# TEST REPORT



**CTK Co., Ltd.** (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea Tel: +82-31-339-9970 Fax: +82-31-624-9501

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## 1. Client

- Name : Samsung Electronics Co., Ltd.
- Address: 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Republic of Korea
- Date of Receipt : 2019-10-08

## 2. Manufacturer

- Name : Samsung Electronics Co., Ltd.
- Address: 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Republic of Korea
- 3. Use of Report : For FCC Certification / ISED Certification
- 4. Test Sample / Model: Wi-Fi/BT Transceiver / WCP732M
- 5. Date of Test : 2019-10-11 to 2019-11-13
- 6. Test Standard(method) used : FCC 47 CFR part 15 subpart C 15.247

RSS-247 & RSS-Gen

- **7. Testing Environment:** Temp.: (25 ± 1) °C, Humidity: (50 ± 3) % R.H.
- 8. Test Results : Compliance

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Tested by Ji-Hye, Kim: (Signature	Technical Manager Won-Jae, Hwang: (Sghacure)
		2019-11-13
	Republic of KOREA CTK Co., Ltd.	



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## **REPORT REVISION HISTORY**

Date	Revision	Page No
2019-11-13	Issued (CTK-2019-04462)	all

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## **1. General Product Description**

## 1.1 Client Information

Company	Samsung Electronics Co., Ltd.
Contact Point	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Republic of Korea
Contact Person	Name : Minhyung Cho E-mail : mh719.cho@samsung.com Tel : +82-277-2688 Fax : -

## **1.2 Product Information**

FCC ID	A3LWCP732M
IC	649E-WCP732M
Product Description	Wi-Fi/BT Transceiver
Model name	WCP732M
Operating Frequency	2 402 MHz - 2 480 MHz
RF Output Power	GFSK : 11.752 dBm (14.969 mW) 8-DPSK : 11.645 dBm (14.605 mW)
Antenna Specification	Antenna type : PIFA Antenna Peak Gain : 2.1 dBi
Number of channels	79
Channel Spacing	1 MHz
Type of Modulation	GFSK(1Mbps), π/4 DQPSK(2Mbps), 8DPSK(3Mbps)
Power Source	DC 5 V
Hardware Rev	V1.5
Software Rev	FC4

## **1.3 Peripheral Devices**

Device	Manufacturer	Model No.	Serial No.
Note Computer	HP	15-bs563TU	CND7253QPR
AC/DC Adapter	HP	HSTNN-LA40	-



## 2. Facility and Accreditations

## 2.1 Test Facility

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

## 2.2 Laboratory Accreditations and Listings

Country	Agency	Registration Number
USA	FCC	805871
CANADA	ISED	8737A-2
KOREA	NRRA	KR0025

## 2.3 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.



## 3. Test Specifications

## 3.1 Standards

Section in FCC	Section in RSS	Requirement(s)	Status (Note 1)	Test Condition
15.247(a)	RSS-247 5.1(b)	Carrier Frequency Separation	С	
15.247(a)	RSS-247 5.1(d)	Number of Hopping Frequencies	С	
15.247(a)	RSS-247 5.1(a)	20 dB Bandwidth	С	Conducted
15.247(a)	RSS-247 5.1(d)	Time of occupancy (Dwell Time)	С	Conducted
15.247(b)	RSS-247 5.4(b)	Maximum peak conducted output power	С	
15.247(d)	RSS-247 5.5	Unwanted emission	С	
15.209	RSS-Gen 6.13	Transmitter emission	С	Radiated
15.207(a)	RSS-Gen 8.8	AC Conducted Emission C Line Conducted		
<u>Note 1</u> : C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable				
Note 2: The data in this test report are traceable to the national or international standards.				
<u>Note 3</u> : The sample was tested according to the following specification: FCC Part 15.247, ANSI C63.10-2013, RSS-247 Issue 2, RSS-GEN Issue 5				

## 3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments. During at testing, system components were manipulated within the confines of typical usage to maximize each emission. All modulation modes were tests. The results are only attached worst cases.

#### Test Frequency

Lowest channel	Middle channel	Highest channel
2 402 MHz	2 441 MHz	2 480 MHz

#### Test mode

Modulation	Packet type	Data rate	Duty Cycle
GFSK	DH5	1 Mbps	57.4 %
8-DPSK	3-DH5	3 Mbps	57.6 %



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## 3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter. Coverage factor k = 2, Confidence levels of 95 %

Description	Uncertainty
Conducted RF Output Power	1.5 dB
Occupied Bandwidth	0.1 MHz
Unwanted Emission(conducted)	3.0 dB
Radiated Emissions (f $\leq$ 1 GHz)	4.0 dB
Radiated Emissions (f > 1 GHz)	5.0 dB

#### 3.4 Test Software

Conducted Test	Ics Pro Ver. 6.0.3
Radiated Test	TOYO EMI software EP5RE Ver. 6.0.1.0
Line Conducted Test	ESCI7, ESCI3 : EMC32 Ver. 8.50.0
	ESR7 : EMC32 Ver. 8.53.0



## 4. Technical Characteristic Test

## 4.1 Carrier Frequency Separation

#### **Test Procedures**

ANSI C63.10-2013 - Section 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:

- a) Span = 5 MHz (wide enough to capture the peaks of two adjacent channels)
- b) RBW = 30 kHz (Start with the RBW set to approximately 30% of the channel spacing;

adjust as necessary to best identify the center of each individual channel)

- c) VBW = 30 kHz ( $\geq$  RBW) d) Sweep = auto
- e) Detector function = peak
- f) Trace = max hold

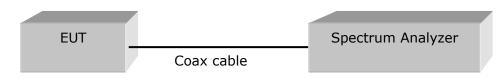


Figure 1 : Measurement setup for the carrier frequency separation

#### 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

Channel	Adjacent Hopping Channel Separation [kHz]	Two-third of 20dB bandwidth [kHz]	Minimum Bandwidth [kHz]	Result
Middle	980	643.1	25	Complies

#### Test mode : 8-DPSK

Channel	Adjacent Hopping Channel Separation [kHz]	Two-third of 20dB bandwidth [kHz]	Minimum Bandwidth [kHz]	Result
Middle	995	844.0	25	Complies

See next pages for actual measured spectrum plots.



gilent Spectrum Analyzer - Swept SA 03:20:47 PM Oct 22, 2019 TRACE 1 2 3 4 5 6 TYPE M WWWWWW DET P P P P P F Peak Search Marker 1 Δ 980.000000 kHz Avg Type: Log-Pwr Avg|Hold:>100/100 Trig: Free Run #Atten: 30 dB PNO: Wide IFGain:Low Ext Gain: -0.60 dB Next Peak ΔMkr1 980 kHz -0.018 dB 10 dB/div Ref 20.00 dBm 1<u>Δ</u>2 Next Pk Right Next Pk Left Marker Delta Mkr→CF Mkr→RefLvl More 1 of 2 Center 2.441000 GHz #Res BW 30 kHz Span 5.000 MHz Sweep 6.733 ms (1001 pts) #VBW 30 kHz

#### Test mode : GFSK

Test mode : 8-DPSK





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## 4.2 Number of Hopping Frequencies

#### **Test Procedures**

ANSI C63.10-2013 - Section 7.8.3

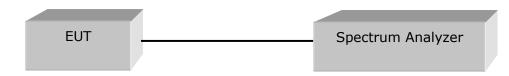
The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:

a) Frequency range	1: Start = 2389.5 MHz, Stop = 2439.5 MHz
	2: Start = 2439.5 MHz, Stop = 2489.5 MHz

b) RBW = 300 kHz (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)

c) VBW = 300 kHz ( $\geq$ RBW)	d) Sweep = auto
e) Detector function = peak	f) Trace = max hold



#### Limit

FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

#### **Test Results**

Test mode : GFSK

Total number of Hopping Channels	Result
79	Complies

#### Test mode : 8-DPSK

Total number of Hopping Channels	Result
79	Complies

See next pages for actual measured spectrum plots.



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vzer Swept S 03:21:06 PM Oct 22, 2019 TRACE 1 2 3 4 5 6 TYPE M WWWW DET P P P P P SENSE:INT Marker 1 Δ 37.00000000 MHz PNO: Fast IFGain:Low HAtten: 30 dB Peak Search Avg Type: Log-Pwr Avg|Hold:>100/100 Ext Gain: -0.60 dB Next Peak ΔMkr1 37.000 0 MHz -0.016 dB 10 dB/div Ref 20.00 dBm 1Δ2 Next Pk Right Next Pk Left Marker Delta Mkr→CF runderhaladontaly Mkr→RefLvi More 1 of 2 Start 2.39000 GHz #Res BW 300 kHz Stop 2.43950 GHz Sweep 1.000 ms (1001 pts) #VBW 300 kHz STATUS



R RF 50 Ω AC arker 1 40.000000000		SENSE:INT	ALIGNAUTO Avg Type: Log-Pwr	03:21:34 PM Oct 22, 2019 TRACE 1 2 3 4 5 6	Peak Search
	PNO: Fast 🖵 IFGain:Low	Trig: Free Run #Atten: 30 dB	Avg Hold:>100/100 Ext Gain: -0.60 dB		
dB/div Ref 20.00 dBn	n		ΔΝ	1kr1 40.00 MHz -0.036 dB	NextPea
a Xaluuuuuuuu	ากกกกก		MANANAN	1Δ2	Next Pk Rig
0.0					Next Pk L
D.0					Marker De
D.0				M <sub>L</sub>	Mkr→
0.0				U. Aler fred a the offer of the offer	Mkr→Ref
art 2.43950 GHz				Stop 2.48950 GHz	<b>M</b> d 1 d
Res BW 300 kHz	#VBW	300 kHz	Sweep 1	.000 ms (1001 pts)	



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Test Mode	:	8-DPSK
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		00.40.07.01			or wat	051				t Spectrum Ai	Agilen XI R
Peak Search	M Oct 22, 2019 CE 123456 PE MWWWWW ET P P P P P P	TRAC	100/100	Avg Type Avg Hold: Ext Gain:			10: Fast 🖵	000 MHz		ker 1 40.	
Next Pea	00 MHz .157 dB	lkr1 40.		Ext Gain:	dB	#Atten: 30	ain:Low		f 20.00 d	3/div Re	10 dE
Next Pk Rig		142	ᠰᠾᡐᡟᡗ	ᡢᢦᠯᠯᡐ		ᠰᡎ᠕᠕	$\gamma \gamma $	MAN	WW	Xp. ww	Log 10.0
Next Pk Le											0.00
Marker De											20.0 30.0
Mkr→C	With one										40.0 50.0
Mkr→RefL	Tenthernen of the standing of										60.0
<b>Mo</b> 1 of	8950 GHz (1001 pts)	Stop 2.48	weep_1			300 kHz	#VBW			t 2.43950 s BW 300	
			STATUS								SG



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## 4.3 20 dB bandwidth & 99% Bandwidth

#### **Test Procedures**

ANSI C63.10-2013 - Section 6.9.2 RSS-GEN Issue 5 - Section 6.7

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.

#### **Test Procedures**

ANSI C63.10-2013 - Section 6.9.3 RSS-GEN Issue 5 - Section 6.7

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

Use the 99% power bandwidth function of the instrument and report the measured bandwidth.

The spectrum analyzer is set to:

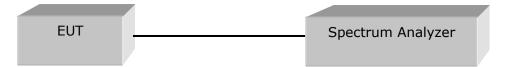
Center frequency = the highest, middle and the lowest channels

a) Span = 3 MHz (between 2 times and 5 times the OBW)

- b) RBW = 30 kHz (1% to 5% of the OBW)
- c) VBW = 100 kHz (approximately 3 times RBW)
- d) Sweep = auto

e) Detector function = peak

f) Trace = max hold



#### Limit

Limit : N/A



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## **Test Results**

#### Test mode : GFSK

Channel	Frequency [MHz]	20 dB Bandwidth [MHz]	99% Bandwidth [MHz]	Result
Low	2 402	0.965	0.877	Complies
Middle	2 441	0.964	0.870	Complies
High	2 480	0.964	0.872	Complies

#### Test mode : 8-DPSK

Channel	Frequency [MHz]	20 dB Bandwidth [MHz]	99% Bandwidth [MHz]	Result
Low	2 402	1.266	1.149	Complies
Middle	2 441	1.263	1.148	Complies
High	2 480	1.266	1.150	Complies

See next pages for actual measured spectrum plots.



#### GFSK - Lowest Frequency (2 402 MHz)

#### [20 dB Bandwidth and 99% Bandwidth]



#### GFSK - Middle Frequency (2 441 MHz)

#### [20 dB Bandwidth and 99% Bandwidth] Occupied BW





#### GFSK - Highest Frequency (2 480 MHz)

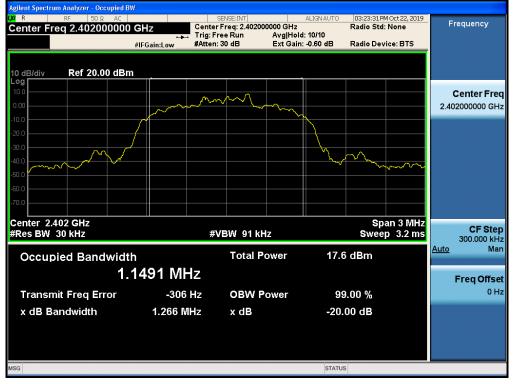
#### [20 dB Bandwidth and 99% Bandwidth]





#### 8-DPSK - Lowest Frequency (2 402 MHz)

#### [20 dB Bandwidth and 99% Bandwidth]



#### 8-DPSK - Middle Frequency (2 441 MHz)

#### [20 dB Bandwidth and 99% Bandwidth]





## 8-DPSK - Highest Frequency (2 480 MHz)

#### [20 dB Bandwidth and 99% Bandwidth]

Agilent Spectrum Analyzer - Occupied	BW					
X         R         RF         50 Ω         AC           Center Freq 2.48000000	0 GHz #IFGain:Low	SENSE:INT Center Freq: 2.4800 Trig: Free Run #Atten: 30 dB	ALIGN 00000 GHz Avg Hold: 10/10 Ext Gain: -0.60	Radio Std: 0		Frequency
10 dB/div Ref 20.00 dB	m		<u>.</u>			
0.00		mm				Center Freq 2.480000000 GHz
-20.0						
-40.0					~~~~~	
-60.0						
Center 2.48 GHz #Res BW 30 kHz		#VBW 91 ki	Hz		an 3 MHz p   3.2 ms	CF Step 300.000 kHz
Occupied Bandwid	th	Total P	ower	17.7 dBm		<u>Auto</u> Man
1	.1502 MH	z				Freq Offset
Transmit Freq Error	-632	Hz OBW F	ower	99.00 %		0 Hz
x dB Bandwidth	1.266 MI	Hz xdB		-20.00 d <b>B</b>		
MSG				STATUS		



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#### 4.4 Time of Occupancy

#### **Test Procedures**

ANSI C63.10-2013 - Section 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  $\leq$  channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.

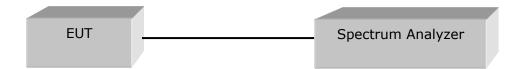
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system 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 =  $(number of hops on spectrum analyzer) \times (period specified in the requirements / analyzer sweep time)$ 



#### 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	Transmit time per hop(msec)	Result (msec)	Limit (msec)
DH1	79	0.375	120.00	400
DH3	79	1.625	260.00	400
DH5	79	2.870	306.13	400

#### Test mode : 8-DPSK

Mode	Number of hops Channels	Transmit time per hop(msec)	Result (msec)	Limit (msec)
3-DH1	79	0.380	121.60	400
3-DH3	79	1.630	260.80	400
3-DH5	79	2.880	307.20	400

#### **\* Remark:**

Average time of occupancy = Transmit time per hop \* Number of hopping channels in 31.6s

According the BLUETOOTH STANDARD SPECIFICATION, the nominal hop rate is 1600 hop/s. All bluetooth units participating in the piconet are time and hop synchronized to the channel.

- The maximum number of hopping channels in 31.6s for DH1 = 1600 / 2 / 79 \* 31.6 = 320- The maximum number of hopping channels in 31.6s for DH3 = 1600 / 4 / 79 \* 31.6 = 160- The maximum number of hopping channels in 31.6s for DH5 = 1600 / 6 / 79 \* 31.6 = 107

See next pages for actual measured spectrum plots.



R RF 50 Ω arker 3 Δ 2.12500 m	AC		JEINS	E:INT		ALIGN AU					
		:Fast ↔	. Trig: Free		Avg Typ	e: Log-P	wr	TRAC	1 Oct 22, 2019 E 1 2 3 4 5 6 PE WWWWWW T P N N N N N	Prop	erties
		n:Low	#Atten: 30	dB	Ext Gain:	-0.60 dE	-			Select	
dB/div Ref 20.00 dE	Зm								125 ms 0.61 dB		3
9 0.0 00	X <sub>2</sub>	ົ\1∆2					3∆1			Rela	tive To
0 0 0 0										X Ax <u>Auto</u>	t <b>is Sca</b> Tim M
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enter 2.441000000 GH es BW 1.0 MHz	lz	#VBW	1.0 MHz			Sweep	5.00		pan 0 Hz 1001 pts)	On	Lin
A         MODE         TRC         SCL           Δ2         1         t         (Δ)           5         Δ1         1         t           Δ1         1         t         (Δ)           5         Δ1         1         t         (Δ)	1.320	0μs (Δ) ms ms (Δ)	-0.62 d 11.42 dB 0.61 d	iB m	CTION FU	NCTION WI		FUNCTIO	IN VALUE		

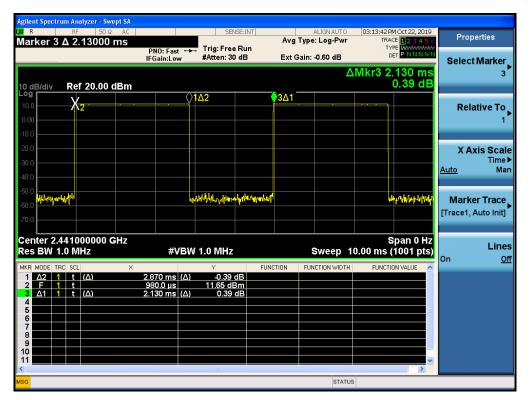
## Transmit time for PACKET Type DH1(GFSK)

## Transmit time for PACKET Type DH3(GFSK)

ilent Spectrum Analyzer - Swept SA R RF 50 Ω AC arker 3 Δ 875.000 μs	PNO: Fast ↔→ IFGain:Low #Atten: 30 dB	ALIGNAUTO Avg Type: Log-Pwr Ext Gain: -0.60 dB	03:12:55 PM Oct 22, 2019 TRACE 1 2 3 4 5 6 TYPE WWWWWW DET P N N N N N	Properties Select Marker
) dB/div Ref 20.00 dBm		1	∆Mkr3 875.0 µs 0.16 dB	3
×2		<u>1Δ2</u> 3Δ1		Relative To
				X Axis Scal <sup>Time</sup> <u>Auto</u> Ma
0.0 0.0 0.0 0.0		watyhtistringen		Marker Trace [Trace1, Auto Init]
enter 2.441000000 GHz es BW 1.0 MHz	#VBW 1.0 MHz	Sweep 5	Span 0 Hz 5.000 ms (1001 pts)	Line On <u>O</u>
	Υ         Υ           1.625 ms         (Δ)         -0.16 dB           1.160 ms         11.63 dBm           875.0 μs         (Δ)         0.16 dB	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	

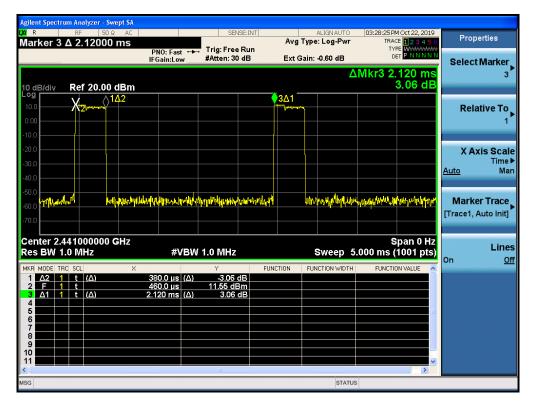


## Transmit time for PACKET Type DH5(GFSK)





#### Transmit time for PACKET Type 3-DH1(8-DPSK)

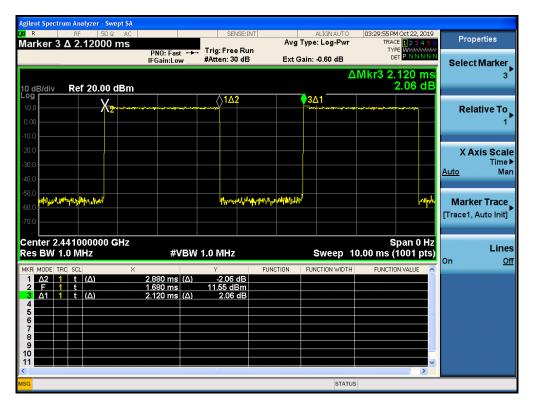


#### Transmit time for PACKET Type 3-DH3(8-DPSK)

R RF 50Ω AC arker 3 Δ 870.000 μs	PNO: Fast ↔→→ Trig: Free IFGain:Low #Atten: 30	Run	e: Log-Pwr :: -0.60 dB	29:16 PM Oct 22, 2019 TRACE 123456 TYPE WWWWWWW DET PNNNNN	Properties Select Marker
dB/div Ref 20.00 dBm			ΔMk	r3 870.0 µs 2.85 dB	3
	μινομα-γγη-γγ 	<b>♦</b> 3∆1	**************************************		<b>Relative To</b> 1
					X Axis Sca Time <u>Auto</u> Ma
0.0 Wett	nhayarayahar	1404 <sup>44</sup>		withing deliging and	<b>Marker Trace</b> [Trace1, Auto Init
enter 2.441000000 GHz es BW 1.0 MHz	#VBW 1.0 MHz		Sweep 5.000		Lin On <u>(</u>
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Υ 1.630 ms (Δ) -2.85 240.0 μs 11.57 dE 870.0 μs (Δ) 2.85	dB 3m		FUNCTION VALUE	



#### Transmit time for PACKET Type 3-DH5(8-DPSK)





## 4.5 Maximum peak Conducted Output Power

#### **Test Procedures**

ANSI C63.10-2013 - Section 7.8.5

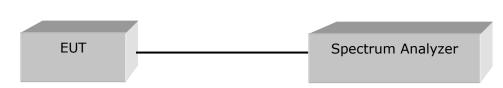
This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test.

#### The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

- a) Span = 5 MHz (approximately 5 times of the 20 dB bandwidth)
- b) RBW = 3 MHz (greater than the 20 dB bandwidth of the emission being measured)
- c) VBW = 3 MHz ( $\geq$  RBW)
- e) Trace = max hold

d) Detector = peakf) 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.



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#### **Test Results**

Test mode : GFSK

Frequency [MHz]	Channel No.	Output Power [dBm]	Output power [mW]	Result
2 402	0	11.307	13.511	Complies
2 441	39	11.752	14.969	Complies
2 480	78	11.536	14.243	Complies

Test mode : 8-DPSK

Frequency [MHz]	Channel No.	Output Power [dBm]	Output power [mW]	Result	
2 402	0	11.436	13.919	Complies	
2 441	39	11.645	14.605	Complies	
2 480	78	11.419	13.864	Complies	

See next pages for actual measured spectrum plots.



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#### Test Mode : GFSK

#### [Lowest channel]

R RF			SENSE:INT	ALIGNAUTO	03:07:17 PM Oct 22, 2019	Frequency
enter Freq	2.40200000	0 GHz PN0: Fast ⊊ IFGain:Low	Trig: Free Run #Atten: 30 dB	Avg Type: Log-Pwr Avg Hold:>30/30 Ext Gain: -0.60 dB	TRACE 123456 TYPE MWWWWW DET PPPPP	requercy
dB/div Re	f 20.00 dBm	II Gail.Low			2.401 985 GHz 11.307 dBm	Auto Tur
			1			Center Fre 2.402000000 GH
00						<b>Start Fre</b> 2.399500000 Gi
1.0						<b>Stop Fr</b> 2.404500000 G
).0						CF Ste 500.000 kl Auto M
.0						Freq Offs 0
enter 2.4020					Span 5.000 MHz	
Res BW 3.0 I	VIHZ	#VBW	3.0 MHz	Sweep 1	.000 ms (1001 pts)	

#### [Middle channel]

Agilent Spectrum Analyzer - Swep					
RF 50 Ω Center Freq 2.441000	AC DOOD GHz PN0: Fast	SENSE:INT	ALIGNAUTO Avg Type: Log-Pwr Avg Hold:>30/30	03:10:05 PM Oct 22, 2019 TRACE 1 2 3 4 5 6 TYPE M	Frequency
10 dB/div Ref 20.00 dE	IFGain:Low	#Atten: 30 dB	Ext Gain: -0.60 dB Mkr1	2.440 845 GHz 11.752 dBm	Auto Tune
10.0		<b>∮</b> <sup>1</sup>			Center Freq 2.441000000 GHz
-10.0					<b>Start Freq</b> 2.438500000 GHz
-20.0					<b>Stop Freq</b> 2.443500000 GHz
-40.0					<b>CF Step</b> 500.000 kHz <u>Auto</u> Man
-60.0					<b>Freq Offset</b> 0 Hz
Center 2.441000 GHz #Res BW 3.0 MHz	#VBW	3.0 MHz	Sweep 1	Span 5.000 MHz .000 ms (1001 pts)	
MSG			STATUS		



[Highest channel]

Agilent Spectrum Analyze								
Renter Freq 2.48	50Ω AC	GHz	SENSE:INT	Avg Type	ALIGNAUTO	03:16:32 PM Oct 22, TRACE 1 2 3	456	requency
		PNO: Fast IFGain:Low	Trig: Free Run #Atten: 30 dB	Avg Hold: Ext Gain:	-0.60 dB	TYPE MWW DET PPP	P P P	
10 dB/div Ref 20	.00 dBm				Mkr1	2.479 845 C 11.536 d	iHz Bm	Auto Tune
10.0			<b>♦</b> <sup>1</sup>					Center Fred 80000000 GH
10.0							2.4	<b>Start Fred</b> 77500000 GH:
20.0							2.4	<b>Stop Fre</b> 82500000 GH
40.0							Auto	<b>CF Stej</b> 500.000 kH Ma
60.0								Freq Offse 0 H
70.0								
Center 2.480000 ( #Res BW 3.0 MHz		#VBW	3.0 MHz		Sweep 1	Span 5.000 ľ .000 ms (1001	/IHz pts)	
MSG					STATUS			



#### Test Mode : 8-DPSK

		Lowe	st cnanne	IJ			
Agilent Spectrum Analyzer - Swept SA							
M <sup>2</sup> R RF 50Ω AC Center Freq 2.402000000	GHz PN0: Fast 😱 IFGain:Low	SENSE:IM Trig: Free Rui #Atten: 30 dB	Avg Type		03:23:17 PM TRACE TYPE DE	Oct 22, 2019 1 2 3 4 5 6 M P P P P P P P	Frequency
10 dB/div Ref 20.00 dBm	II Gall.20w				2.401 9 11.43	70 GHz 86 dBm	Auto Tune
10.0		1					Center Freq 2.402000000 GHz
-10.0							Start Freq 2.399500000 GHz
-20.0							<b>Stop Freq</b> 2.404500000 GHz
-40.0							<b>CF Step</b> 500.000 kHz <u>Auto</u> Man
-60.0							Freq Offset 0 Hz
-70.0 Center 2.402000 GHz					Span 5	000 MHz	
#Res BW 3.0 MHz	#VBW	3.0 MHz		Sweep 1	1.000 ms (1	001 pts)	
MSG				STATU			

#### [Lowest channel]

#### [Middle channel]

Agilent Spectrum Analyzer	- <mark>Swept SA</mark> 50 Ω AC		051				00.05.54.0		
Center Freq 2.44	1000000 GI	Hz		ISE:INT	Avg Type	ALIGNAUTO	TRAC	4 Oct 22, 2019 E 1 2 3 4 5 6 E M 444444	Frequency
10 dB/div Ref 20.0	IF	PNO: Fast 🕞	Trig: Free #Atten: 30		Avg Hold: Ext Gain:	-0.60 dB	2.440 9	30 GHz	Auto Tune
10.0			<b>\</b>	1					Center Freq 2.441000000 GHz
-10.0									<b>Start Freq</b> 2.438500000 GHz
-20.0									<b>Stop Freq</b> 2.443500000 GHz
-40.0									CF Step 500.000 kHz <u>Auto</u> Man
-60.0									Freq Offset 0 Hz
Center 2.441000 G #Res BW 3.0 MHz	Hz	#VBW	3.0 MHz			Sweep 1	Span 5 .000 ms (	.000 MHz 1001 pts)	
MSG						STATUS			



[Highest channel]

Agilent Spectrum Analyzer - Swept SA				
X R RF 50Ω AC Center Freq 2.480000000	GHz PNO: East Trig: Free Run	ALIGNAUTO Avg Type: Log-Pwr Avg Hold:>30/30	03:32:25 PM Oct 22, 2019 TRACE 1 2 3 4 5 6 TYPE M	Frequency
10 dB/div Ref 20.00 dBm	PNO: Fast 🎧 Trig: Free Run IFGain:Low #Atten: 30 dB	Ext Gain: -0.60 dB	2.479 960 GHz 11.419 dBm	Auto Tune
10.0	<b>1</b>			Center Freq 2.480000000 GHz
-10.0				Start Free 2.477500000 GH:
-20.0				<b>Stop Fred</b> 2.482500000 GH:
-40.0				CF Step 500.000 kH Auto Mar
-60.0				Freq Offse 0 H:
-70.0 Center 2.480000 GHz #Res BW 3.0 MHz	#VBW 3.0 MHz	Sweep 1	Span 5.000 MHz .000 ms (1001 pts)	
MSG		STATUS		



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## 4.6 Unwanted Emissions (Conducted)

#### **Test Procedures**

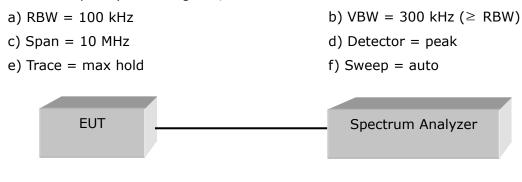
ANSI C63.10-2013 - Section 7.8.6, 7.8.8

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.

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:

Center frequency = the highest, middle and the lowest channels



#### 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.

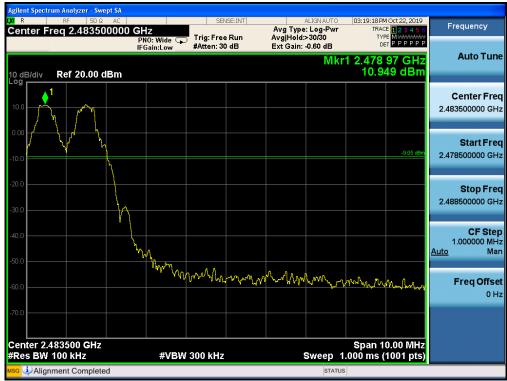


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## Band Edge

Test Mode : Hopping mode, GFSK









#### Test Mode : Hopping mode, 8-DPSK





	Analyzer - Swept SA								
	RF 50 Ω AC	) GHz PNO: Wide 🗔	PNO: Wide 🕟 Trig: Free Run		ALIGNAUTO Avg Type: Log-Pwr Avg Hold:>30/30		03:07:43 PM Oct 22, 2019 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P P P P P P		Frequency
10 dB/div R	ef 20.00 dBm	IFGain:Low	#Atten: 30	dB	Ext Gain:		1 2.402	00 GHz I0 dBm	Auto Tune
10.0						1			Center Freq 2.400000000 GHz
-10.0								-8.99 dBm	<b>Start Freq</b> 2.395000000 GHz
-20.0					$\overline{\mathbf{n}}$		\		<b>Stop Freq</b> 2.405000000 GHz
-40.0			AA	www			Law have	\	<b>CF Step</b> 1.000000 MHz <u>Auto</u> Man
-60.0	n war	V.M. Maria	www.y					-v Ww	<b>Freq Offset</b> 0 Hz
Center 2.400	0000 GHz	#\/B\W	300 kHz			Sweep 1.	Span 10	0.00 MHz	
MSG			000 MH2			STATUS	eco ma (	noor proj	

#### Test Mode : Non-Hopping mode, GFSK







#### Test Mode : Non-Hopping mode, 8-DPSK





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## **Spurious Emission**

#### Test Mode : GFSK

[Lowest channel]

Agilent Spectr	rum Analyzer - Swept SA RF 50 Ω AC		CENCE	TAIT			00,00,57,04	0-+22,2010	
	req 7.515000000	O CHZ PNO: Fast Trig: Free Run IFGain:Low #Atten: 30 dB		un	ALIGN AUTO Avg Type: Log-Pwr Avg Hold>30/30 Ext Gain: -0.60 dB		03:08:57 PM Oct 22, 2019 TRACE 1 2 3 4 5 6 TYPE MWWWWW DET P P P P P P		Frequency
10 dB/div	Ref 20.00 dBm	I Guilleow					1kr1 3.3 -33.8	23 GHz 37 dBm	Auto Tune
10.0									<b>Center Fred</b> 7.515000000 GH:
-10.00								-8.85 dBm	Start Free 30.000000 MH:
-20.0									<b>Stop Fre</b> 15.000000000 GH
40.0									CF Ste 1.497000000 GH <u>Auto</u> Ma
60.0 <mark></mark>	digite law and a state of the second state of	the photogenetic and the second second	al yester being the	ronderstance	and the section	huulupiyat <sup>y fl</sup> oosa <sup>pi</sup>	the all all a features	golanamin	Freq Offse 0 H
-70.0 Start 30 N #Res BW		#VBW	300 kHz			Sweep	Stop 15. 1.431 s (	000 GHz 1001 pts)	
SG						STATUS			





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[Middle Channel]



	DΩ AC	SENSE:INT	ALIGNAUTO Avg Type: Log-Pwr	03:15:19 PM Oct 22, 2019	Frequency
enter Freq 20.00	UUUUUUU GHZ PNO: Fast IFGain:Low		Avg Hold>30/30 Ext Gain: -0.60 dB	TRACE 123456 TYPE M WWWWW DET P P P P P P	
0 dB/div Ref 20.0	0 dBm		Ν	/lkr1 23.98 GHz -47.903 dBm	Auto Tur
-					Center Fre 20.000000000 GF
0.00				-8.96 dBm	<b>Start Fr</b> 15.000000000 Gi
80.0					<b>Stop Fr</b> 25.000000000 G
0.0			the second statement and the second		CF St 1.000000000 G <u>Auto</u> M
50.0	and the many test where the second	har and the second descent of the first second and the second second second second second second second second	**************************************		Freq Offs 0
* tart 15.000 GHz Res BW 100 kHz		BW 300 kHz		Stop 25.000 GHz 55.7 ms (1001 pts)	



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[Highest Channel]



	100 kHz		#VBW	300 kHz			Sweep 9	55.7 ms (	1001 pts)	
tart 15.0	000 GHz	^						Stop 25	.000 GHz	
0.0										
0.0										Freq Offs 0
0.0	لهدوده فسيعوله سيد والعمواج	U <sup>PYYY</sup> YYYY <mark>YYY</mark>	Marine and	have have been were	the ward a state of a	P. Low Production	REAR PARTE AND ALL PROPERTY	valville <sup>togt fritte</sup> t her ge <sup>ger</sup>	"Who and the work of the	
									1	1.00000000 G <u>Auto</u> N
0.0										CF St
0.0										25.000000000
0.0										Stop Fi
0.0									-8.99 dBm	15.000000000 0
.00										Start Fi
0.0										20.000000000
										Center F
) dB/div	Ref 20.00	dBm							22 dBm	
			Gain:Low	#Atten: 30	l dB	Ext G	ain: -0.60 dB		03 GHz	Auto Tu
enter F	req 20.000		PNO: Fast 🗔	Trig: Free		AvgiH	ype: Log-Pwr old:>30/30	TRAC TYI	CE 1 2 3 4 5 6 PE M WWWWWW ET P P P P P P	Frequency
R	RF 50 S			SEN	ISE:INT		ALIGN AUTO		4 Oct 22, 2019	<b>F</b>

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#### Test Mode : 8-DPSK

[Lowest channel]







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[Middle Channel]



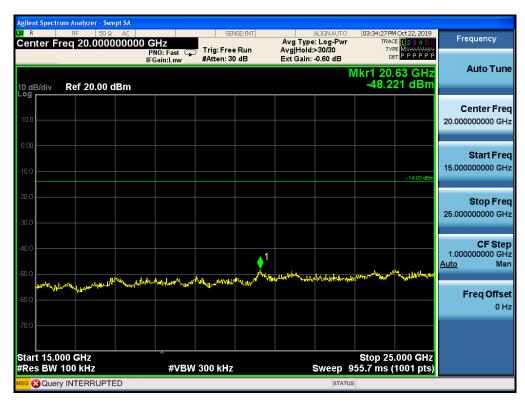




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[Highest Channel]







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### 4.7 Radiated Emission

#### Test Location

 $\boxtimes$  10 m SAC (test distance :  $\square$  10 m,  $\boxtimes$  3 m)  $\boxtimes$  3 m SAC (test distance : 3 m)

#### **Test Procedures**

ANSI C63.10-2013 - Section 6.5, 6.6

- 1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. 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.

#### Instrument Settings

Frequency Range = 9 kHz  $\sim$  25 GHz (2.4 GHz 10<sup>th</sup> harmonic)

a) RBW = 1 MHz for f  $\geq$  1 GHz, 100 kHz for f < 1 GHz, 9 kHz for f < 30 MHz

- b) VBW  $\geq$  RBW
- c) Sweep time = auto couple



#### Limit :

Unwanted emissions that do not fall within the restricted frequency bands of Table 1 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

FCC Part 15 § 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
<sup>1</sup> 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	<sup>2</sup> Above 38.6
8.362-8.366	37.5-38.25	322-335.4	2483.5-2500	9300-9500	

**Table 1. Restricted Frequency Bands** 

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

### <sup>2</sup> 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.



FCC Part 15 § 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 :

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 2 Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m	Measurement 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

#### Table 2. General Field Strength Limits for Licence-Exempt Transmitters

\*\* 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 :

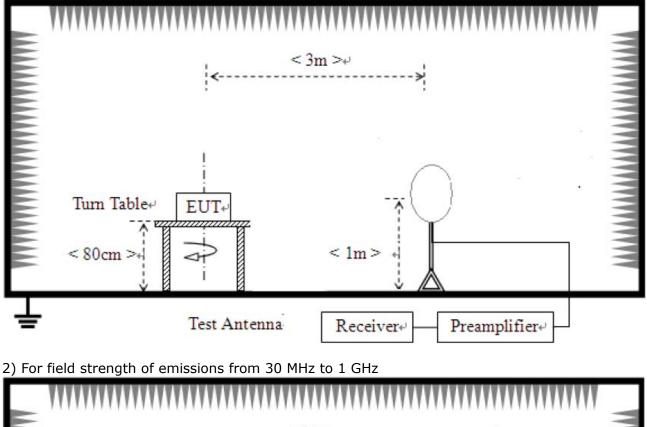
- 1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
- For above 1 GHz, limit field strength of harmonics : 54 dBuV/m@3m (AV) and 74 dBuV/m@3m (PK)
- 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.

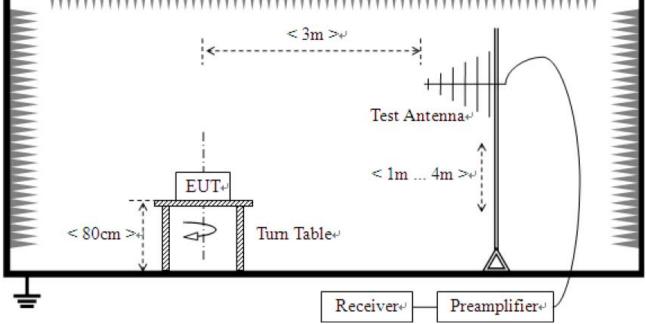


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# Test Setup:



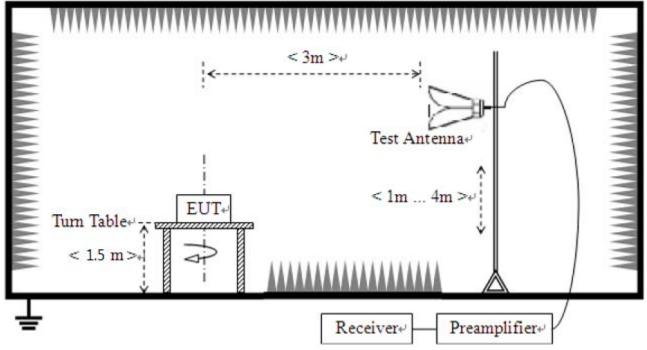






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## 3) For field strength of emissions above 1 GHz





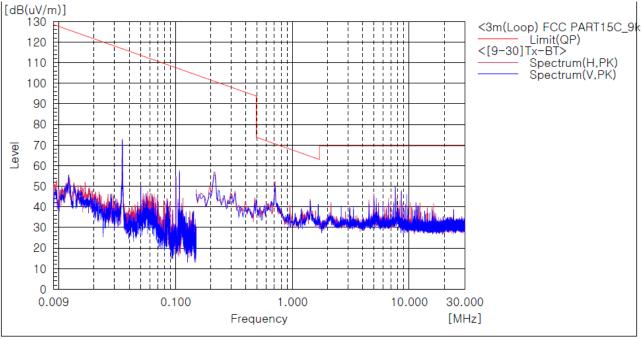
### **Test results**

#### 1) 9 kHz to 30 MHz

Test mode : Transmitter (Worst Case)

The requirements are:  $\square$  Complies

### Test Data



Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark					
The emissions 9 kHz to 30 MHz were 20 dB lower than the limit.								

#### Remark :

1. The unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down positon(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.

2. Result = Reading + c.f(Correction factor)

3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain

4. This data is the Peak(PK) value.

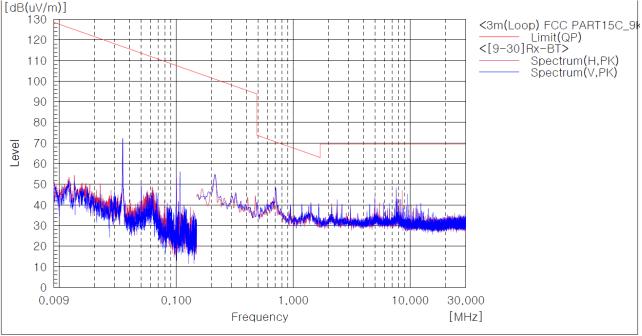


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#### Test mode : Receiver (Worst Case)

The requirements are:  $\square$  Complies

### Test Data



Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark						
The emissions 9 kHz to 30 MHz were 20 dB lower than the limit.									

#### Remark :

1. The unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down positon(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.

2. Result = Reading + c.f(Correction factor)

3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain

4. This data is the Peak(PK) value.



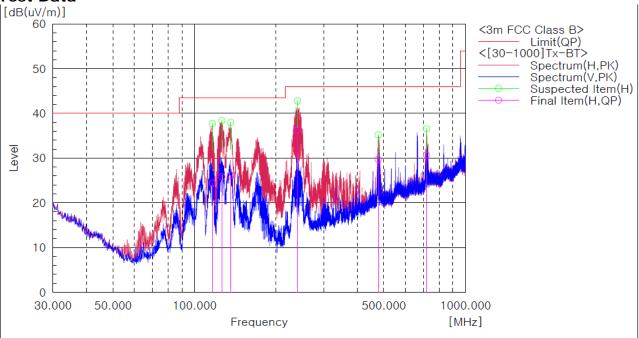
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#### 2) 30 MHz to 1 GHz

Test mode : Transmitter (Worst Case)

The requirements are:  $\square$  Complies

#### Test Data





No.	Frequency	(P)	Reading QP	c.f	Result QP	Limit QP	Margin QP	Height	Angle
	[MHz]		[dB(uV)]	[dB(1/m)]	[dB(uV/m)]	[dB(uV/m)]	[dB]	[cm]	[deg]
1	116.451	Н	36.2	-11.8	24.4	43.5	19.1	208.0	6.0
2	126.151	Н	37.2	-11.4	25.8	43.5	17.7	208.0	16.0
3	135.973	Н	37.6	-11.4	26.2	43.5	17.3	208.0	8.0
4	240.005	Н	47.2	-10.8	36.4	46.0	9.6	101.0	351.0
5	476.564	Н	32.7	-3.0	29.7	46.0	16.3	208.0	259.0
6	718.579	Н	28.9	1.8	30.7	46.0	15.3	101.0	262.0

#### Remark :

1. The unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down positon(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.

2. Result = Reading + c.f(Correction factor)

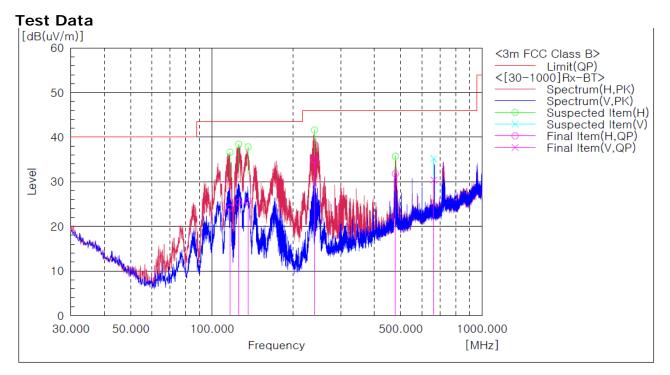
3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain



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#### Test mode : Receiver (Worst Case)

# The requirements are: $\square$ Complies



#### Final Result

No.	Frequency	(P)	Reading QP	c.f	Result QP	Limit QP	Margin QP	Height	Angle
	[MHz]		[dB(uV)]	[dB(1/m)]	[dB(uV/m)]	[dB(uV/m)]	[dB]	[cm]	[deg]
1	116.573	Н	35.9	-11.8	24.1	43.5	19.4	100.0	323.0
2	125.545	Н	36.8	-11.4	25.4	43.5	18.1	292.0	4.0
3	136.094	Н	37.0	-11.4	25.6	43.5	17.9	192.0	37.0
4	240.005	Н	45.7	-10.8	34.9	46.0	11.1	100.0	323.0
5	477.898	Н	34.7	-2.9	31.8	46.0	14.2	192.0	258.0
6	663.774	V	29.8	0.6	30.4	46.0	15.6	100.0	172.0

#### Remark :

1. The unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down positon(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.

2. Result = Reading + c.f(Correction factor)

3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain

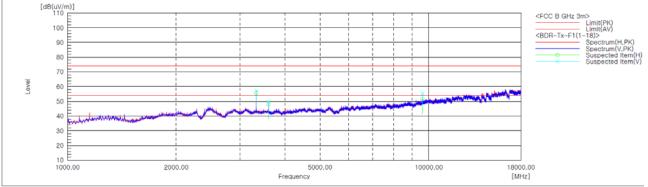


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# 3) above 1 GHz

The requirements are:  $\square$  Complies

# Test Data





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#### Test mode : Transmitter (GFSK)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
3 330.05	н	54.0	74.0	41.3	57.1	12.7	16.9
3 330.05	V	54.0	74.0	49.3	57.3	4.7	16.7
3 602.05	Н	54.0	74.0	36.6	50.4	17.4	23.6
3 602.05	V	54.0	74.0	40.2	50.5	13.8	23.5
9 608.15	Н	54.0	74.0	39.4	51.1	14.6	22.9
9 608.15	V	54.0	74.0	46.2	54.0	7.8	20.0

#### Lowest frequency(2 402 MHz)

#### Middle frequency(2 441 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
3 330.05	н	54.0	74.0	42.1	55.9	11.9	18.1
3 330.05	п	54.0	74.0	42.1	55.9	11.9	10.1
3 330.05	V	54.0	74.0	47.7	56.1	6.3	17.9
3 660.70	Н	54.0	74.0	34.3	47.9	19.7	26.1
3 660.70	V	54.0	74.0	39.0	50.5	15.0	23.5
9 763.70	Н	54.0	74.0	39.0	54.4	15.0	19.6
9 763.70	V	54.0	74.0	43.9	52.8	10.1	21.2

#### Highest frequency(2 480 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
3 330.05	Н	54.0	74.0	39.4	55.6	14.6	18.4
3 330.05	V	54.0	74.0	42.3	57.7	11.7	16.3
3 719.35	Н	54.0	74.0	34.5	46.9	19.5	27.1
3 719.35	V	54.0	74.0	39.4	49.3	14.6	24.7

#### Remarks

1. The unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down positon(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.

2. Correction factor = Antenna factor + Cable loss - Amp Gain



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#### Test mode : Transmitter (8-DPSK)

Frequency	(P)	Limit AV	Limit PK	Result AV	Result PK	Margin AV	Margin PK
[MHz]		[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]
3 330.5	Н	54.0	74.0	43.1	57.6	10.9	16.4
3 330.5	V	54.0	74.0	44.0	57.4	10.0	16.6
3 602.5	Н	54.0	74.0	34.5	49.2	19.5	24.8
3 602.5	V	54.0	74.0	48.5	37.1	16.9	25.5
9 608.15	Н	54.0	74.0	37.9	50.0	16.1	24.0
9 608.15	V	54.0	74.0	43.4	52.0	10.6	22.0

#### Lowest frequency(2 402 MHz)

#### Middle frequency(2 441 MHz)

Frequency	(P)	Limit AV	Limit PK	Result AV	Result PK	Margin AV	Margin PK
[MHz]		[dBuV/m]	[dBuV/m] [dBuV/m]		[dBuV/m]	[dB]	[dB]
3 330.05	Н	54.0	74.0	40.8	57.4	13.2	16.6
3 330.05	V	54.0	74.0	46.9	57.3	7.1	16.7
3 659.00	Н	54.0	74.0	33.7	46.2	20.3	27.8
3 659.00	V	54.0	74.0	36.7	49.4	17.3	24.6
9 759.45	Н	54.0	74.0	38.0	51.5	16.0	22.5
9 759.45	V	54.0	74.0	42.3	52.8	11.7	21.2

#### Highest frequency(2 480 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
3 330.50	Н	54.0	74.0	40.2	54.9	13.8	19.1
3 330.50	V	54.0	74.0	43.5	56.6	10.5	17.4
3 719.35	Н	54.0	74.0	33.1	45.4	20.9	28.6
3 719.35	V	54.0	74.0	36.4	48.1	17.6	25.9

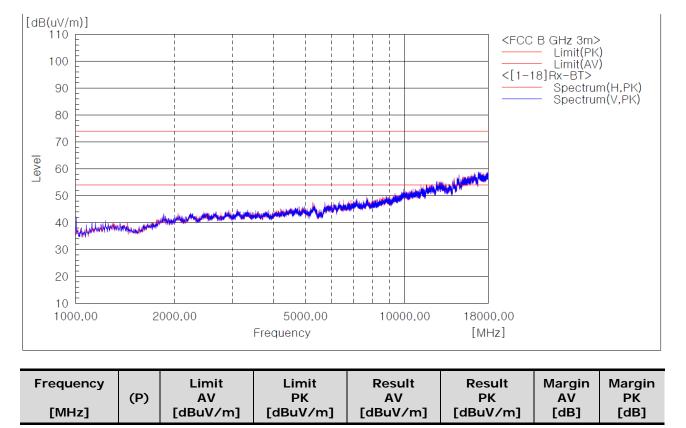
#### Remarks

1. The unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down positon(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.

2. Correction factor = Antenna factor + Cable loss - Amp Gain



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#### Test mode : Receiver (Worst Case)

Re	ma	ark	S

1. The unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down positon(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.

The emissions above 1 GHz were 20 dB lower than the limit.

2. Correction factor = Antenna factor + Cable loss - Amp Gain



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# 4.8 AC Power Line Conducted Emissions

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz-30 MHz, shall not exceed the limits.

#### Instrument Settings

IF Band Width: 9 kHz

#### **Test Procedures**

RSS-Gen - Section 8.8

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

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

\* The level decreases linearly with the logarithm of the frequency.

\*\* A linear average detector is required.

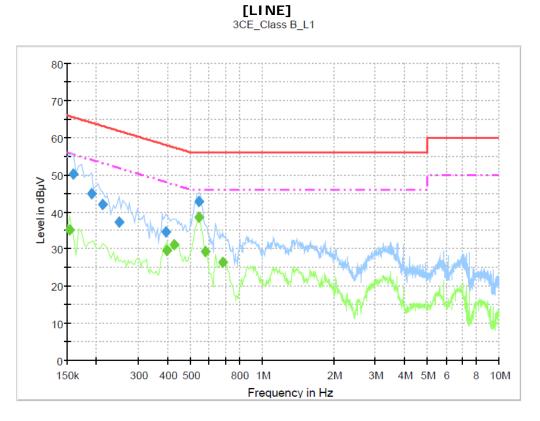
#### **Test Results**

The requirements are:  $\square$  Complies



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# Test Data



# **Final Result 1**

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.159000	50.1	1000.0	9.000	On	L1	10.0	15.4	65.5
0.190500	45.0	1000.0	9.000	On	L1	10.0	19.0	64.0
0.213000	41.9	1000.0	9.000	On	L1	9.9	21.2	63.1
0.249000	37.2	1000.0	9.000	On	L1	9.7	24.6	61.8
0.393000	34.7	1000.0	9.000	On	L1	10.0	23.3	58.0
0.541500	42.9	1000.0	9.000	On	L1	10.0	13.1	56.0

# **Final Result 2**

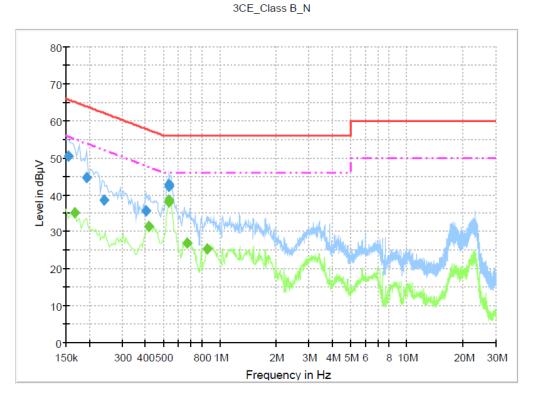
Frequency (MHz)	CAverage (dBµV)	Meas. Time	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
(11112)	(00µV)	(ms)	(KH2)			(ub)	(ub)	(ασμν)
0.154500	35.2	1000.0	9.000	On	L1	9.9	20.6	55.8
0.397500	29.6	1000.0	9.000	On	L1	10.0	18.4	47.9
0.424500	31.1	1000.0	9.000	On	L1	10.0	16.2	47.4
0.541500	38.5	1000.0	9.000	On	L1	10.0	7.5	46.0
0.577500	29.4	1000.0	9.000	On	L1	10.0	16.6	46.0
0.685500	26.4	1000.0	9.000	On	L1	10.0	19.6	46.0

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[NEUTRAL]



# **Final Result 1**

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.154500	50.5	1000.0	9.000	On	Ν	9.9	15.2	65.8
0.195000	44.7	1000.0	9.000	On	N	10.0	19.1	63.8
0.240000	38.6	1000.0	9.000	On	N	9.8	23.5	62.1
0.402000	35.5	1000.0	9.000	On	Ν	10.0	22.3	57.8
0.532500	42.4	1000.0	9.000	On	Ν	10.0	13.6	56.0
0.537000	42.9	1000.0	9.000	On	Ν	10.0	13.1	56.0

# **Final Result 2**

Frequency (MHz)	CAverage (dBµV)	Meas. Time	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
		(ms)						
0.168000	35.2	1000.0	9.000	On	Ν	10.1	19.9	55.1
0.415500	31.4	1000.0	9.000	On	Ν	10.0	16.2	47.5
0.532500	38.0	1000.0	9.000	On	Ν	10.0	8.0	46.0
0.537000	38.5	1000.0	9.000	On	Ν	10.0	7.5	46.0
0.672000	27.0	1000.0	9.000	On	Ν	10.0	19.0	46.0
0.856500	25.4	1000.0	9.000	On	Ν	9.9	20.6	46.0



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# 4.9 Frequency Hopping System Requirements

#### Standard Applicable

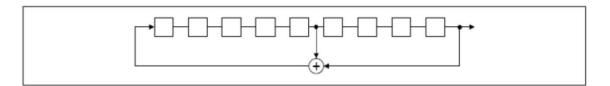
According to FCC Part 15.247(a)(1), The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths 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 pseudo random 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:  $2^9-1 = 511$  bits Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

0246	62 64	78 1	73 75 77
		<u></u>	İ

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.



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#### 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.



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# **APPENDIX A – Test Equipment Used For Tests**

	Name of Equipment	Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date
1	Signal Analyzer	Agilent	N9020A	MY48011598	2019-10-16	2020-10-16
2	Signal Generator	Rohde & Schwarz	SMB100A	175528	2019-10-16	2020-10-16
3	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2019-10-22	2020-10-22
4	Bilog Antenna	Schaffner	CBL6111C	2551	2018-05-10	2020-05-10
5	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2018-05-27	2020-05-27
6	6dB Attenuator	R&S	DNF	272.4110.50-2	2019-10-25	2020-10-25
7	AMPLIFIER	SONOMA	310	291721	2019-01-28	2020-01-28
8	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2019-01-29	2020-01-29
9	Preamplifier	Agilent	8449B	3008A02011	2018-12-03	2019-12-03
10	Horn Antenna	ETS-Lindgren	3117	00154525	2019-09-25	2021-09-25
11	Horn Antenna	ETS-Lindgren	3116	00062916	2017-12-04	2019-12-04
12	Band Reject Filter	Micro Tronics	BRM50702	G233	2019-01-28	2020-01-28
13	LISN	Rohde & Schwarz	ENV216	101235	2019-01-29	2020-01-29

	Cable	Manufacturer	Model No.	Serial No.	Check Date
1	RF Cable	Canare Corporation	L-5D2W	N/A	2018-12-19
2	RF Cable	Junkosha Inc.	MWX221	1510S087	2019-10-22
3	RF Cable	HUBER+SUHNER	SUCOFLEX 102	MY073/2	2018-12-19
4	RF Cable	HUBER+SUHNER	SUCOFLEX 102	MY4728/2	2018-12-19
5	RF Cable	HUBER+SUHNER	SUCOFLEX 104	MY27558/4	2018-12-19
6	RF Cable	HUBER+SUHNER	SUCOFLEX 104	N/A	2018-12-19
7	RF Cable	HUBER+SUHNER	SUCOFLEX 104	MY27573/4	2018-12-19
8	RF Cable	HUBER+SUHNER	SUCOFLEX 106	N/A	2018-12-19