emission. CR0301LR

Project:	48668REM.006
Company:	LIBELIUM
Sample:	S/03
Operation mode:	OM#01
Description:	EUT ON. Idle LTE Band 2. Idle WIFI. Idle RF 900MHz. Idle RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case)

FCC class B



FCC Part 15 Class B Electric Field Strength QP+AV
MaxPeak
Preview Result 1-PK+
QuasiPeak

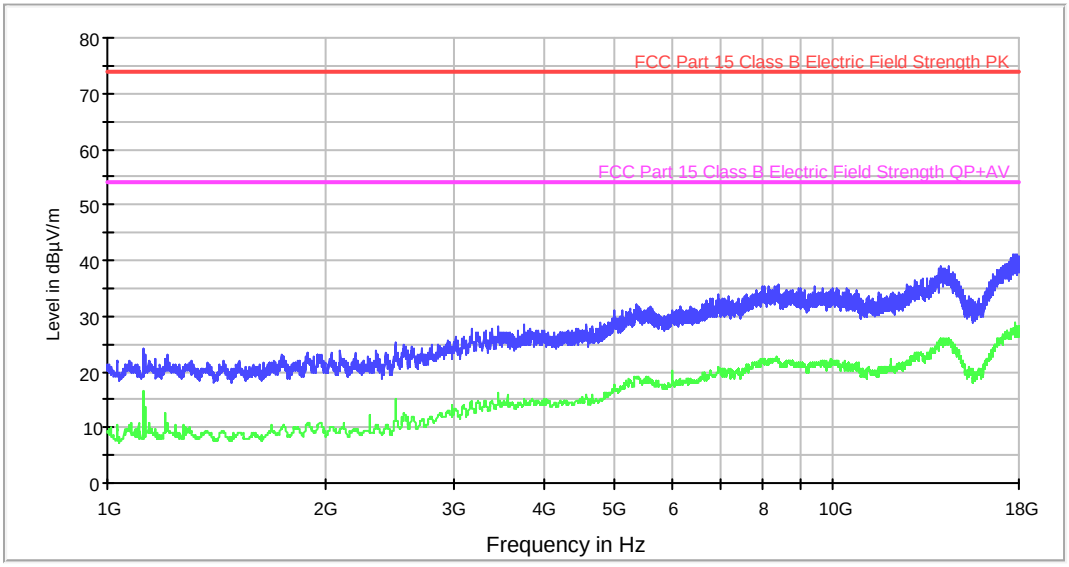
Maximizations

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)
36.003006	36.0	27.2	15000.0	120.000	98.0	V	326.0
36.008016	35.8	26.7	15000.0	120.000	98.0	V	-3.0
99.666934	42.7	41.4	15000.0	120.000	341.0	H	347.0
143.976954	34.7	32.5	15000.0	120.000	192.0	H	52.0
239.954910	42.5	39.8	15000.0	120.000	121.0	H	41.0
348.774950	35.5	33.4	15000.0	120.000	124.0	V	346.0

Radiated Emission. CR0301HR1_PH

Project:	48668REM.006
Company:	LIBELIUM
Sample:	S/03
Operation mode:	OM#01
Description:	EUT ON. Idle LTE Band 2. Idle WIFI. Idle RF 900MHz. Idle RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case) Horizontal Polarization

FCC 1-18GHz class B



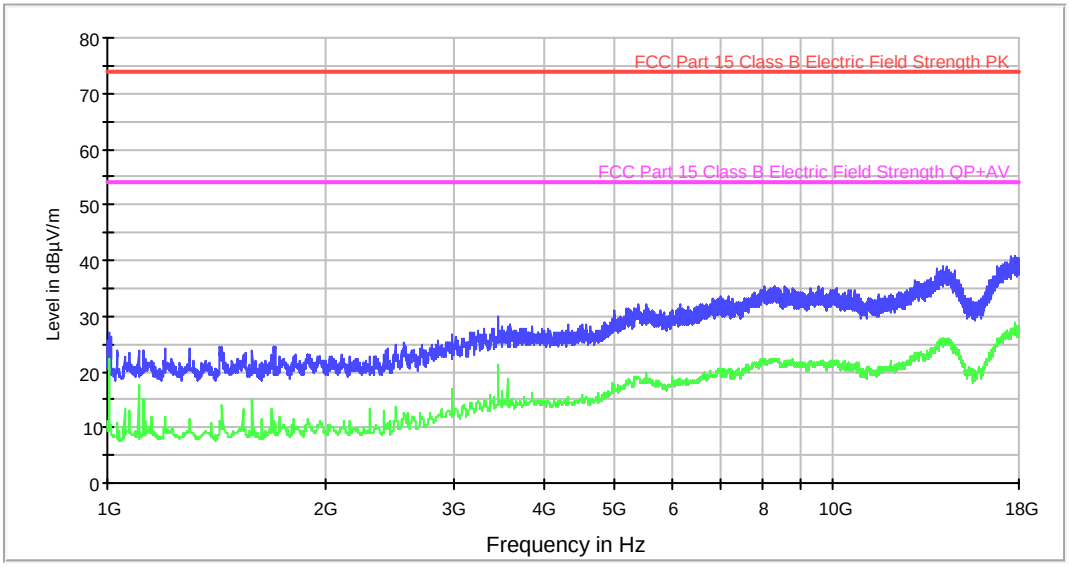
Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV/m)	Average-ClearWrite (dBµV/m)
1120.000000	24.2	16.6
1742.000000	22.9	10.2
2096.000000	23.8	9.6
3177.000000	27.9	14.1
3757.000000	28.6	14.8
5350.000000	32.0	18.8
6961.000000	34.0	20.7
8389.000000	35.7	22.2
13427.000000	36.7	23.5
17907.000000	41.1	27.5

Radiated Emission. CR0301RA1_PV

Project:	48668REM.006
Company:	LIBELIUM
Sample:	S/03
Operation mode:	OM#01
Description:	EUT ON. Idle LTE Band 2. Idle WIFI. Idle RF 900MHz. Idle RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case) Vertical Polarization

FCC 1-18GHz class B



MaxPeak-ClearWrite-PK+
FCC Part 15 Class B Electric Field Strength PK
Average-ClearWrite-AVG
FCC Part 15 Class B Electric Field Strength QP+AV

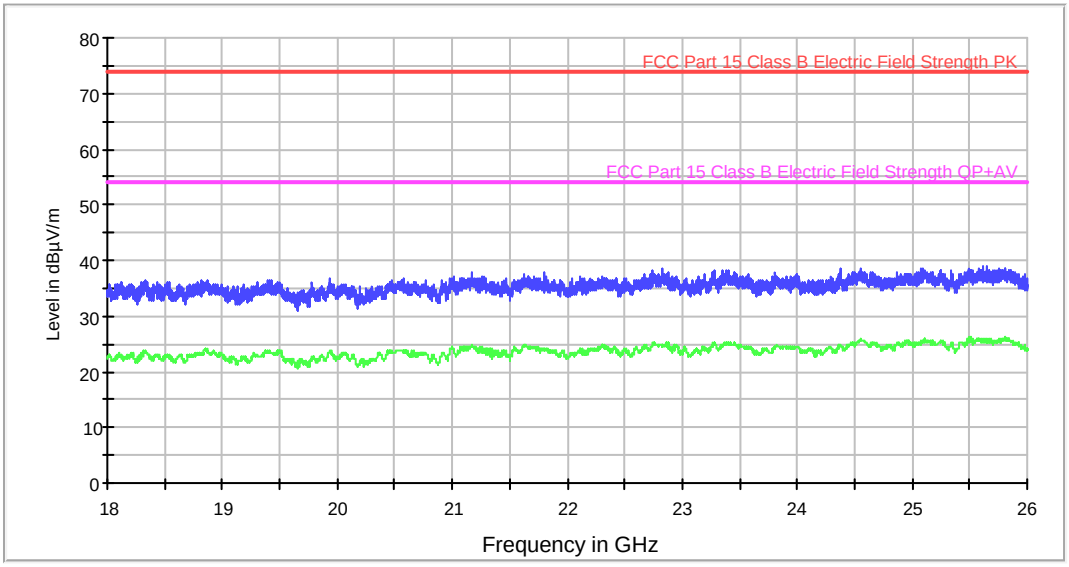
Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV/m)	Average-ClearWrite (dBµV/m)
1008.000000	27.1	22.3
1431.000000	24.6	11.2
1884.000000	23.0	10.5
3165.000000	27.2	14.3
3456.000000	29.8	21.1
5375.000000	32.1	19.2
7175.000000	33.5	20.0
8015.000000	35.4	22.0
12923.000000	36.6	23.0
17750.000000	40.8	28.4

Radiated Emission. CR0301HR2_PH

Project:	48668REM.006
Company:	LIBELIUM
Sample:	S/03
Operation mode:	OM#01
Description:	EUT ON. Idle LTE Band 2. Idle WIFI. Idle RF 900MHz. Idle RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case) Horizontal Polarization

FCC 18-26GHz class B



MaxPeak-ClearWrite-PK+
FCC Part 15 Class B Electric Field Strength PK
Average-ClearWrite-AVG
FCC Part 15 Class B Electric Field Strength QP+AV

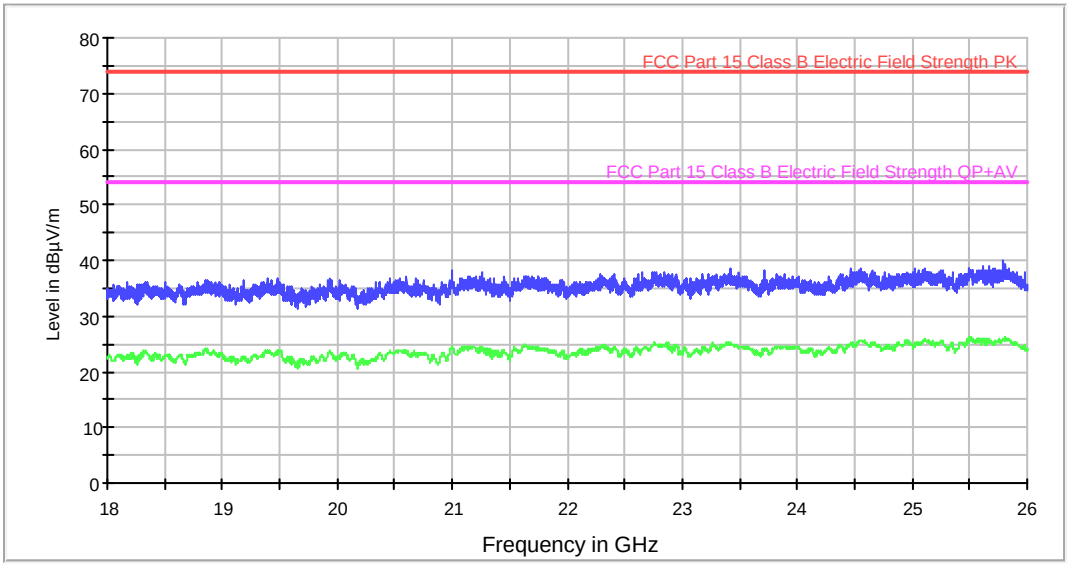
Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV/m)	Average-ClearWrite (dBµV/m)
18327.000000	36.3	23.7
18820.000000	36.5	23.0
19934.000000	36.7	23.5
20575.000000	36.9	23.8
21178.000000	37.9	24.7
21801.000000	37.7	24.2
22825.000000	38.4	24.6
23400.000000	38.3	25.2
24561.000000	38.7	25.6
25649.000000	38.8	25.8

Radiated Emission. CR0301HR2_PV

Project:	48668REM.006
Company:	LIBELIUM
Sample:	S/03
Operation mode:	OM#01
Description:	EUT ON. Idle LTE Band 2. Idle WIFI. Idle RF 900MHz. Idle RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case) Vertical Polarization

FCC 18-26GHz class B



MaxPeak-ClearWrite-PK+
FCC Part 15 Class B Electric Field Strength PK
Average-ClearWrite-AVG
FCC Part 15 Class B Electric Field Strength QP+AV

Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV/m)	Average-ClearWrite (dBµV/m)
18343.000000	36.1	23.5
18847.000000	36.4	24.1
19487.000000	36.7	23.2
20605.000000	37.2	23.6
20997.000000	38.1	24.3
22294.000000	37.6	24.4
22658.000000	37.9	24.1
23418.000000	38.6	25.0
24464.000000	38.7	25.0
25799.000000	39.9	25.9

CONTINUOUS CONDUCTED EMISSION

LIMITS:	Product standard :	FCC RULES AND REGULATIONS 47 CFR PART 15, SUBPART B (10-01-13 Edition); ICES-003 ISSUE 5 (2012)
	Test standard :	FCC RULES AND REGULATIONS 47 CFR PART 15, SUBPART B (10-01-13 Edition); ICES-003 ISSUE 5 (2012)

CLASS B

The applied limit for continuous conducted emissions in power leads, according with the requirements of FCC Rules and Regulations 47 CFR Part 15, Subpart B (10-01-15 Edition), Secs. 15.107, 15.109 and Subpart C (10-1-15 Edition) Secs. 15.207 & ICES-003 Issue 6 (2016), in the frequency range 0,15 to 30 MHz, for Class B equipment was:

Frequency range (MHz)	**Limit (dBµV)**	
	Quasi-peak	**Average**
0,15 to 0,5	66-56	56-46
0,5 to 5	56	46
5 to 30	60	50

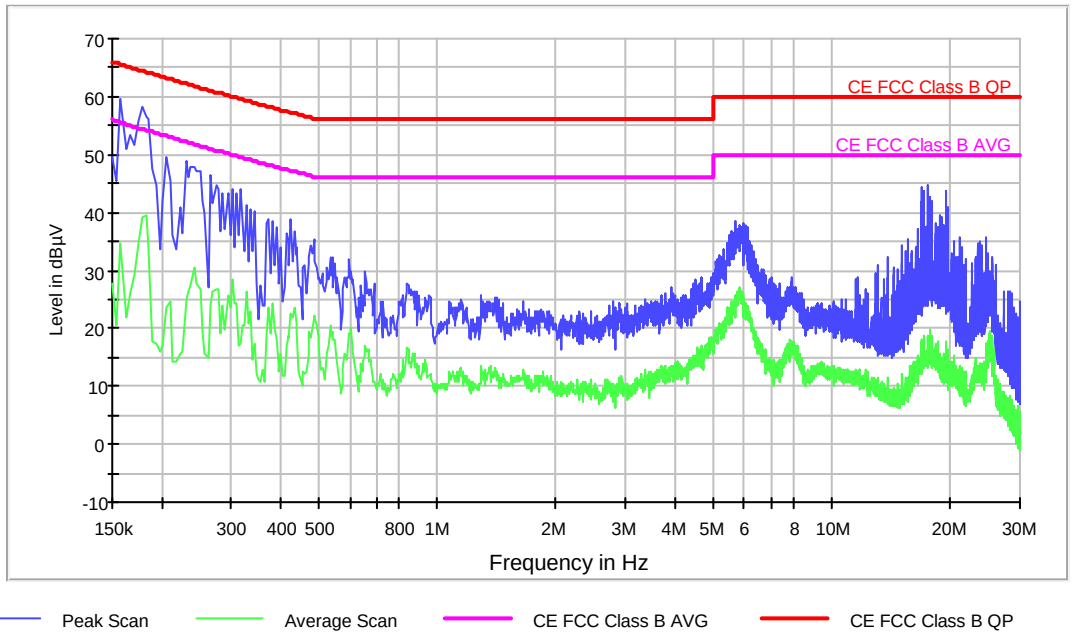
TESTED SAMPLES:	S/03
TESTED OPERATION MODES:	OM#01 & 02 & 03
TEST RESULTS :	CCmmnnhh: CC, Conducted Condition; mm: Sample number; nn: Operation mode; hh: wire

CCmmnnhh	**Description**	**Result**
CC03010N	Neutral wire noise.	P
CC0301L1	Phase wire noise.	P
CC03020N	Neutral wire noise.	P
CC0302L1	Phase wire noise.	P
CC0303	The programming mode (03) is previewed and compared with normal modes (01 and 02). It is checked that the working operation mode is the worst case, so the final measurements are performed on operation modes 01 and 02.	P

Conducted Emission. CC03010N

Project:	48668REM.006
Company:	Libelium
Sample:	S/03
Operation mode:	OM#01
Description:	EUT ON. Idle LTE Band 2. Idle WIFI. Idle RF 900MHz. Idle RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case). Neutral wire noise.

EC FCC Class B



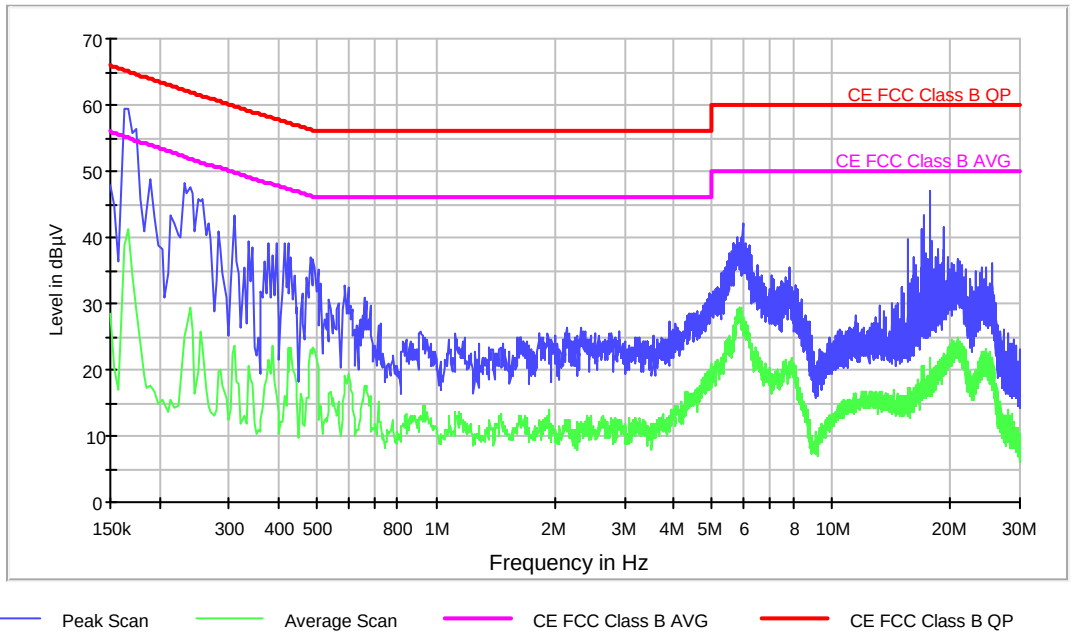
Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV)	Average-ClearWrite (dBµV)
0.158000	59.6	34.7
0.266000	46.6	24.0
0.434000	36.9	23.6
0.842000	27.7	16.5
1.290000	25.6	12.3
3.370000	24.8	12.0
5.726000	38.5	25.2
6.122000	36.0	23.5
17.586000	44.6	18.8
19.358000	43.8	17.6

Conducted Emission. CC0301L1

Project:	48668REM.006
Company:	Libelium
Sample:	S/03
Operation mode:	OM#01
Description:	EUT ON. Idle LTE Band 2. Idle WIFI. Idle RF 900MHz. Idle RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case). Phase wire noise.

EC FCC Class B



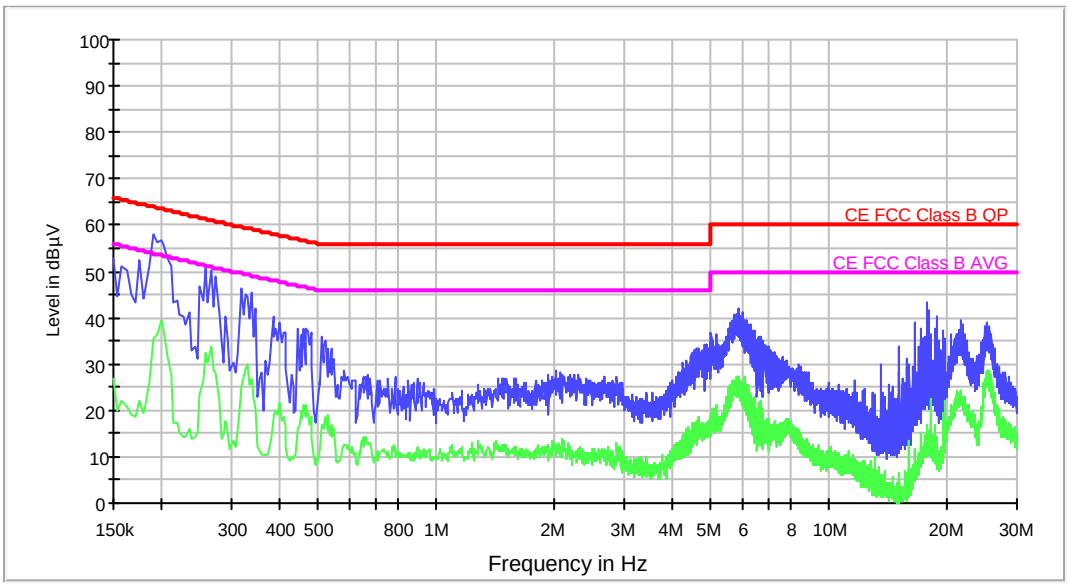
Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV)	Average-ClearWrite (dBµV)
0.162000	59.4	38.8
0.258000	45.8	23.3
0.482000	36.9	22.9
0.914000	25.9	13.1
1.822000	25.6	11.5
2.134000	26.3	12.4
5.962000	42.2	27.4
6.190000	38.8	25.0
17.102000	43.4	20.7
17.830000	47.0	21.9

Conducted Emission. CC03020N

Project:	48668REM.006
Company:	Libelium
Sample:	S/03
Operation mode:	OM#02
Description:	EUT ON. TCH LTE Band 2. TX WIFI. TX RF 900MHz. TX RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case). Neutral wire noise.

EC FCC Class B



Peak Scan Average Scan CE FCC Class B AVG CE FCC Class B QP

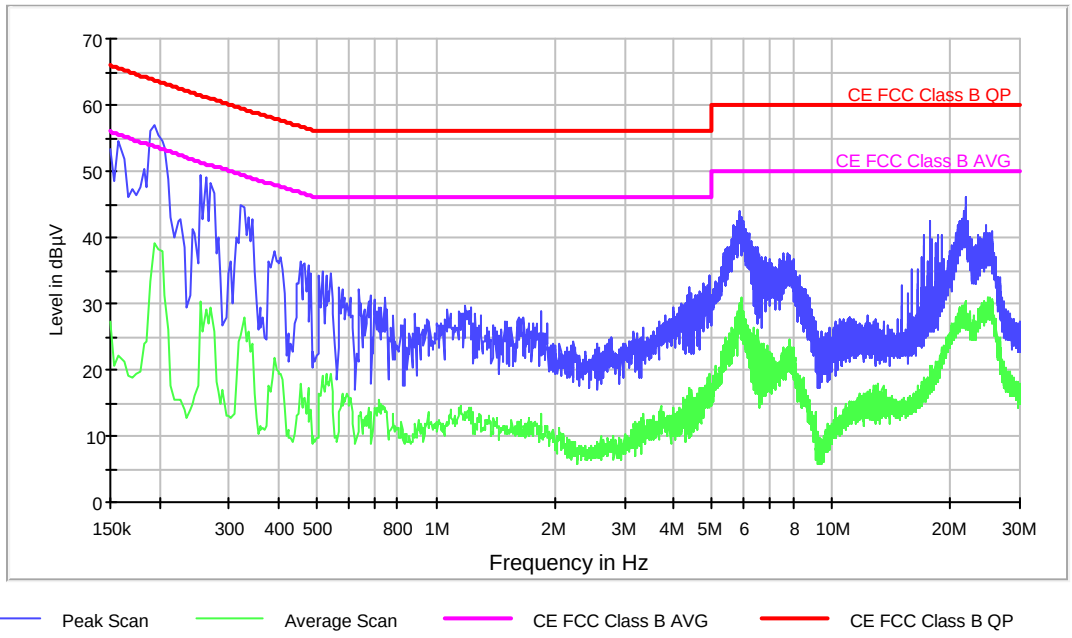
Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV)	Average-ClearWrite (dBµV)
0.190000	58.1	35.3
0.258000	50.7	32.5
0.458000	37.7	21.4
0.782000	27.4	11.8
2.006000	28.5	11.2
2.290000	27.8	11.7
5.878000	42.0	25.6
6.122000	39.2	25.5
16.550000	39.0	11.5
17.774000	43.2	16.8

Conducted Emission. CC0302L1

Project:	48668REM.006
Company:	Libelium
Sample:	S/03
Operation mode:	OM#02
Description:	EUT ON. TCH LTE Band 2. TX WIFI. TX RF 900MHz. TX RF 2.4GHz. GPS ON. Power supply: 115Vac + POE (Worst case). Phase wire noise.

EC FCC Class B



Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV)	Average-ClearWrite (dBµV)
0.194000	57.0	39.1
0.262000	49.1	29.1
0.454000	36.3	17.8
0.746000	30.8	14.0
1.846000	28.8	13.4
3.354000	26.2	13.4
5.858000	44.0	29.3
6.158000	40.6	24.1
17.218000	40.2	18.9
21.770000	46.0	30.4