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TEST REPORT

According to : FCC 47CFR part 15 subpart C

Test Report No.	:	CTK-2017-00867
Date of Issue	:	2017-05-11
FCC ID	:	2AALG-NWP-F121
Basic Model/Type No.	:	NWP-F121
Kind of Product	:	Neo smartpen N2
Applicant	:	NeoLAB Convergence
Applicant Address	:	#1501, Mario Tower, 28, Digital-ro 30-gil, Guro-gu, Seoul, Korea 08389
Manufacturer	:	NeoLAB Convergence
Manufacturer Address	:	#1501, Mario Tower, 28, Digital-ro 30-gil, Guro-gu, Seoul, Korea 08389
Contact Person	:	Bongki Park
Telephone	:	+82–70-4377-0740
Received Date	:	2017-04-19
Test period	:	Start : 2017-05-01 End : 2017-05-11
Test Results	:	☒ In Compliance ☐ Not in Compliance

The test results presented in this report relate only to the object tested.

Tested by

Y. T. Lee

Young-taek Lee
Test Engineer
Date: 2017-05-11

Reviewed by

Y. J. Park

Young-Joon, Park
Technical Manager
Date: 2017-05-11

REPORT REVISION HISTORY

Date	Revision	Page No
2017-05-11	Issued (CTK-2017-00867)	All

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1.0 General Product Description

Kind of product	Neo smartpen N2
FCC ID	2AALG-NWP-F121
Model name	NWP-F121
Variant Model name	-
RF Power setting in Test SW	Initial value
Antenna type	PCB antenna
Antenna Gain	Peak 2.28 dBi
Frequency Range	2 402 MHz - 2 480 MHz
RF power	-3.72 dBm Peak Conducted (GFSK)
Number of channels	79
Channel Spacing	1 MHz
Type of Modulation	GFSK(1Mbps)
Power Source	DC 3.7 V
Test Site Registration Number	8737A-2

1.1 Tested Frequency

	LOW	MID	HIGH
Frequency (MHz)	2 402	2 441	2 480

1.2 Tested Mode

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

- Following channel(s) was (were) selected for the final test as listed below.

Tested Ch	Modulation Technology	Modulation Type	Packet Type
Low, Mid, High	FHSS	GFSK	DH5

1.3 Device Modifications

The following modifications were necessary for compliance:

Not applicable

1.4 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	HP	HP ProBook 650 G1	5CG5114K13

1.5 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

1.6 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea.

1.7 Laboratory Accreditations and Listings

Country	Agency	Scope of Accreditation	Registration Number	Logo
USA	**FCC**	FCC Part 15 & 18 EMI (Electromagnetic Interference / Emission)	805871	
JAPAN	**VCCI**	VCCI V-3 EMI (Electromagnetic Interference / Emission)	C-986 T-1843 R-3627 G-387	
KOREA	**MSIP**	EMI (Electromagnetic Interference / Emission) EMS (Electromagnetic Susceptibility / Immunity)	KR0025	

2.0 Summary of tests

FCC Part Section(s)	Parameter	Status (note)
15.247(a)	Carrier Frequency Separation	C
15.247(a)	Number of Hopping Frequencies	C
15.247(a)	20 dB Bandwidth	C
15.247(a)	Time of occupancy (Dwell Time)	C
15.247(b)	Transmitter Output Power	C
15.247(d)	Unwanted Emission(Conducted)	C
15.209	Unwanted Emission (Radiated)	C
NA	Receiver Emission	C
15.207	AC Power Line Conducted Emissions	C
2.1091	RF exposure evaluation	C

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

The sample was tested according to the following specification:
- FCC Part 15.247, ANSI C63.10-2013
- RSS-247 Issue 1

The tests were performed according to the method of measurements prescribed in DA 00-705.

2.1 Requirements

2.1.1 Carrier Frequency Separation

Test Procedures(ANSI C63.10-2013 7.8.2)

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT has its hopping function enabled.
After the trace being stable, the reading value between the peaks of the adjacent channels using the marker-delta function was recorded as the measurement results.

The spectrum analyzer is set to:
Span : wide enough to capture the peaks of two adjacent channels
RBW : approximately 30% of the channel spacing;
adjust as necessary to best indentify the center of each individual channel.
VBW ≥ RBW Sweep : auto
Detector function = peak
Trace = max hold

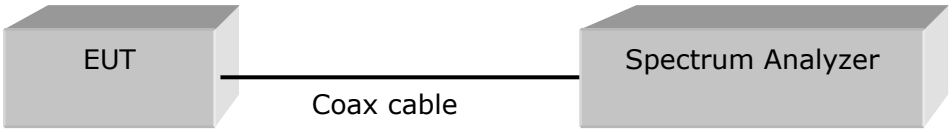


Figure 1 : Measurement setup for the carrier frequency separation

Limit
FHSS operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the -20 dB bandwidth of the hopping channel, whichever is greater.

Test Results

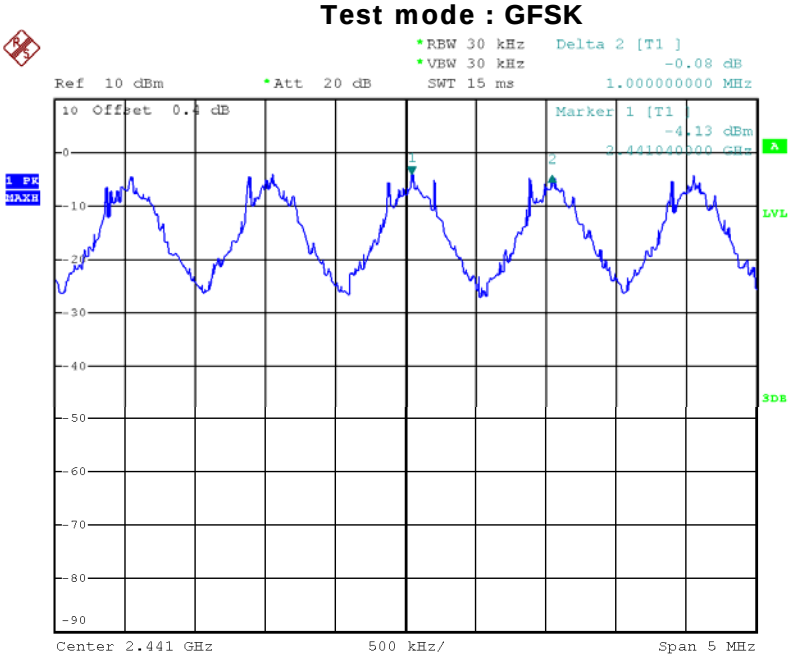
Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Channel	Adjacent Hopping Channel Separation (kHz)	Two-third of 20dB bandwidth (kHz)	Minimum Bandwidth (kHz)	Result
2 441MHz	1 000	954	25	Complies

See next pages for actual measured spectrum plots.

Carrier Frequency Separation

Test mode : GFSK



Date: 10.MAY.2017 12:14:00

2.1.2 Number of Hopping Frequencies

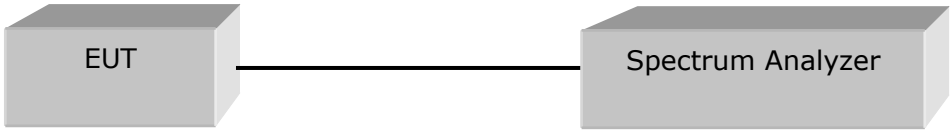
Test Procedures(ANSI C63.10-2013 7.8.3)

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:

Frequency range 1: Start = 2 389.5 MHz, Stop = 2 439.5 MHz
2: Start = 2 439.5 MHz, Stop = 2 489.5 MHz

RBW : To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
VBW ≥ RBW Sweep = auto
Detector function = peak
Trace = max hold



Limit

FHSs operating in the band 2 400-2 483.5 MHz shall use at least 15 hopping channels.

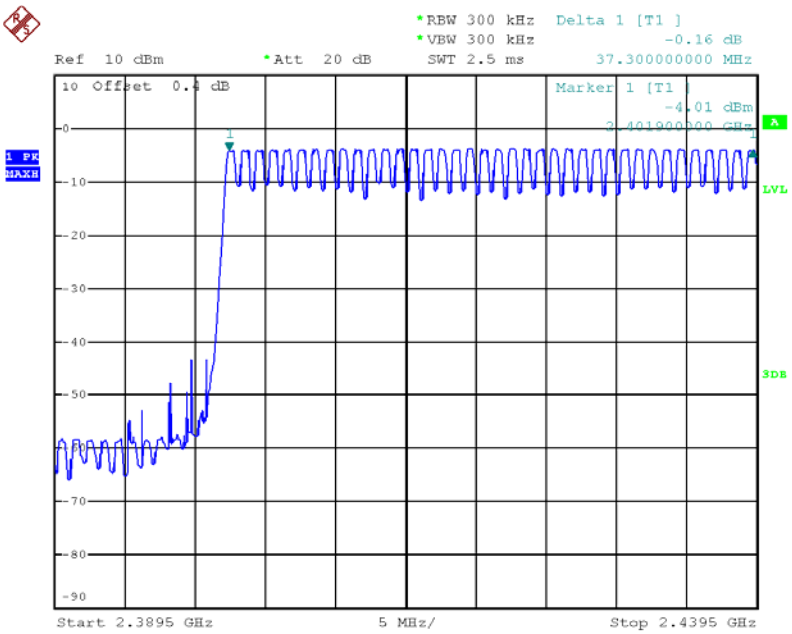
Test Results

Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Total number of Hopping Channels	Result
79	Complies

See next pages for actual measured spectrum plots.

Number of Hopping Frequencies(GFSK)



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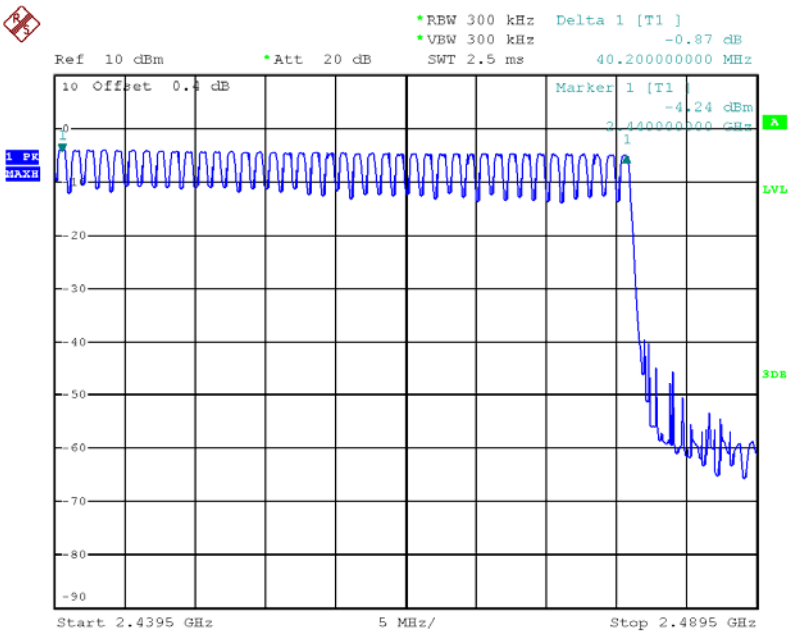

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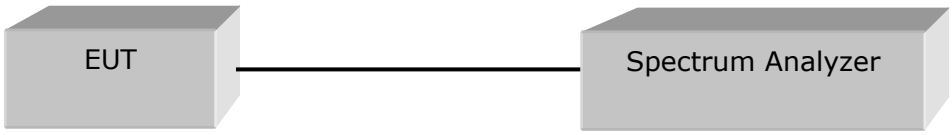
2.1.3 20 dB bandwidth

Test Procedures(ANSI C63.10-2013 6.9.2)

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

The spectrum analyzer is set to:
Center frequency = the highest, middle and the lowest channels
Span = between 2 times and 5 times the OBW
RBW = 1% to 5% of the OBW Sweep = auto
VBW : approximately 3 times RBW Detector function = peak
Trace = max hold



Limit

Limit : N/A

Test Results

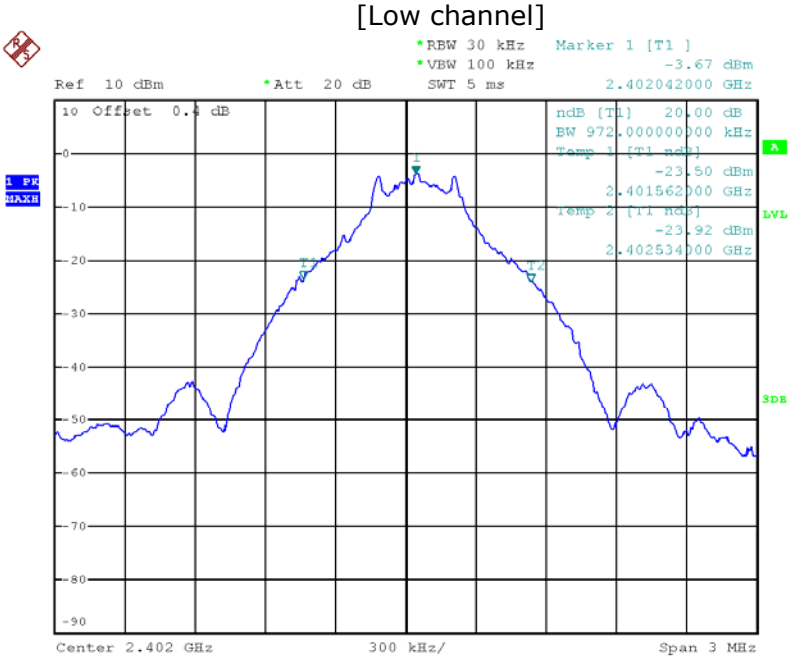
Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency (MHz)	Channel Number.	Measured Bandwidth (MHz)	Result
2 402	0	0.972	Complies
2 441	39	0.960	Complies
2 480	78	0.906	Complies

See next pages for actual measured spectrum plots.

20 dB Bandwidth - GFSK

[Low channel]



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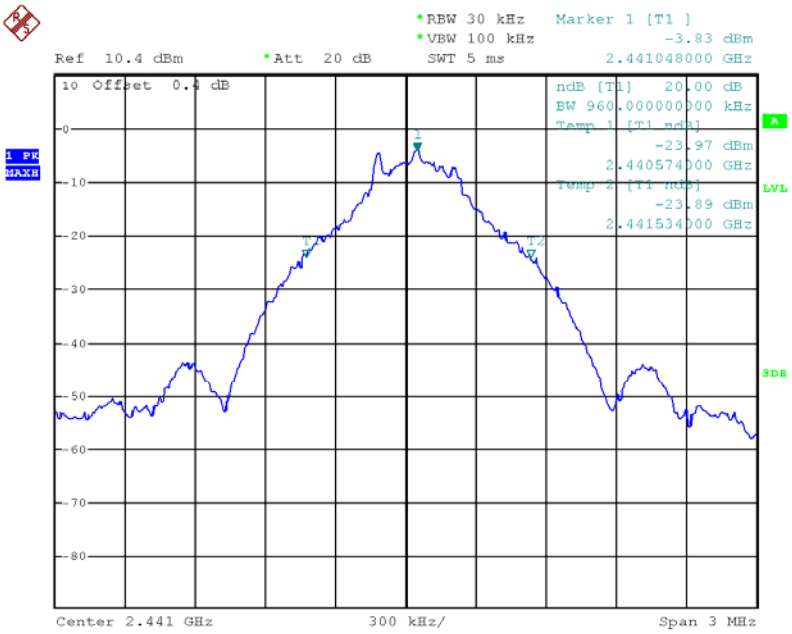
[Middle channel]



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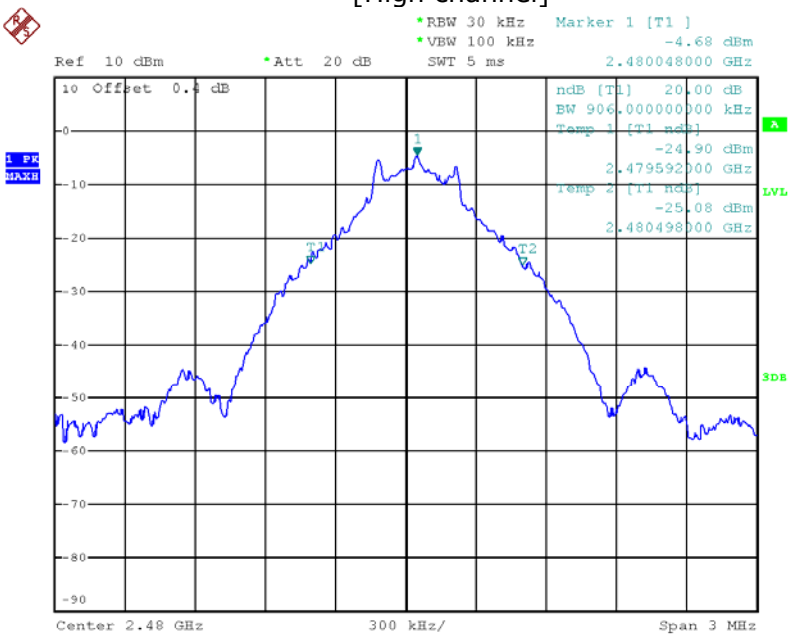
[High channel]



Date: 10.MAY.2017 14:09:58

2.1.4 Time of Occupancy (Dwell Time)

Test Procedures(ANSI C63.10-2013 7.8.4)

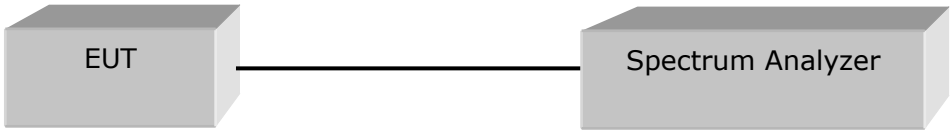
The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT has its hopping function enabled.

a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment
to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) =
(number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)



Limit

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

Test Results

Test mode : GFSK

Mode	Number of hops Channels	Length of Transmission Time(msec)	Result (msec)	Limit (msec)
DH1	79	0.596	**190.72**	400
DH3	79	1.690	**270.40**	400
DH5	79	2.940	**313.60**	400

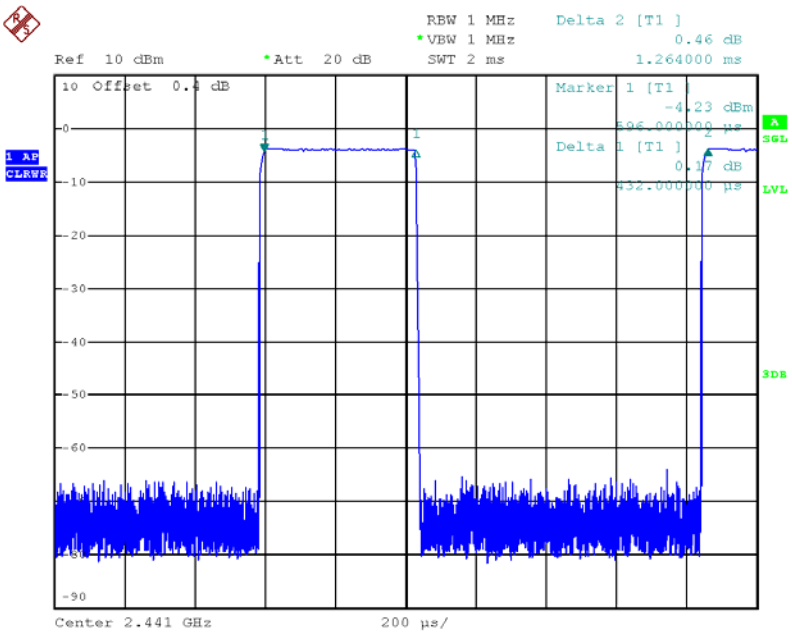
※ Remark:

dwell time = {(hopping rate / time slots) / hopping channel} x Hopping channel x Burst ON time x 0.4

- Time slots for DH1 = 2 slots(TX=1 slot / RX 1slot)
- Time slots for DH3 = 4 slots(TX=3 slot / RX 1slot)
- Time slots for DH5 = 6 slots(TX=5 slot / RX 1slot)
- Hopping Rate = 1600 for FH mode & 800 for AFH mode

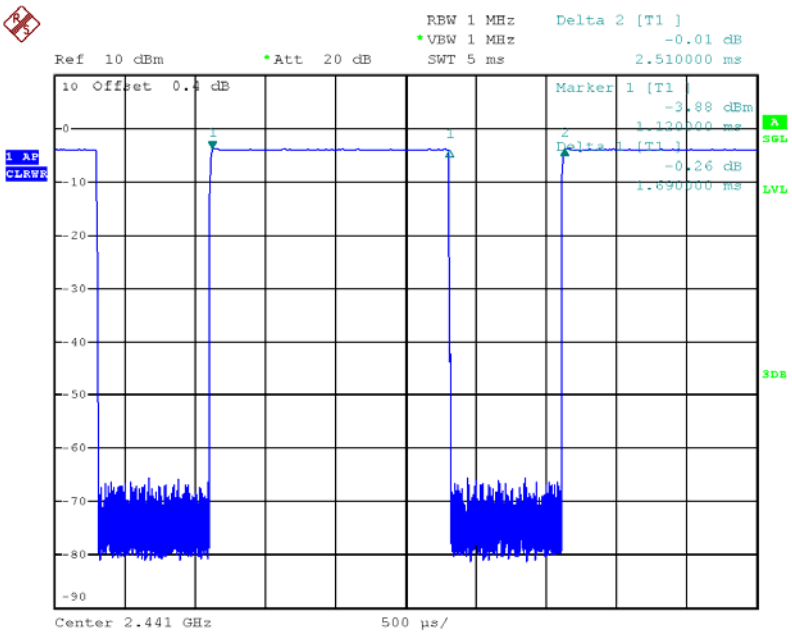
See next pages for actual measured spectrum plots.

Time of Occupancy for PACKET Type DH1(GFSK)



Date: 10.MAY.2017 14:24:18

Time of Occupancy for PACKET Type DH3(GFSK)



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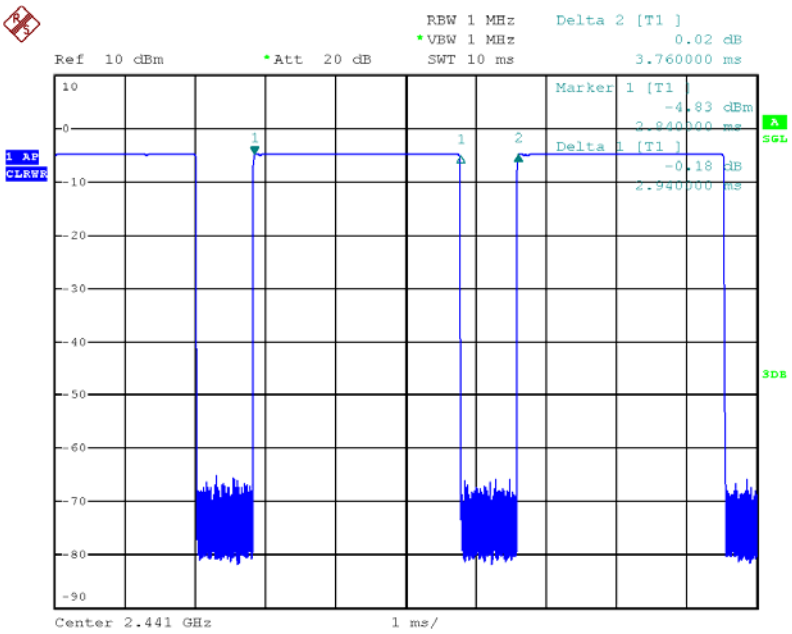
Time of Occupancy for PACKET Type DH5(GFSK)



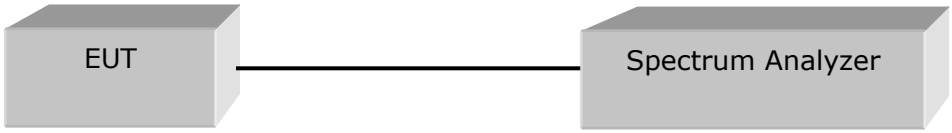
Date: 11.MAY.2017 14:12:33

2.1.5 Maximum peak Conducted Output Power

Test Procedures(ANSI C63.10-2013 7.8.5)

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test.

The spectrum analyzer is set to:
Center frequency = the highest, middle, and the lowest channels
Span = approximately 5 times of the 20 dB bandwidth
RBW > 20 dB bandwidth of the emission being measured
VBW ≥ RBW Detector function = peak
Trace = max hold Sweep = auto



Limit

For FHSS operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels.

Test Results

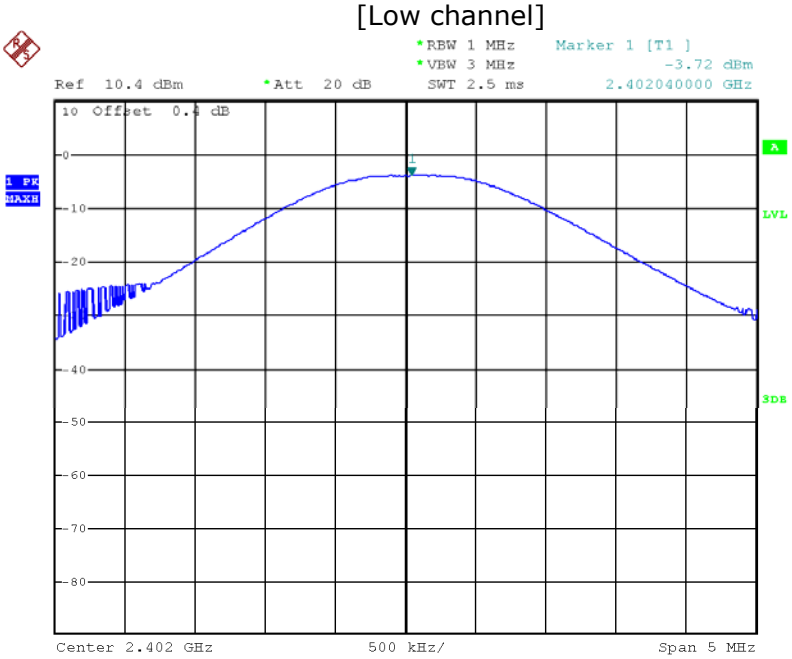
Test mode : GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency (MHz)	Channel No.	Peak output power(dBm)	Peak output power(mW)	Result
2 402	0	-3.72	0.43	Complies
2 441	39	-3.90	0.41	Complies
2 480	78	-4.90	0.32	Complies

See next pages for actual measured spectrum plots.

Maximum peak Conducted Output Power - GFSK

[Low channel]



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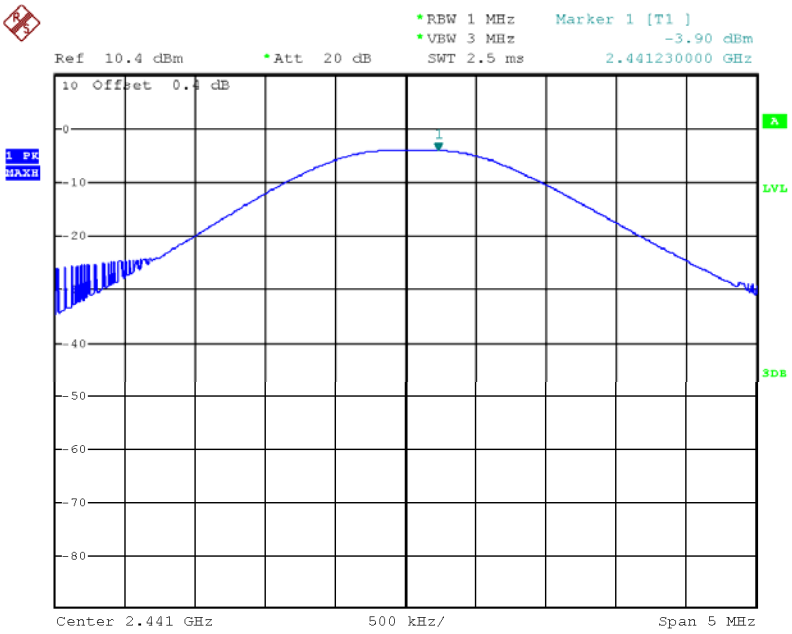
[Middle channel]



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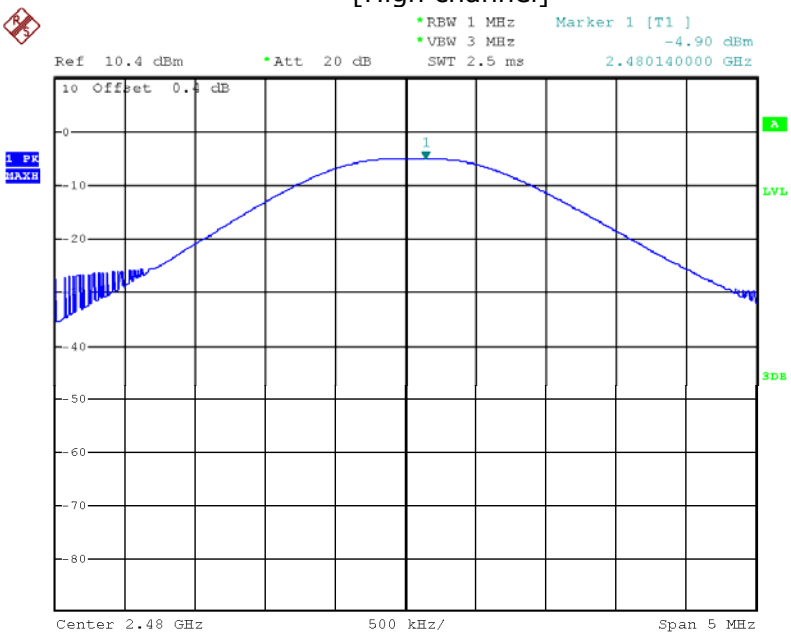
[High channel]



Date: 11.MAY.2017 15:43:01

2.1.6 Unwanted Emissions (Conducted)

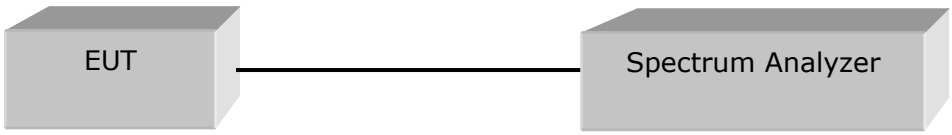
Test Procedures(ANSI C63.10-2013 7.8.6 / ANSI C63.10-2013 7.8.8)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen Issue 4 is not required.

The bandwidth at 20 dB down from the highest inband spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT has its hopping function disabled at the highest, middle and the lowest available channels.

The spectrum analyzer is set to:

RBW : 100 kHz
VBW : 300 kHz
Span : 30 MHz to 10 times the operating frequency in GHz
Detector function = peak
Trace : max hold Sweep = auto



Limit

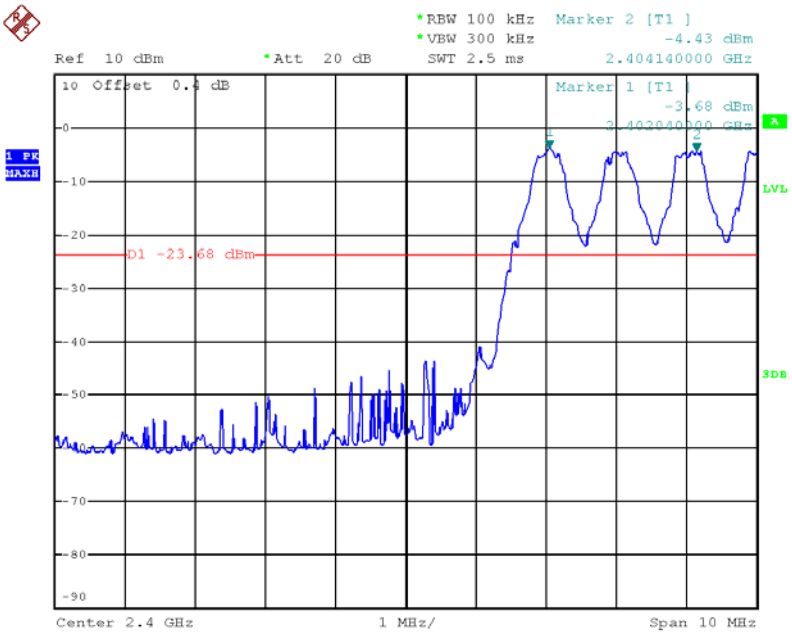
> 20 dBc

Test Results

All conducted emission in any 100 kHz bandwidth outside of the spectrum band was at least 20 dB lower than the highest level of the in-band spectral density.
Therefore the applying equipment meets the requirement.

See next pages for actual measured spectrum plots.

Band – edge (Hopping mode) - GFSK



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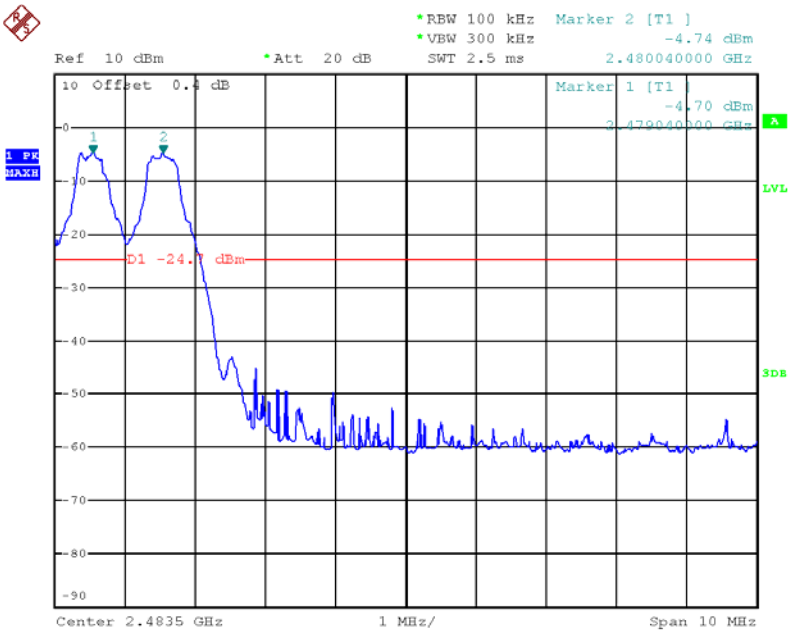

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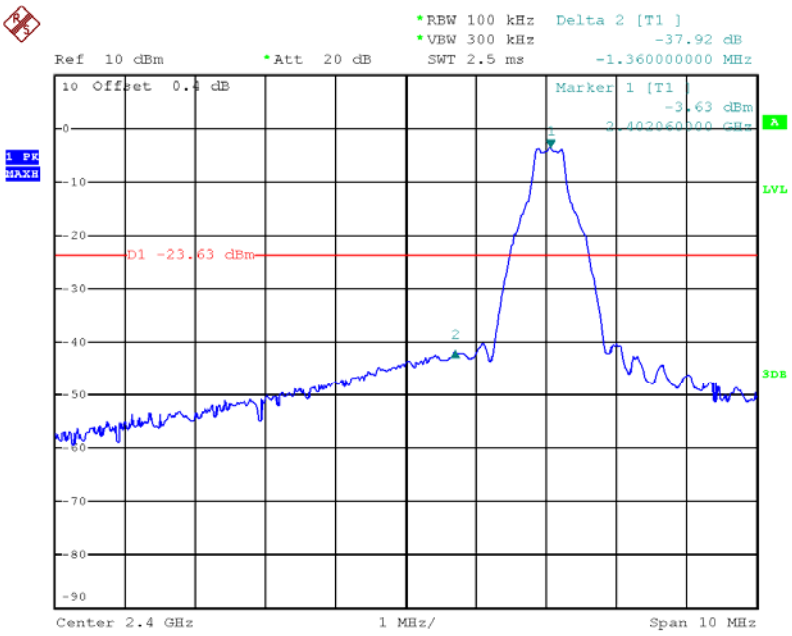
Band – edge (Non-Hopping mode) - GFSK



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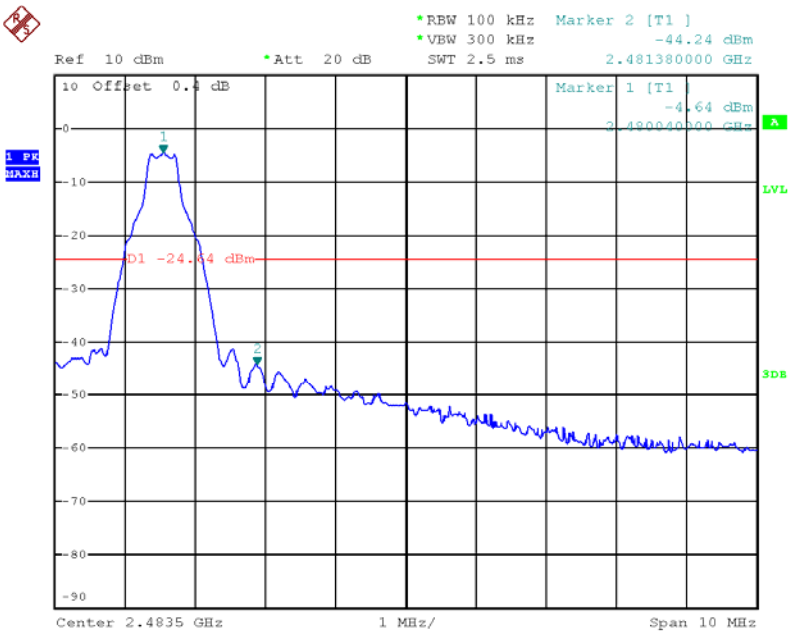
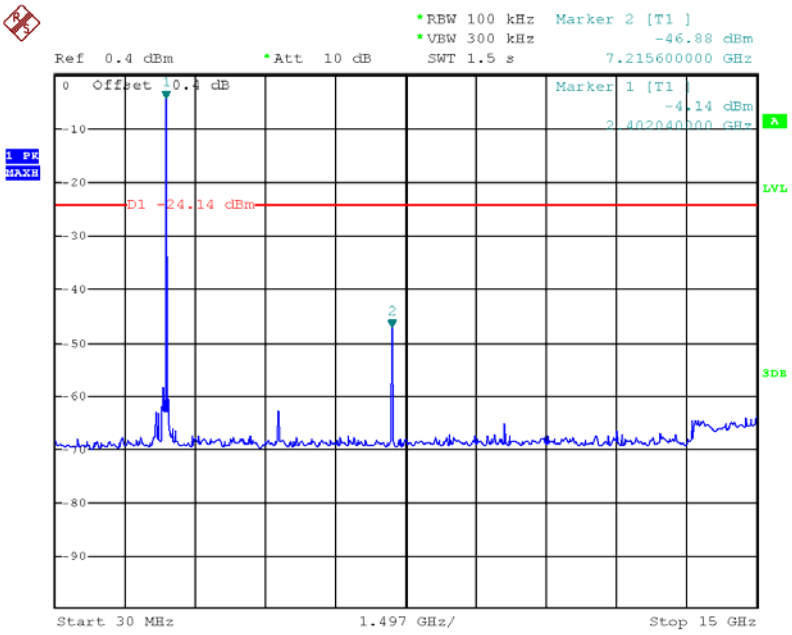


Date: 10.MAY.2017 14:59:17

Spurious (at 20 dB blow) – Low channel
Frequency Range = 30 MHz ~ 10th harmonic
(Test mode : GFSK)



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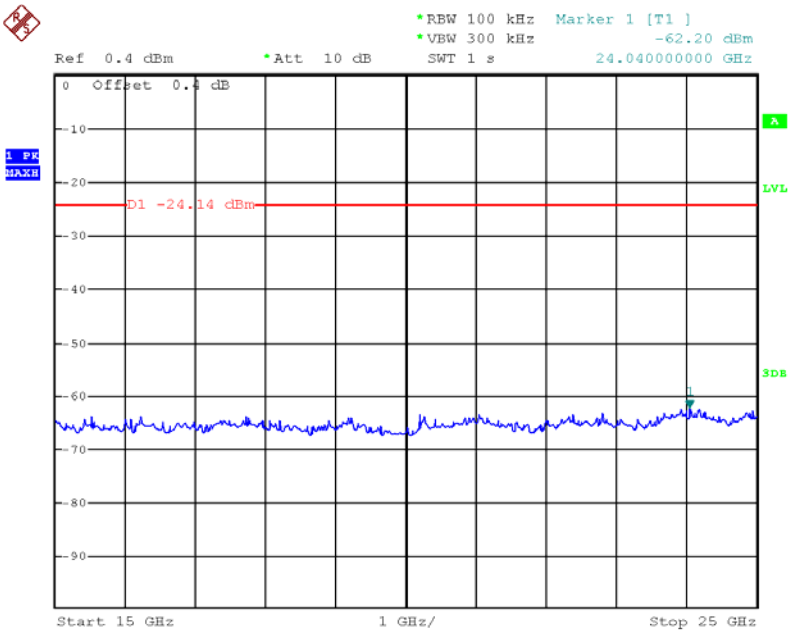
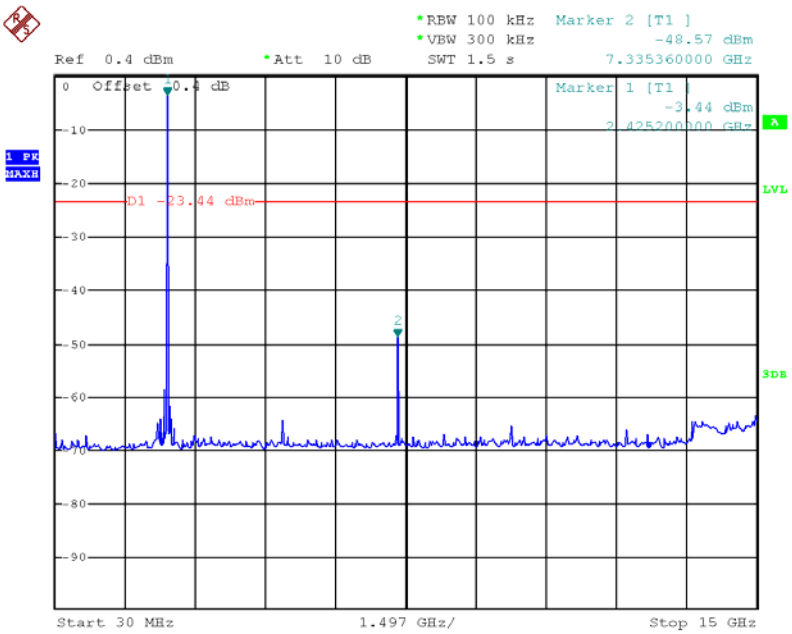


Date: 10.MAY.2017 15:10:03

Spurious (at 20 dB blow) – Mid channel
Frequency Range = 30 MHz ~ 10th harmonic
(Test mode : GFSK)



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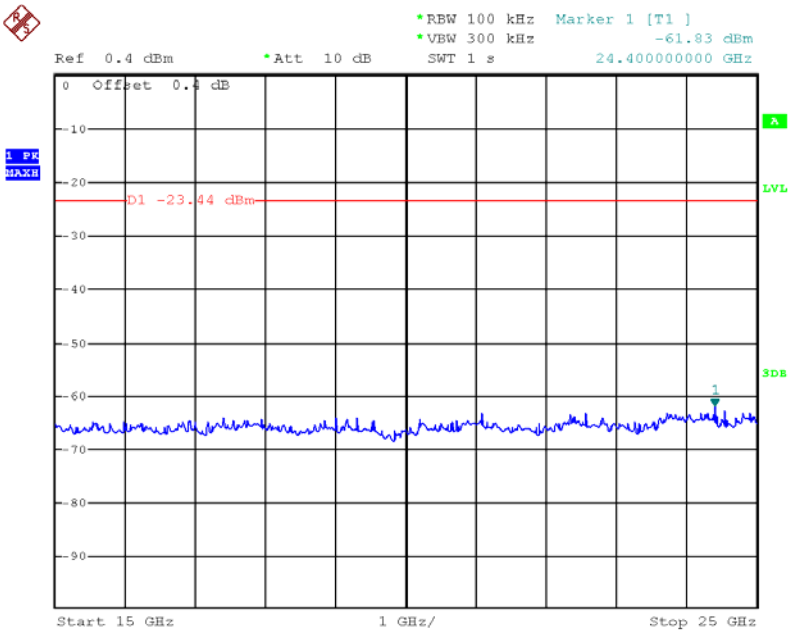
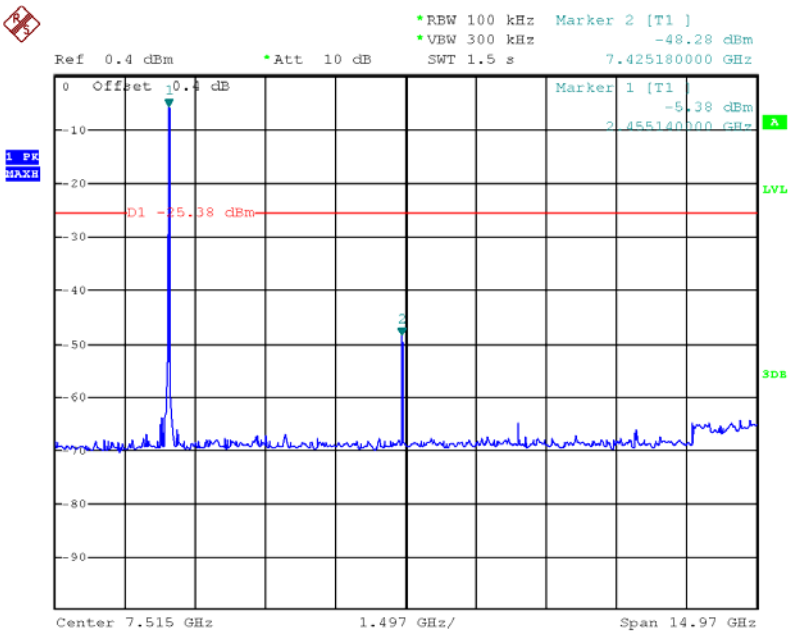


Date: 10.MAY.2017 15:12:46

Spurious (at 20 dB blow) – High channel
Frequency Range = 30 MHz ~ 10th harmonic
(Test mode : GFSK)



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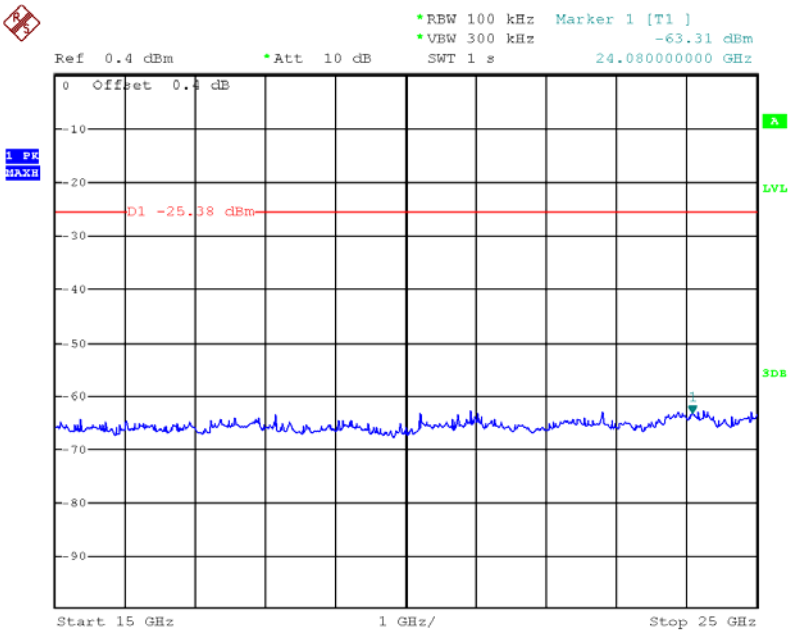


Date: 10.MAY.2017 15:14:59

2.1.7 Unwanted emissions (Radiated)

Test Location

☒ 10 m SAC (test distance : ☐ 10 m, ☒ 3 m)
☒ 3 m SAC (test distance : 3 m)

Test Procedures

1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. The Test Antenna is positioned with its plane vertical at 1m distance from the EUT. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
2) In the frequency rage above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) and Horn Test Antenna(above 1 GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.

The spectrum analyzer is set to:

Frequency Range = 9 kHz ~ 25 GHz (2.4 GHz 10^{th} harmonic)
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz, 9 kHz for f < 30 MHz
VBW ≥ RBW
Sweep = auto

Limit

§ 15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	MHz	GHz
0.09-0.11	8.37626-8.38675	73-74.6	399.9-410	2690-2900	10.6-12.7
[1]0.495-0.505	8.41425-8.41475	74.8-75.2	608-614	3260-3267	13.25-13.4
2.1735-2.1905	12.29-12.293	108-121.94	960-1240	3332-3339	14.47-14.5
4.125-4.128	12.51975-12.52025	123-138	1300-1427	3345.8-3358	15.35-16.2
4.17725-4.17775	12.57675-12.57725	149.9-150.05	1435-1626.5	3600-4400	17.7-21.4
4.20725-4.20775	13.36-13.41	156.52475-156.52525	1645.5-1646.5	4500-5150	22.01-23.12
6.215-6.218	16.42-16.423	156.7-156.9	1660-1710	5350-5460	23.6-24
6.26775-6.26825	16.69475-16.69525	162.0125-167.17	1718.8-1722.2	7250-7750	31.2-31.8
6.31175-6.31225	16.80425-16.80475	167.72-173.2	2200-2300	8025-8500	36.43-36.5
8.291-8.294	25.5-25.67	240-285	2310-2390	9000-9200	[2]Above 38.6
8.362-8.366	37.5-38.25	322-335.4	2483.5-2500	9300-9500	

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

[2] Above 38.6

§ 15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown is Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§ 15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

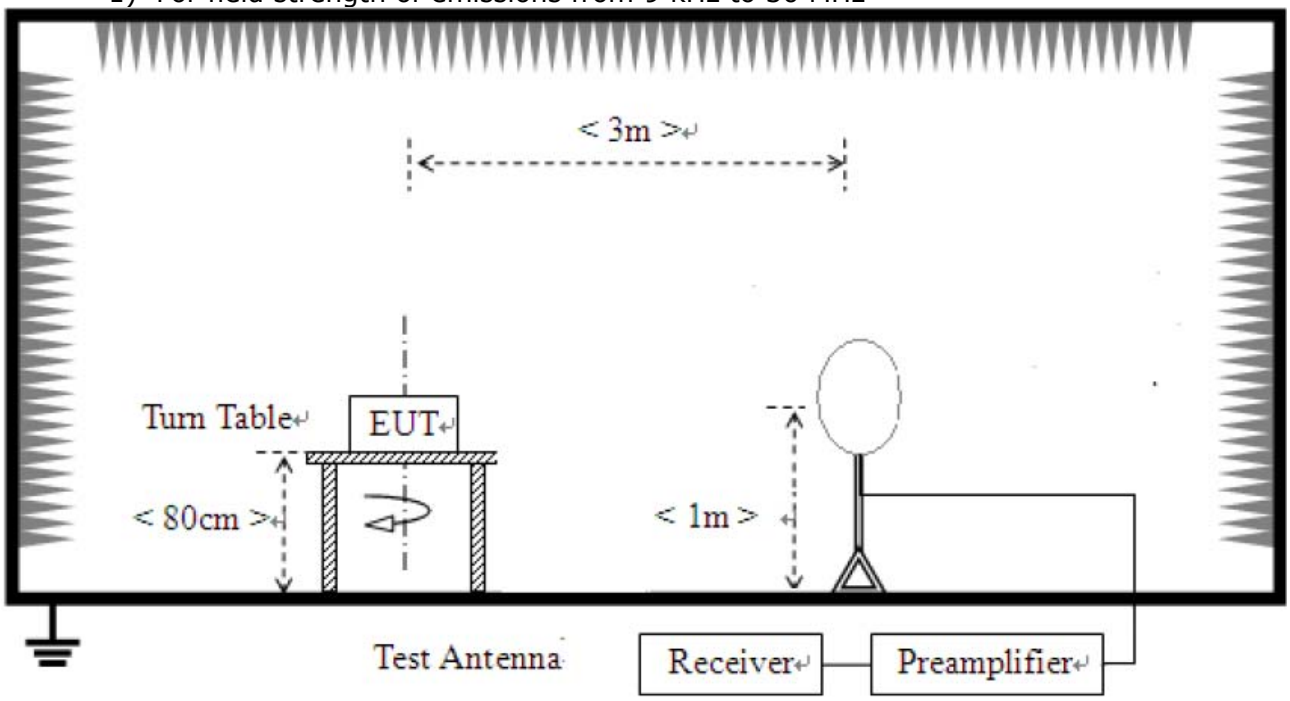
Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m	Deasurement Distance (meters)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705-30	30	-	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

** Except as provided in 15.209(g).fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

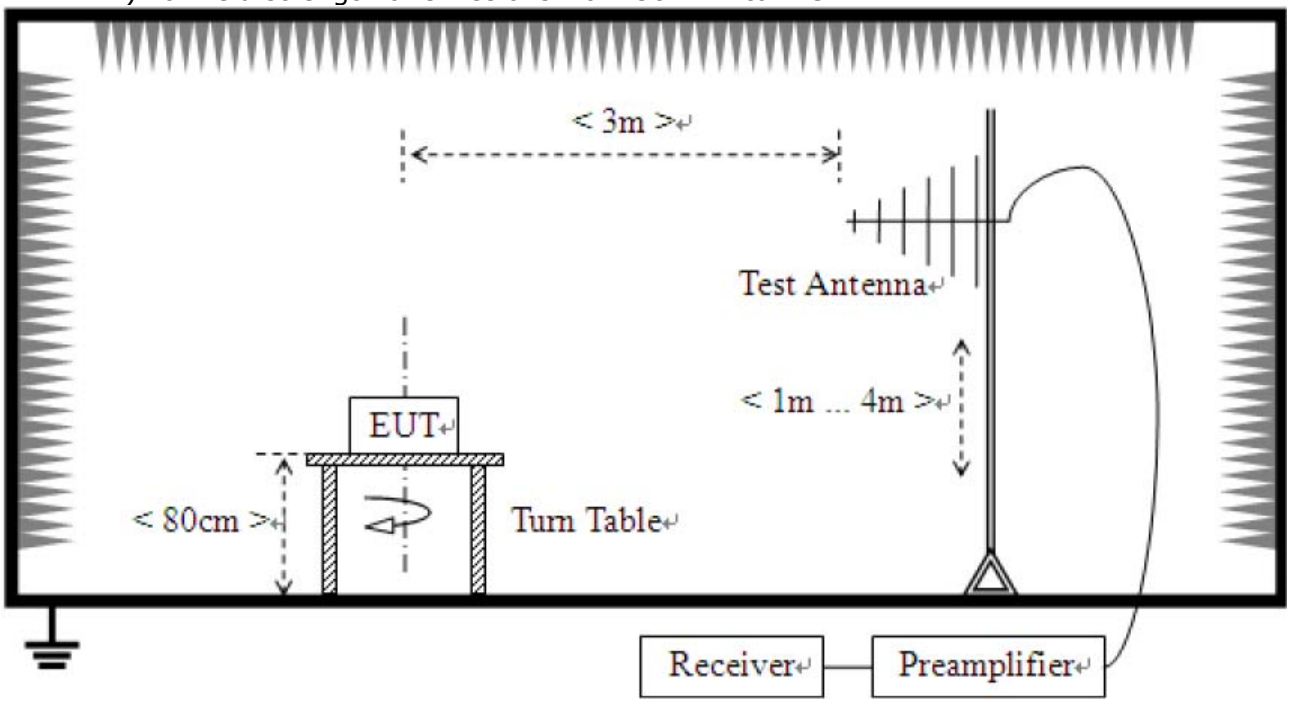
Note :
1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
2) For above 1 GHz, limit field strength of harmonics : 54 dBuV/m@3m (AV) and 74 dBuV/m@3m (PK)
3) For measurement above 1GHz, the resolution bandwidth is set to 1 MHz and video bandwidth is set to 1 MHz for peak measurement and 10 Hz for average measurement.(Duty Cycle is > 98%,)
4) Duty Cycle is < 98%, VBW setting will need to > 1/T.
(VBW : 390Hz) (T : minimum transmitter on time)

Test Setup:

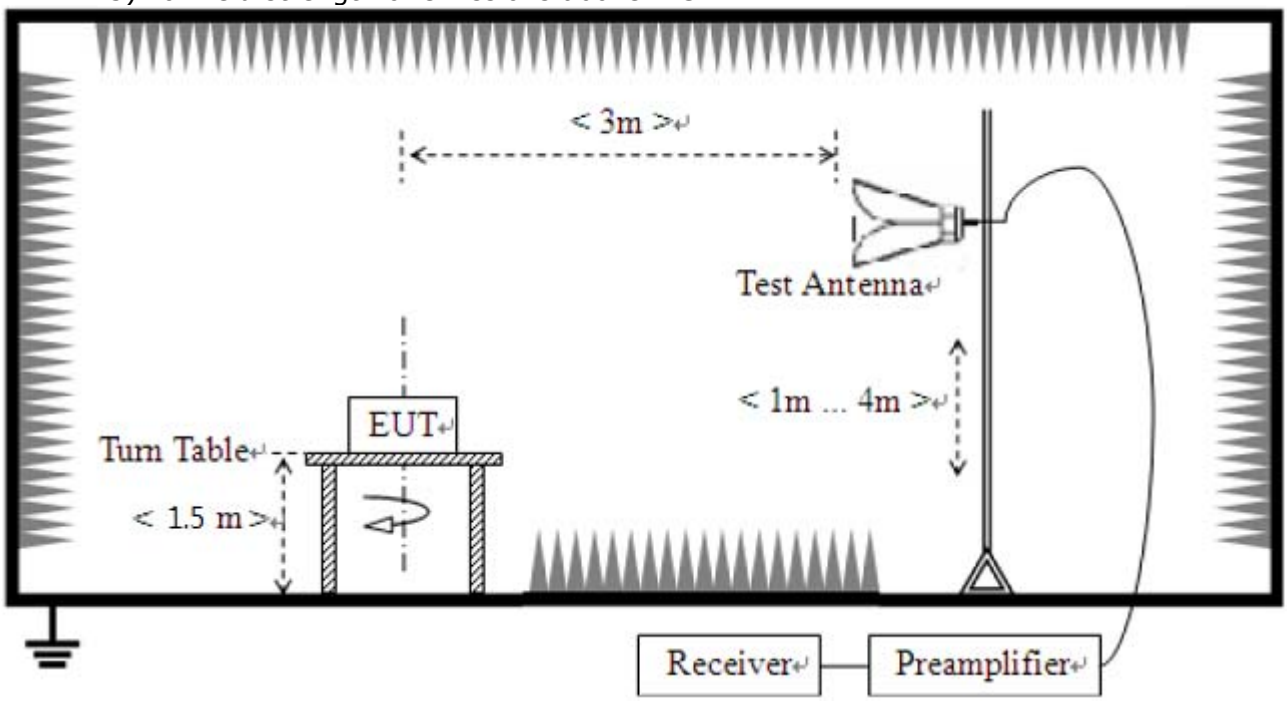
1) For field strength of emissions from 9 kHz to 30 MHz



2) For field strength of emissions from 30 MHz to 1 GHz



3) For field strength of emissions above 1 GHz



Test Results

1) 9 kHz to 30 MHz

EUT	Neo smartpen N2	Measurement Detail	
	Frequency Range	9 kHz – 30 MHz	
Test mode	GFSK(Worst case)	Detector function	Quasi-Peak

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
-	-	-	See note

Note :

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = 40 log (specific distance / test distance) (dB)

2) 30 MHz to 1 GHz(worst case)

Test mode : Hopping(GFSK), CFG PKT Packet Type : 15 Packet Size : 339(DH5)

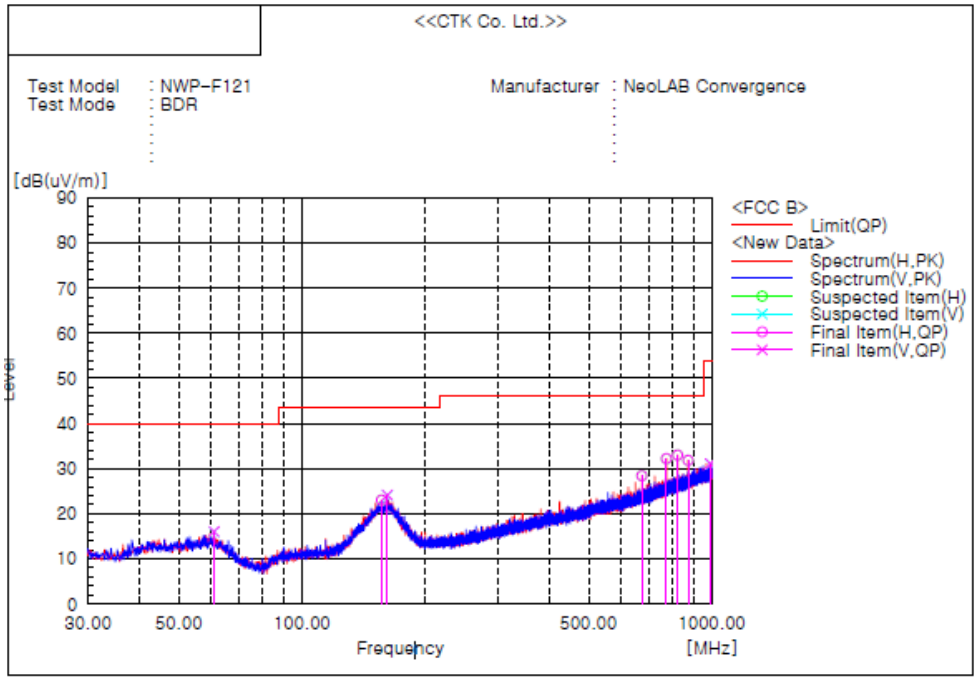
EUT	Neo smartpen N2	Measurement Detail	
Model	NWP-F121	Frequency Range	Below 1 000MHz
Mode	GFSK, Hopping	Detector function	Quasi-Peak

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
825.01	33.0	13.0	-

Test Data



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	o.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Angle [deg]
1	60.923	V	30.8	-14.8	16.0	40.0	24.0	194.5
2	156.116	H	29.8	-6.8	23.0	43.5	20.5	355.9
3	161.330	V	30.6	-6.5	24.1	43.5	19.4	67.9
4	675.009	H	33.7	-5.3	28.4	46.0	17.6	46.1
5	775.053	H	35.8	-3.6	32.2	46.0	13.8	27.6
6	825.014	H	35.9	-2.9	33.0	46.0	13.0	46.1
7	875.097	H	33.7	-1.9	31.8	46.0	14.2	46.1
8	991.390	V	31.0	0.1	31.1	54.0	22.9	289.4

Remark :
1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + Correction factor
3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain

3) above 1 GHz

[Low Channel]

EUT	Neo smartpen N2	Measurement Detail	
Model	NWP-F121	Frequency Range	1-25GHz
Channel	Channel 0	Detector function	Peak / Average

Remarks
We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
7 206.23	52.7	11.1	Average

Test Data

Test mode : Transmit, GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency [MHz]	Reading [dBuV/m] AV	Reading [dBuV/m] Peak	Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] Peak
7 206.227	37.02	45.33	H	1.5	5.9	54.0	74.0	42.9	51.2	11.1	22.8

Restricted band edge test data

Measured frequency range : 2310-2390 MHz

Test mode : GPSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency [MHz]	Reading [dBuV/m] AV	Reading [dBuV/m] Peak	Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] Peak
2 350.095	38.58	47.16	H	1.5	-4.3	54.0	74.0	34.3	42.9	19.7	31.1

[Middle Channel]

EUT	Neo smartpen N2	Measurement Detail	
Model	NWP-F121	Frequency Range	1-25GHz
Channel	Channel 39	Detector function	Peak

Remarks
We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
7 323.17	35.73	12.7	Average

Test Data

Test mode : GPSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency [MHz]	Reading [dBuV/m] AV	Reading [dBuV/m] Peak	Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] Peak
7 323.171	35.73	45.11	H	1.5	5.6	54.0	74.0	41.3	50.7	12.7	23.3

Restricted band edge test data

Measured frequency range : 2 310-2 390 MHz, 2 483.5-2 500 MHz

Test mode : GPSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency [MHz]	Reading [dBuV/m] AV / Peak	Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV / Peak	Result [dBuV/m] AV / Peak	Margin [dB] AV / Peak
No other emissions were detected at a level greater than 20dB below limit.							

[High channel]

EUT	Neo smartpen N2	Measurement Detail	
Model	NWP-F121	Frequency Range	1-25GHz
Channel	Channel 78	Detector function	Peak

Remarks
We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
7 440.16	32.83	15.1	Average

Test Data

Test mode : Transmit, GFSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency [MHz]	Reading [dBuV/m] AV	Reading [dBuV/m] Peak	Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] Peak
7 440.159	32.83	44.12	H	1.5	6.1	54.0	74.0	38.9	50.2	15.1	23.8

Restricted band edge test data

Measured frequency range : 2 310-2 390 MHz, 2 483.5-2 500 MHz

Test mode : GPSK, CFG PKT Packet Type : 15 Packet Size : 339(DH5)

Frequency [MHz]	Reading [dBuV/m] AV	Reading [dBuV/m] Peak	Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] Peak
2 483.5	31.5	58.7	H	1.5	-4.1	54.0	74.0	27.4	54.6	26.6	19.4

2.1.8 AC Power Line Conducted Emissions

Frequency Range of Measurement
150 kHz to 30 MHz

Instrument Settings
IF Band Width: 9 kHz

Test Procedures
The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m.
Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit
- **15.207(a)**

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 ~ 0.5	66 to 56*	56 to 46*
0.5 ~ 5	56	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency.

Test Results
The requirements are:

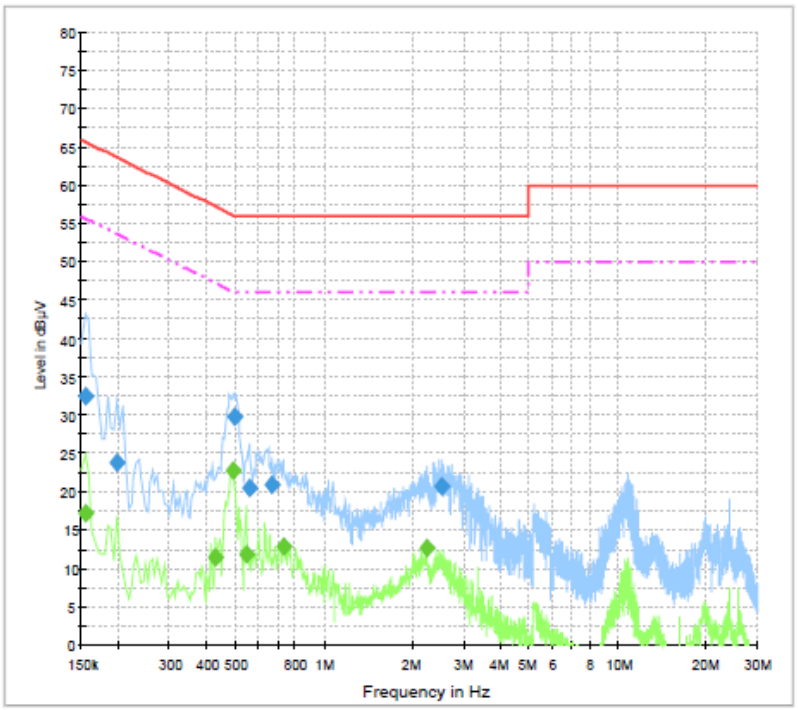
☒ Complies

Test mode : Charging mode

Frequency (MHz)	Measured Data (dBuV)	Margin (dB)	Remark
0.483	23.7	22.6	CAverage

Test Data

[L1]
Class B_L1



Final Result 1

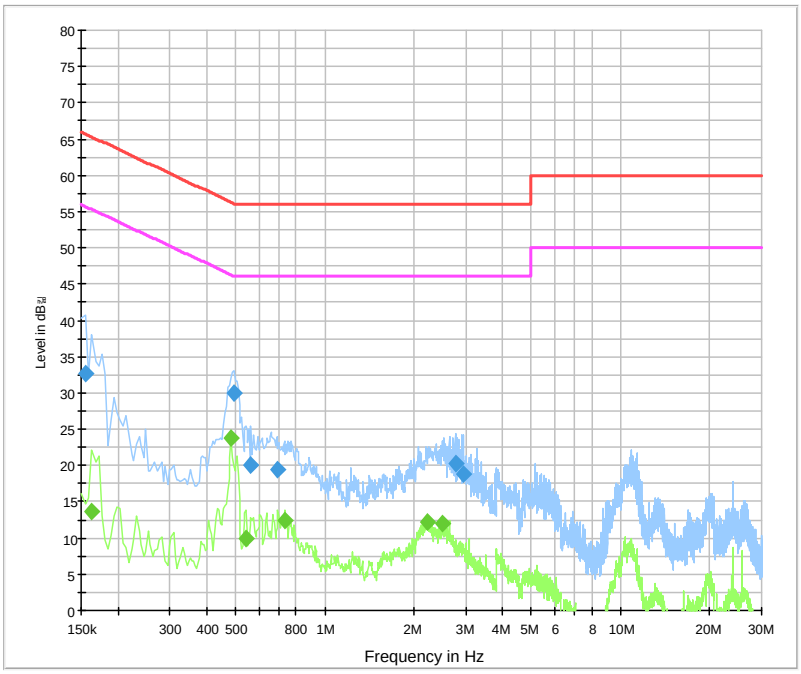
Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.154500	32.5	1000.0	9.000	GND	L1	0.0	33.2	65.8
0.199500	23.7	1000.0	9.000	GND	L1	0.0	39.9	63.6
0.496500	29.8	1000.0	9.000	GND	L1	0.0	26.3	56.1
0.559500	20.5	1000.0	9.000	GND	L1	0.0	35.5	56.0
0.672000	20.8	1000.0	9.000	GND	L1	0.0	35.2	56.0
2.521500	20.7	1000.0	9.000	GND	L1	0.1	35.3	56.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.154500	17.2	1000.0	9.000	GND	L1	0.0	38.5	55.8
0.429000	11.3	1000.0	9.000	GND	L1	0.0	36.0	47.3
0.492000	22.7	1000.0	9.000	GND	L1	0.0	23.4	46.1
0.546000	11.9	1000.0	9.000	GND	L1	0.0	34.1	46.0
0.730500	12.9	1000.0	9.000	GND	L1	0.0	33.1	46.0
2.251500	12.6	1000.0	9.000	GND	L1	0.1	33.4	46.0

[NEUTRAL]

Class B_N



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.154500	32.7	1000.0	9.000	GND	N	0.0	33.0	65.8
0.492000	30.0	1000.0	9.000	GND	N	0.0	26.1	56.1
0.564000	20.0	1000.0	9.000	GND	N	0.0	36.0	56.0
0.690000	19.4	1000.0	9.000	GND	N	0.0	36.6	56.0
2.760000	20.3	1000.0	9.000	GND	N	0.1	35.7	56.0
2.935500	18.8	1000.0	9.000	GND	N	0.1	37.2	56.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.163500	13.6	1000.0	9.000	GND	N	0.0	41.7	55.3
0.483000	23.7	1000.0	9.000	GND	N	0.0	22.6	46.3
0.541500	10.0	1000.0	9.000	GND	N	0.0	36.0	46.0
0.730500	12.5	1000.0	9.000	GND	N	0.0	33.5	46.0
2.224500	12.2	1000.0	9.000	GND	N	0.1	33.8	46.0
2.490000	12.1	1000.0	9.000	GND	N	0.1	33.9	46.0

2.1.9 Frequency Hopping System Requirements

Standard Applicable

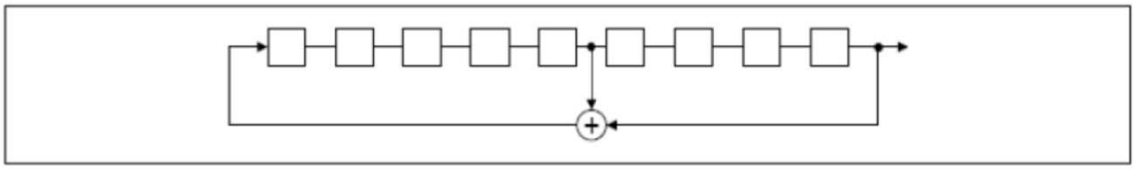
According to FCC Part 15.247(a)(1), The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

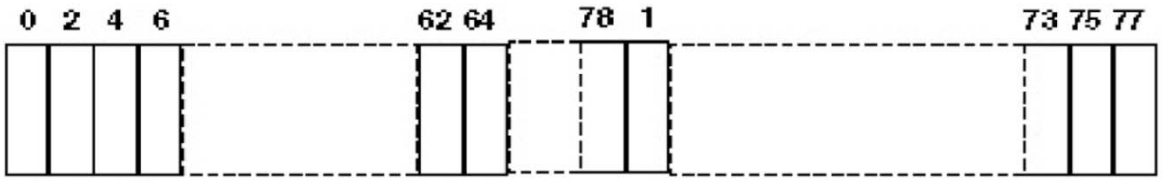
(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

EUT Pseudorandom Frequency Hopping Sequence

The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage, and the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones. Number of shift register stages: 9 Length of pseudo-random sequence: 29-1 = 511 bits Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence



Each frequency used equally on the average by each transmitter. The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

Frequency Hopping System

This transmitter device is frequency hopping device, and complies with FCC part 15.247 rule. This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centred from 2402 to 2480 MHz) in the range 2,400-2,483.5 MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

*Example for a Bluetooth device using channel numbers would be :
Ch 44, 35, 78, 03, 15, 21, 76, 40, 56, 13, 02, 19, 67, 39, 78, 20, 21, 64, 75 etc.

2.1.10 RF Exposure evaluation

Requirement

This device belongs to Mobile device. The definition of the category as following:

Mobile Derives:
CFR Title 47 §2.1091(b)
(b) For purposes of this section, a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.

FCC Limits

According to FCC Part 1.1307, systems operating under the provisions of this section shall be operated in a manner the ensures that the public is not exposed to radio frequency energy level in excess of the commission's guidelines.

Limits for General Population/Uncontrolled Exposure			
Frequency range (MHz)	**Electric field strength (V/m)**	**Magnetic field strength (A/m)**	**Power density (mW/cm^2)**
0.3-1.34	614	1.63	*100
1.34-30	824/f	2.19/f	$*180/f^2$
30-300	27.5	0.073	0.2
300-1,500			f/1500
1,500-100,000			**1.0**

f = frequency in MHz, * = Plane-wave equivalent power density

MPE Calculation formula

$$S = PG / 4\pi R^2$$

S = Power density
P = Output Power(W)
G = Power gain of the antenna in the direction of interest relative to an isotropic radiator
R = Separation distance between radiator and human body(m)

Result

Maximum peak output power at antenna input terminal(dBm): -3.72
Maximum peak output power at antenna input terminal(mW): 0.43
Prediction distance(cm): 20
Predication frequency(MHz): 2402
Antenna Gain (typical) (dBi): 2.28
Power density at predication frequency at 20 cm(mW/cm^2): **0.0001**

FCC MPE limit for RF exposure at prediction frequency(mW/cm^2): 1

So the SAR report is not required.

APPENDIX A – Test Equipment Used For Tests

	Name of Equipment	Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date
1	SPECTRUM ANALYZER	Rohde & Schwarz	FSP-30	100994	2016-11-01	2017-11-01
2	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2016-11-02	2017-11-07
3	EMI Test Receiver	Rohde & Schwarz	ESCI7	100816	2016-11-02	2017-10-31
4	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2016-05-14	2017-05-14
5	Bilog Antenna	Schaffner	CBL6111C	2551	2017-04-19	2019-04-19
6	Double Ridged Guide Antenna	ETS-Lindgren	3117	00154525	2015-09-02	2017-09-02
7	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2017-05-25	2018-05-25
8	Attenuator	Rohde & Schwarz	DNF	272.4110.50-2	2016-11-01	2017-11-01
9	PREAMPLIFIER	Agilent	8449B	3008A02011	2016-12-01	2017-12-01
10	AMPLIFIER	Sonoma Instrument Co.	310	291721	2017-02-02	2018-02-02
11	Signal Generator	Rohde & Schwarz	SMB100A	175528	2016-11-01	2017-11-01
12	DC POWER SUPPLY	HP	E3632A	MY40011638	2016-11-01	2017-11-01
13	LISN	Rohde & Schwarz	ENV216	101760	2017-02-03	2018-02-03
14	Band Reject Filter	Micro Tronics	BRM50702	G233	2017-02-03	2018-02-03