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Rapport d'essai / *Test report*

N° 200907-5554R-A1-R3-E **JDE :** 99843

DELIVRE A / *ISSUED TO*	:	**FESYS** Parc des Ruires 3, rue Irène Joliot Curie 38320 EYBENS
Objet / *Subject*	:	Essais de compatibilité électromagnétique conformément aux normes **FCC CFR 47 Part 15, Subpart B et C.** *Electromagnetic compatibility tests according to the standards* ***FCC CFR 47 Part 15, Subpart B and C***
Matériel testé / *Apparatus under test*	:	
• Produit / *Product*	:	**Télécommande de traçabilité / *Traceability remote control***
• Marque / *Trade mark*	:	**BIOMERIEUX**
• Constructeur / *Manufacturer*	:	**FESYS**
• Type / *Model*	:	**RUID**
• N° de série / *serial number*	:	**000005**
• FCC ID	:	**YV2-RUID**
Date des essais / *Test date*	:	Du 18 au 31 Mai 2010 / *From May 18th to 31st, 2010*
Lieu d'essai / *Test location*	:	**LCIE SUD-EST** ZI Centr'Alp – 170 rue de Chatagnon 38430 MOIRANS - France
Test réalisé par / *Test performed by*	:	Anthony MERLIN

Ce document comporte /*Composition of document :* 24 pages.

MOIRANS, LE 9 FEVRIER 2011 / FEBRUARY 9TH, 2011

Ecrit par / *Written by*
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Approuvé par / *Approved by*
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SUMMARY

1. TEST PROGRAM

Standard: **- FCC Part 15, Subpart C 15.247**
- ANSI C63.4 (2009)

EMISSION TEST	LIMITS			RESULTS (Comments)
Limits for conducted disturbance at mains ports 150kHz-30MHz	**Frequency**	**Quasi-peak value (dBµV)**	**Average value (dBµV)**	**See results in test report 61915-A1-R1-E*[2]**
	150-500kHz	66 to 56	56 to 46	
	0.5-5MHz	56	46	
	5-30MHz	60	50	
Radiated emissions 9kHz-30MHz	**Measure at 300m** 9kHz-490kHz : 67.6dBµV/m /F(kHz) **Measure at 30m** 490kHz-1.705MHz : 87.6dBµV/m /F(kHz) 1.705MHz-30MHz : 29.5 dBµV/m			**PASS**
Radiated emissions 30MHz-25GHz*	**Measure at 3m** 30MHz-88MHz : 40 dBµV/m 88MHz-216MHz : 43.5 dBµV/m 216MHz-960MHz : 46.0 dBµV/m Above 960MHz : 54.0 dBµV/m			**PASS** **Frequencies <1GHz: See results in report 61915-A1-R1-E*[2]**
Maximum Peak Output Power 15.247 (b)	**Limit: 21dBm** Conducted or Radiated measurement			**PASS**
Hopping Channel Separation 15.247 (a) (1)	**Minimum between:** Two-third 20dB Bandwidth or 25kHz Whichever is greater			**PASS**
Number of Hopping Frequencies 15.247 (a) (1) (iii)	**At least 15 channels used**			**PASS**
Time of Occupancy (Dwell Time) 15.247 (a) (1) (iii)	**Maximum 0.4 sec within 31.6sec**			**PASS**
Band Edge Measurement 15.247 (d)	**Limit: -20dBc**			**PASS**

***§15.33:** The highest internal source of a testing device is defined like more the highest frequency generated or used in the testing device or on which the testing device works or agrees.
- If the highest frequency of the internal sources of the testing device is lower than 108 MHz, measurement must be only performed until 1GHz.
- If the highest frequency of the internal sources of the testing device ranges between 108 MHz and 500 MHz, measurement must be only performed until 2GHz.
- If the highest frequency of the internal sources of the testing device ranges between 500 MHz and 1 GHz, measurement must be only performed until 5GHz.
If the highest frequency of the internal sources of the testing device is above 1 GHz, measurement must be only performed until 5 times the highest frequency or 40 GHz, while taking smallest of both.

****[2]: In report 61915-A1-R1-E, tests are performed with Bluetooth module activated in typical use but the equipment is been considered digital device and so tested in compliance with Part15b.***
Complementary tests of 15.247 are performed in this test report.

2. SYSTEM TEST CONFIGURATION

2.1. JUSTIFICATION

The system was configured for testing in a typical fashion (as a customer would normally use it).

2.2. HARDWARE IDENTIFICATION

- **Equipment under test (EUT):**

RUID **Serial Number: 000005**

E.U.T. : RUID

Serial number: 000005

Power supply: FRIWO FW7662/05 (Output 5Vdc – 1.1A)

- **Inputs/outputs:**

1 x USB port (for maintenance only, not tested)
1 x DC input
1 x Mini USB

- **Cables:**

1 x USB cable (2m)

- **Auxiliaries equipment used during test:**

Laptop TOSHIBA SATELLITE PS141E-04YC sn: 13594938G

- **Equipment information:**

- External antenna connector: NO
- Radiated fundamental frequency band: 2400-2483.5MHz
- Antenna type: Integral
- Stand By mode: None
- Normal power source: AC/DC adapter
- Modulation Type: GFSK
- Modulation Technology: FHSS
- Packet Type: DH1, DH2, DH3
- Maximum Antenna Gain: 0dBi

2.3. EUT CONFIGURATION

Following parameters are used during the tests:

- Mode (DH1, DH3, DH5)
- Modulation (GFSK)
- Hopping sequence ON/OFF
- Emitted in continue on frequency (Channel 0, 39, 78)

Configuration 1 :
Power supply : - Internal battery

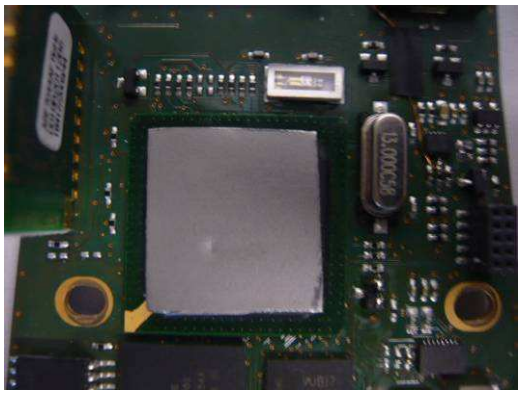
Configuration 2 :
Power supply : - Power supply adapter

A summary of the worst case emissions found in all test configurations and modes is presented in this test report.

2.4. EQUIPMENT MODIFICATIONS

Modifications performed for all tests.

1)



Conductive foam on chip

2) Capacitor C185 (value: 22µF) on ESF for all tests except radiated emission in configuration 1

2.5. SPECIAL ACCESSORIES

None

3. RADIATED EMISSION DATA

3.1. CLIMATIC CONDITIONS

Date of test : May 19th, 2010
Test performed by : A.MERLIN
Atmospheric pressure : 975mb
Relative humidity : 34%
Ambient temperature : 20°C

3.2. TEST SETUP

The installation of EUT is identical for pre-characterization measurement in a 3 meters semi anechoic chamber and for measures on a 10 meters Open site.

3.3. TEST SEQUENCE AND RESULTS

3.3.1. Pre-characterization at 3 meters [9kHz-30MHz]

A pre-scan of all the setup has been performed in a 3 meters semi anechoic chamber.
The distance between EUT and antenna is 3 meters. For Pre-characterization, the loop antenna was rotated during the test for maximized the emission measurement. Measurement performed on 3 axis of EUT.
Frequency band investigated is 9kHz to 30MHz.

3.3.2. Pre-characterization [30MHz-25GHz]

For frequency band 30MHz to 1GHz, a pre-scan of all the setup has been performed in a 3 meters semi anechoic chamber.
The distance between EUT and antenna is 3 meters. Test is performed in horizontal (H) and vertical (V) polarization with a log-periodic antenna. The EUT is being rotated on 360° and on 3 axis during the measurement. The pre-characterization graphs are obtained in PEAK detection.
For frequency band 1GHz to 25GHz, a search is performed in the semi-anechoic chamber in order to determine frequencies radiated by the EUT (Measuring distance reduced to 1m and 20cm for frequencies from 12GHz to 25GHz).

See graphs for 30MHz-1GHz in test report 61915-A1-R1-E

3.3.3. Characterization on 10 meters open site below 30 MHz

The product has been tested according to ANSI C63.4 (2009), FCC part 15 subpart C. Radiated Emissions were measured on an open area test site. A description of the facility is on file with the FCC.
The product has been tested at a distance of **10 meters** from the antenna and compared to the FCC part 15 subpart C §15.109 limits and C §15.209.
Antenna height was 1m for both horizontal and vertical polarization.
Antenna was rotated around its vertical axis.
Continuous linear turntable azimuth search was performed with 360 degrees range. Measurement performed on 3 axis of EUT. A summary of the worst case emissions found in all test configurations and modes is shown in following tables.

Frequency (MHz)	QPeak Limit (dBµV/m) @ 30m	Qpeak (dBµV/m)	Qpeak-Limit (Margin dB)	Turntable Angle (deg)	Ant. Pol./ Angle (deg)	Tot Corr (dB)
No Frequency Observed						

*: Measure have been done at 10m distance and corrected according to requirements of 15.209.e) (M@30m = M@10m-19.1dB)

3.3.4. Characterization on open site from 1GHz to 25GHz

The product has been tested at a distance of **3 meters** from the antenna and compared to the FCC part 15 subpart B §15.109 limits and C §15.209 limits. Measurement bandwidth was 1MHz from 1GHz to 25GHz.
Antenna height search was performed from 1m to 4m for both horizontal and vertical polarization. Continuous linear turntable azimuth search was performed with 360 degrees range. Measurement performed on 3 axis of EUT.
A summary of the worst case emissions found in all test configurations and modes is presented in this test report.

Frequency band 1GHz to 25GHz
Measurements are performed using a PEAK and Average detection. (RBW = 1MHz)

No	Frequency (GHz)	Limit Average (dBµV/m)	Measure Average (dBµV/m)	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. factor (dB)	Comments
1	4804.00	54.0	41.1	**-12.9**	120	V	130	34.0	
2	4882.00	54.0	41.1	**-12.9**	100	V	130	34.1	
3	4960.00	54.0	40.7	**-13.3**	120	V	120	34.2	
4	7206.00	54.0	44.9	**-9.1**	150	V	130	36.8	
5	7323.00	54.0	44.7	**-9.3**	150	H	120	36.9	
6	7440.00	54.0	40.2	**-13.8**	160	V	130	37.1	

No	Frequency (GHz)	Limit Peak (dBµV/m)	Measure Peak (dBµV/m)	Margin (Mes-Lim) (dB)	Angle Table (deg)	Pol Ant.	Ht Ant. (cm)	Correc. factor (dB)	Comments
1	4804.00	74.0	54.3	**-19.7**	120	V	130	34.0	
2	4882.00	74.0	53.7	**-20.3**	100	V	130	34.1	
3	4960.00	74.0	54.2	**-19.8**	120	V	120	34.2	
4	7206.00	74.0	60.5	**-13.5**	150	V	130	36.8	
5	7323.00	74.0	60.3	**-13.7**	150	H	120	36.9	
6	7440.00	74.0	59.9	**-14.1**	160	V	130	37.1	

RESULTS: PASS

3.4. FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follow:

FS = RA + AF + CF – AG

Where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Factor
AG = Amplifier Gain

Assume a receiver reading of 52.5dBµV is obtained. The antenna factor of 7.4 and a cable factor of 1.1 are added. The amplifier gain of 29dB is subtracted, giving a field strength of 32 dBµV/m.
FS = 52.5 + 7.4 + 1.1 – 29 = 32 dBµV/m
The 32 dBµV/m value can be mathematically converted to its corresponding level in µV/m.
Level in µV/m = Common Antilogarithm [(32dBµV/m)/20] = 39.8 µV/m.

4. MAXIMUM PEAK OUTPUT POWER (15.247)

4.1. TEST CONDITIONS

Date of test : May 19th, 2010
Test performed by : A.MERLIN
Atmospheric pressure : 975mb
Relative humidity : 34%
Ambient temperature : 20°C

4.2. EQUIPMENT CONFIGURATION

Modulation: GFSK
Packet Type: DH5 (Worst case)
Hopping sequence: NO

4.3. SETUP

Conducted measurement:
The EUT is turned ON and connected to measurement instrument; the center frequency of the spectrum analyzer is set to the fundamental frequency and using 3MHz RBW and 10MHz VBW.
The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.

Radiated measurement:
The product has been tested at a distance of 3 meters from the antenna and using 3MHz RBW and 10MHz VBW.
Antenna height search was performed from 1m to 4m for both horizontal and vertical polarization. Continuous linear turntable azimuth search was performed with 360 degrees range. Measurement performed on 3 axis of EUT.
A summary of the worst case emissions found in all test configurations and modes is shown on following table.
The captured power is measured and recorded; the measurement is repeated until all frequencies required were complete.
To demonstrate compliance with peak output power requirement of section 15.247 (b), the transmitter's peak output power is calculated using the following equation:

$$E = \frac{\sqrt{30PG}}{d}$$

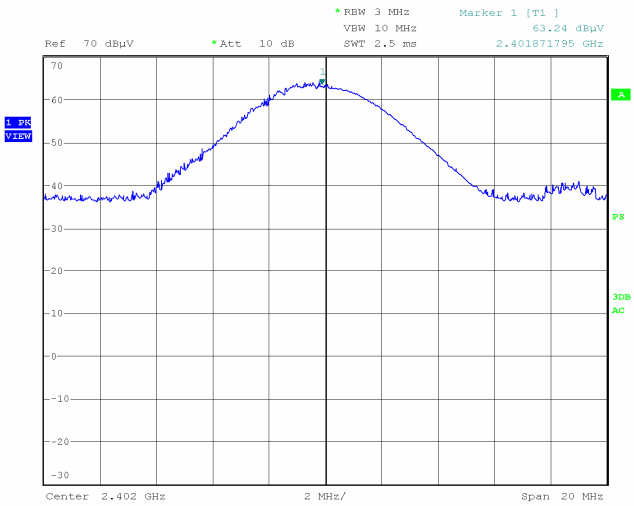
Where:
- E is the measured maximum fundamental field strength in V/m, utilizing a RBW ≥ the 20 dB bandwidth of the emission, VBW > RBW, peak detector function. Follow the procedures in C63.4-1992 with respect to maximizing the emission.
- G is the numeric gain of the transmitting antenna with reference to an isotropic radiator.
- d is the distance in meters from which the field strength was measured.
- P is the power in watts for which you are solving:

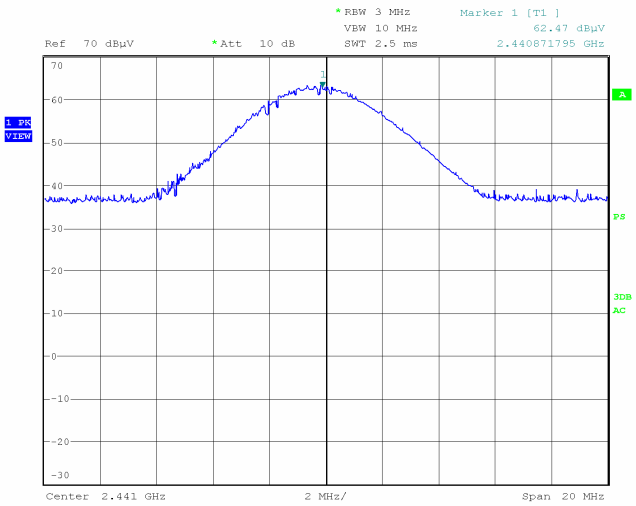
$$P = \frac{(Ed)^2}{30G}$$

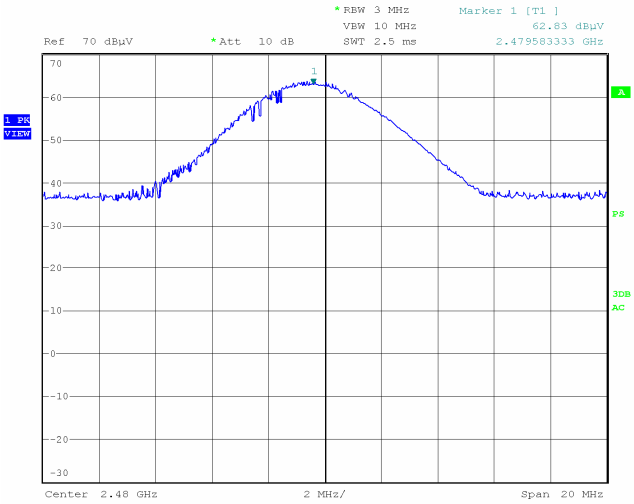
Radiated measurement

Channel	Channel Frequency (MHz)	Maximum Field (dBµV/m)	Peak Output Power (dBm)	Power Limit (dBm)	FC (dB)	PASS / FAIL
0	2402	92.30	-2.93	21	29.0	P
39	2441	91.60	-3.63	21	29.1	P
78	2480	91.90	-3.33	21	29.1	P

Note: Distance is 3m and calculated factor (see 4.3), included in the measurement. The antenna is an integral antenna; the conducted measurement is not possible.







5. HOPPING CHANNEL SEPARATION (15.247)

5.1. TEST CONDITIONS

Date of test : May 19th, 2010
Test performed by : A.MERLIN
Atmospheric pressure : 975mb
Relative humidity : 34%
Ambient temperature : 20°C

5.2. LIMIT

For frequency hopping system operating in the 2400-2483.5MHz, if the 20dB bandwidth of hopping channel is greater than 25kHz, two-thirds 20dB Bandwidth of hopping channel shell be a minimum limit for the hopping channel separation.

5.3. EQUIPMENT CONFIGURATION

Modulation: GFSK
Packet Type: DH5 (Worst case)
Hopping sequence: YES

5.4. SETUP – 20DB BANDWIDTH

The EUT is placed in an anechoic chamber; levels have been corrected to be in compliant with the Peak Output Power measured. The EUT is turn ON and using the MaxHold function, the frequency separation of two frequencies that were attenuated 20dB from the Peak Output Power level. A delta marker is used to measure the frequency difference as the emission bandwidth.

5.5. SETUP – ADJACENT CHANNEL SEPARATION

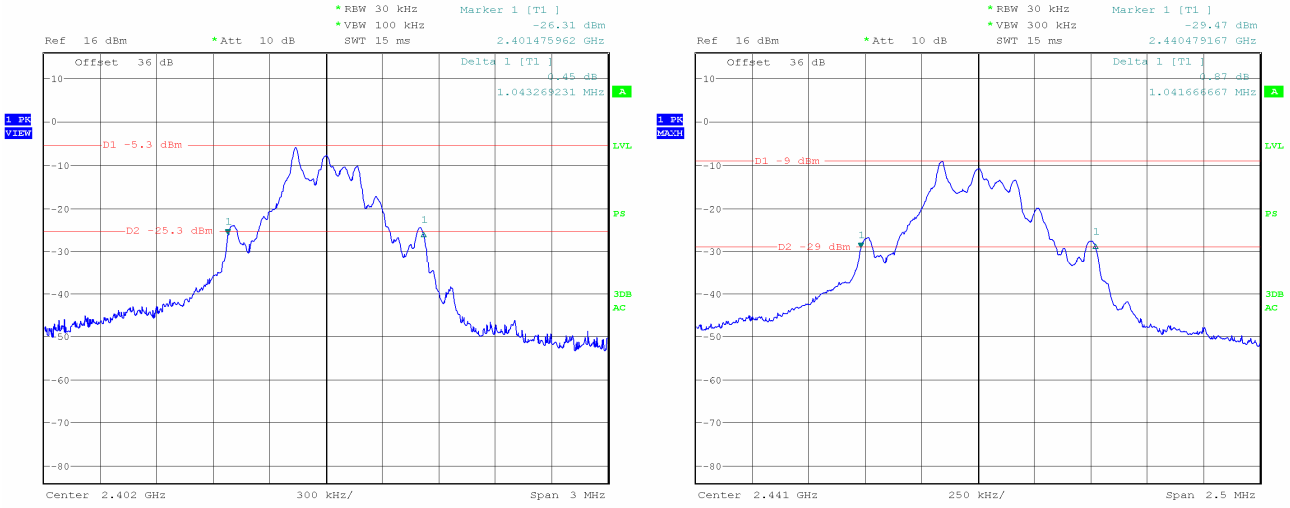
The EUT is placed in an anechoic chamber; levels have been corrected to be in compliant with the Peak Output Power measured. The EUT is turn ON and using the MaxHold function, the separation of two adjacent channels is recorded. A delta marker is used to measure the frequency difference.

5.6. RESULTS – 20DB BANDWIDTH

Modulation:

Channel	Channel Frequency (MHz)	20dB Bandwidth (MHz)
0	2402	1.043
39	2441	1.041
78	2480	1.043

Graph:



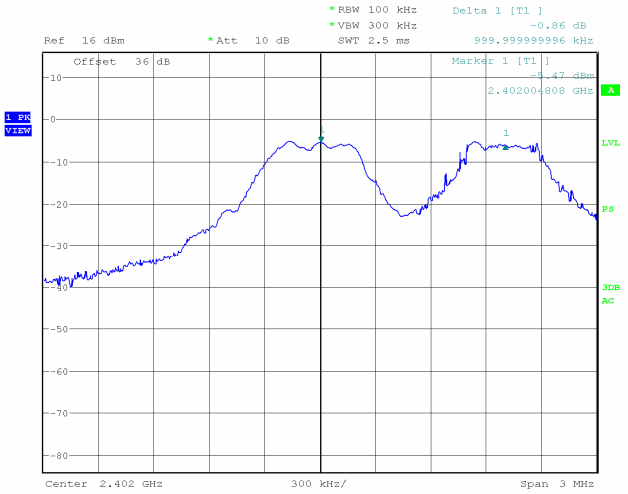
5.7. SETUP – ADJACENT CHANNEL SEPARATION

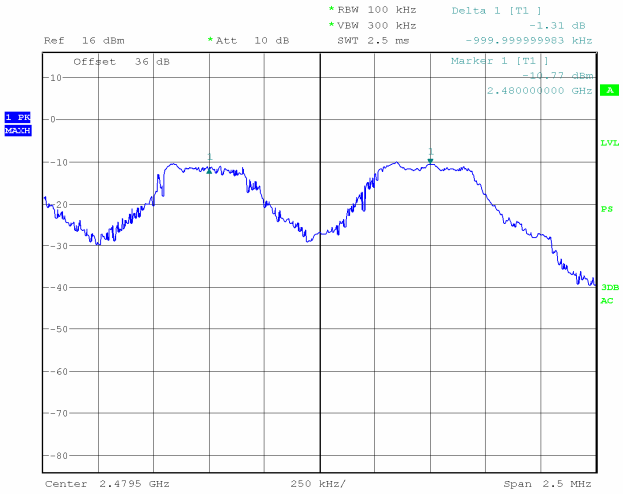
Modulation:

Channel	Channel Frequency (MHz)	Adjacent Channel Separation (MHz)	20dB Bandwidth (MHz)	Minimum Limit (MHz)	PASS / FAIL
0	2402	0.999	1.043	0.695	P
39	2441	0.999	1.041	0.694	P
78	2480	0.999	1.043	0.695	P

Limit used: Two-third 20dB Bandwidth

Graph:





6. NUMBER OF HOPPING FREQUENCIES (15.247)

6.1. TEST CONDITIONS

Date of test : May 19th, 2010
Test performed by : A.MERLIN
Atmospheric pressure : 975mb
Relative humidity : 34%
Ambient temperature : 20°C

6.2. LIMIT

For frequency hopping system operating in the 2400-2483.5MHz, at least 15 channels frequencies must be used and should be equally spaced.

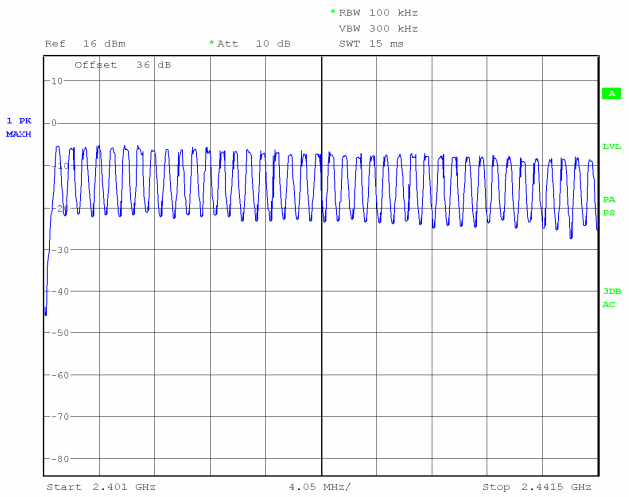
6.3. EQUIPMENT CONFIGURATION

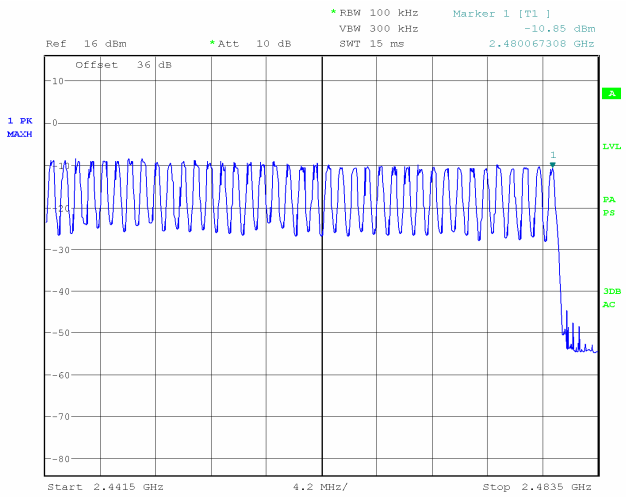
Modulation: GFSK
Packet Type: DH5 (same results for packet types)
Hopping sequence: ON

6.4. SETUP

The EUT is placed in an anechoic chamber. The EUT is turn ON and using the MaxHold function and a delta marker the number of frequencies used for this FHSS system is recorded, see following graphs.
RBW: 100kHz
VBW: 300kHz

6.5. RESULTS





Number of frequency used in the hopping sequence: 79 Channels

7. TIME OF OCCUPANCY (DWELL TIME) (15.247)

7.1. TEST CONDITIONS

Date of test : May 31st, 2010
Test performed by : A.MERLIN
Atmospheric pressure : 980mb
Relative humidity : 35%
Ambient temperature : 21°C

7.2. LIMIT

The average time of occupancy on any channel shall not be greater than 0.4 seconds within period of 0.4 seconds multiplied by the number of hopping channels employed.

7.3. EQUIPMENT CONFIGURATION

Modulation: GFSK
Channel frequency: 2402MHz
Hopping sequence: ON

7.4. SETUP

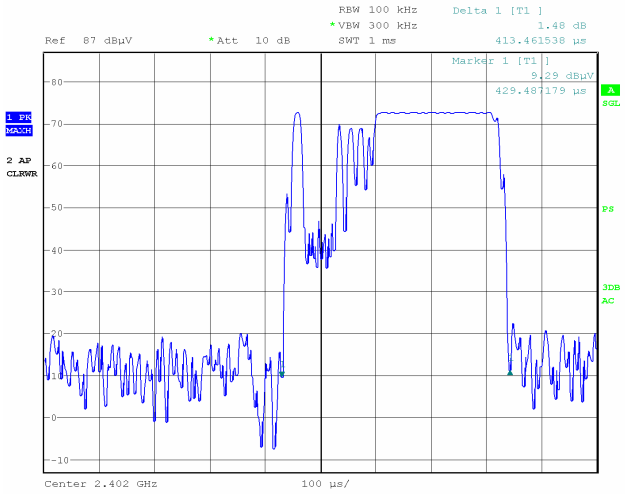
The EUT is placed in an anechoic chamber. The EUT is turn ON; the Dwell Time is measured and calculated using the zero SPAN mode on a channel frequency and a SWEEP with an adapter value to measure the number of transmission within a period and the time of transmission
RBW: 100kHz
VBW: 300kHz

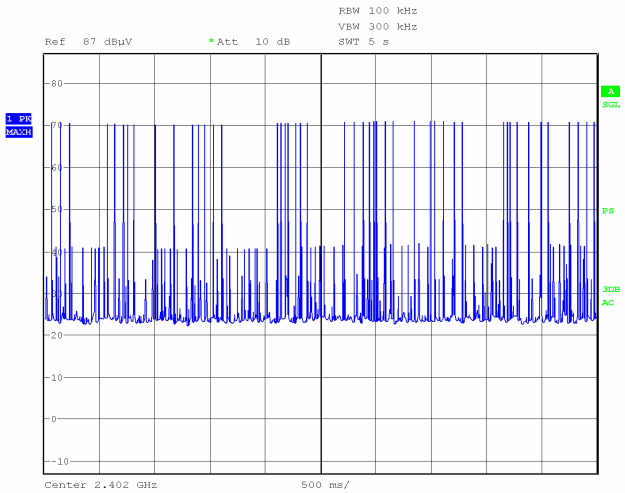
7.5. RESULTS

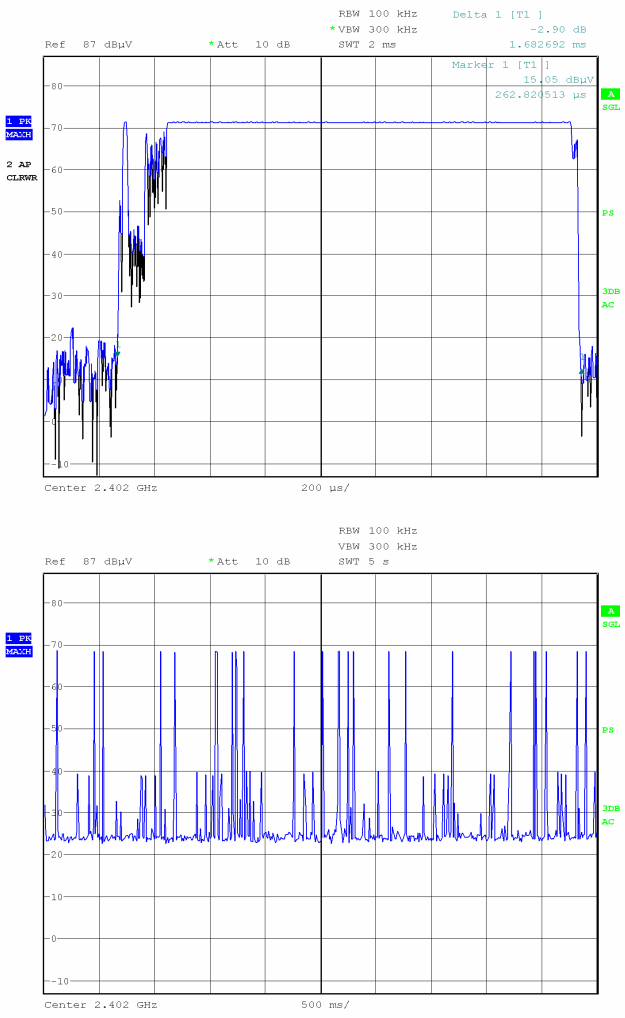
Modulation:

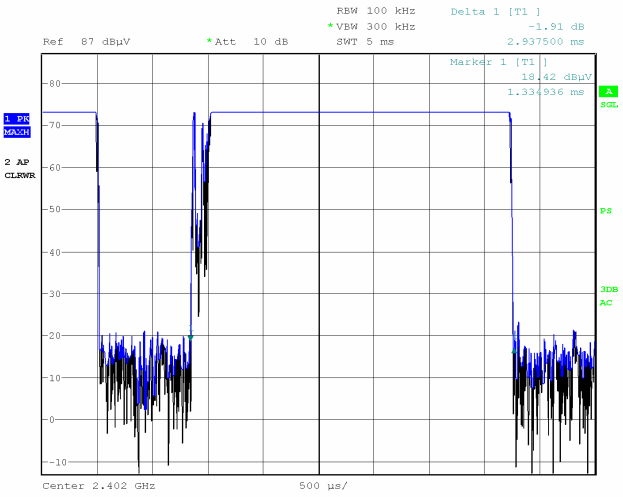
Packet Mode	Number of transmission in the period	Length of transmission time (ms)	Result (ms)	Limit (ms)	PASS / FAIL
DH1	47 (times/ 5 sec) * 6.32 = 297	0.413	123	400	P
DH3	23 (times/ 5 sec) * 6.32 = 145	1.683	245	400	P
DH5	16 (times/ 5 sec) * 6.32 = 102	2.937	300	400	P

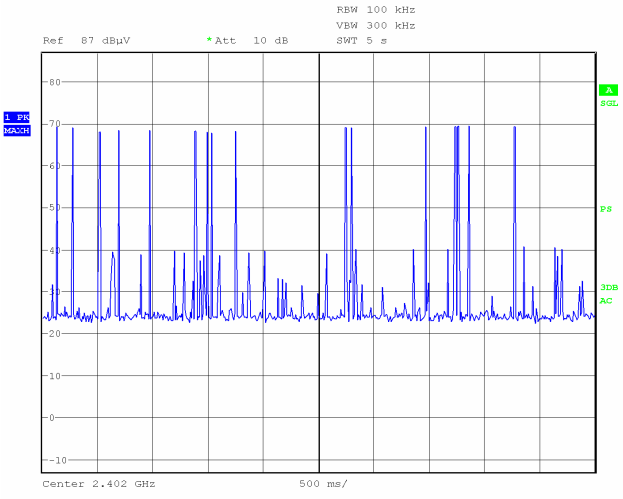
Note: Period of 31.6 seconds (79 channels x 0.4)






RBW 100 kHz
*VBW 300 kHz
SWT 2 ms
Delta 1 [T1]
-2.90 dB
1.682692 ms
Marker 1 [T1]
15.05 dBµV
262.820513 µs
Ref 87 dBµV
*Att 10 dB
1 PK MAXH
2 AP CLRWR
A SGL
PS
3DB AC
Center 2.402 GHz
200 µs/
RBW 100 kHz
VBW 300 kHz
SWT 5 s
Ref 87 dBµV
*Att 10 dB
1 PK MAXH
A SGL
PS
3DB AC
Center 2.402 GHz
500 ms/


RBW 100 kHz
*VBW 300 kHz
SWT 5 ms
Delta 1 [T1]
-1.91 dB
2.937500 ms
Marker 1 [T1]
18.42 dBµV
1.334936 ms
Ref 87 dBµV
*Att 10 dB
1 PK MAXH
2 AP CLRWR
A SGL
PS
3DB AC
Center 2.402 GHz
500 µs/


RBW 100 kHz
VBW 300 kHz
SWT 5 s
Ref 87 dBµV
*Att 10 dB
1 PK MAXH
A SGL
PS
3DB AC
Center 2.402 GHz
500 ms/

8. BAND EDGE MEASUREMENT (15.247)

8.1. TEST CONDITIONS

Date of test : May 19th, 2010
Test performed by : A.MERLIN
Atmospheric pressure : 975mb
Relative humidity : 34%
Ambient temperature : 20°C

8.2. LIMIT

In Bandedge, the limit of spurious emissions are below -20dB of the highest emission level of operating band (in 100kHz RBW).
In the restrict band (2310-2390MHz) and (2483.5-2500MHz) including bandedge, the limit of spurious emissions are 15.209. (RBW:1MHz / VBW:1MHz)

8.3. EQUIPMENT CONFIGURATION

Modulation: GFSK
Channel frequency: 2402MHz and 2480MHz
Hopping sequence: ON and OFF, worst case reported
Packet type: DH5 (Worst case)

8.4. SETUP

The EUT is placed in an anechoic chamber; levels have been corrected to be in compliant with Peak Output Power measurement. The EUT is turn ON; the graphs of the restrict frequency band are recorded with a display line indicating the highest level and other the 20dB offset below to show compliance with 15.247 (d) and 15.205. The emissions in restricted bands are compared to 15.209 limits.
RBW: 100kHz
VBW: 300kHz

8.5. RESULTS

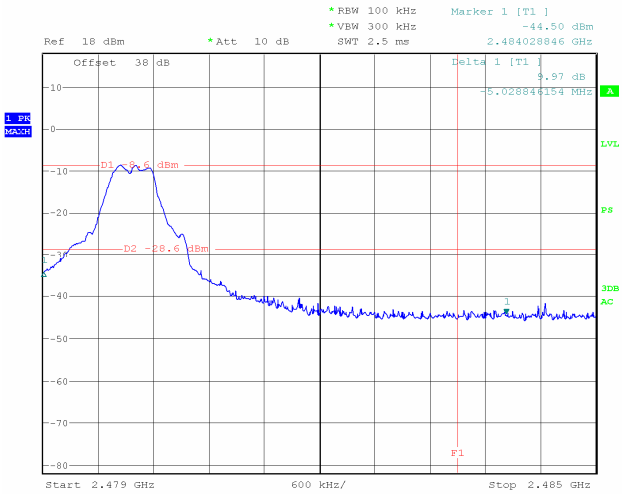
Restricted Band (2310-2390) MHz

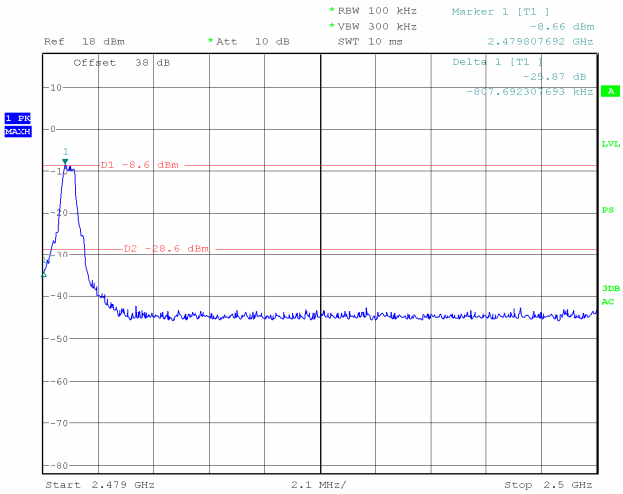
Frequency (MHz)	Maximum field strength in restrict band (dBµV/m)	Limit (dBµV/m)	Detector
No frequency observed		74	PK
		54	AV

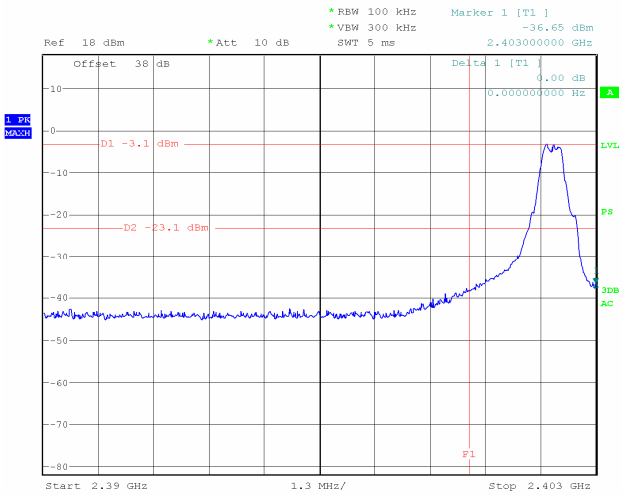
Restricted Band (2483.5-2500) MHz

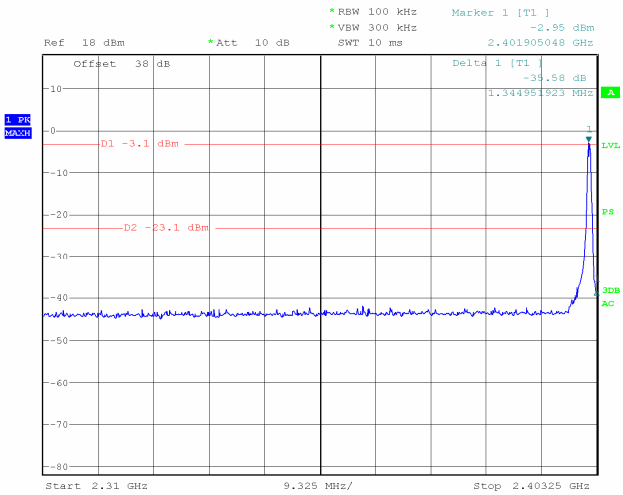
Frequency (MHz)	Maximum field strength in restrict band (dBµV/m)	Limi (dBµV/m)	Detector
No frequency observed		74	PK
		54	AV

NOTE:
1. Average value =Peak value + 20 Log (duty cycle) = Peak value – 30.1dB.
2. The DH5 packet was the worse case duty cycle for a transmit dwell time on a channel, based upon Bluetooth theory the transmitter is on 0.625 * 5 per 296.25 ms per channel. Therefore, the duty cycle correction factor be equal to: 20log (3.125/100) = -30.1 dB.









9. TEST EQUIPMENT LIST

	N°LCIE	TYPE	COMPANY	REF	Comments
MAXIMUM PEAK OUTPUT POWER					
X	C2042027VO	Antenna horn	EMCO	3115	
X	A7122167	Attenuator 10dB 18GHz 2W	JFW		
X	A5329041VO	Cable SMA			
X	A5329206VO	Cable	UTIFLEX		
X	A2642019VO	Measurement Receiver 20Hz – 8GHz	ROhde & Schwarz	ESU8	
X	F2000409VO	OATS MOIRANS			
X	F2000392VO	Antenna mast (OATS)	ETS Lindgren	2071-2	
X	F2000403VO	Turntable (OATS)	ETS Lindgren	Model 2187	
X	F2000372VO	Turntable / Mast controller (OATS)	ETS Lindgren	Model 2066	
HOPPING CHANNEL SEPARATION					
X	C2042027VO	Antenna horn	EMCO	3115	
X	A5329041VO	Cable SMA			
X	A5329206VO	Cable	UTIFLEX		
X	A2642019VO	Measurement Receiver 20Hz – 8GHz	ROhde & Schwarz	ESU8	
NUMBER OF HOPPING CHANNEL					
X	C2042027VO	Antenna horn	EMCO	3115	
X	A5329041VO	Cable SMA			
X	A5329206VO	Cable	UTIFLEX		
X	A2642019VO	Measurement Receiver 20Hz – 8GHz	ROhde & Schwarz	ESU8	
TIME OF OCCUPANCY					
X	C2042027VO	Antenna horn	EMCO	3115	
X	A5329041VO	Cable SMA			
X	A5329206VO	Cable	UTIFLEX		
X	A2642019VO	Measurement Receiver 20Hz – 8GHz	ROhde & Schwarz	ESU8	
BAND EDGE MEASUREMENT					
X	C2042027VO	Antenna horn	EMCO	3115	
X	A5329041VO	Cable SMA			
X	A5329206VO	Cable	UTIFLEX		
X	A2642019VO	Measurement Receiver 20Hz – 8GHz	ROhde & Schwarz	ESU8	

10. UNCERTAINTIES CHART

Type de mesure / *Kind of measurement*	**Incertitude élargie laboratoire / *Wide uncertainty laboratory* (k=2) ± x**	**Incertitude limite du CISPR / *CISPR uncertainty limit* ± y**
Mesure des perturbations conduites en tension sur le réseau d'énergie *Measurement of conducted disturbances in voltage on the power port*	3.57 dB	3.6 dB
Mesure des perturbations conduites en tension sur le réseau de télécommunication *Measurement of conducted disturbances in voltage on the telecommunication port.*	3.28 dB	A l'étude / Under consid.
Mesure des perturbations discontinues conduites en tension *Measurement of discontinuous conducted disturbances in voltage*	3.47 dB	3.6 dB
Mesure des perturbations conduites en courant *Measurement of conducted disturbances in current*	2.90 dB	A l'étude / Under consid.
Mesure du champ électrique rayonné sur le site en espace libre de Moirans *Measurement of radiated electric field on the Moirans open area test site*	5.07 dB	5.2 dB