TEST REPORT

Part 15 Subpart C 15.247

Equipment under test	In-vehicle Infotainment System
Model name	XS90116CA
Derivative Model	XS90116C
FCC ID	YE4XSG4V2
Applicant	Glosys Inc.
Manufacturer	Glosys Inc.
Date of test(s)	2021.10.05 ~ 2021.10.06
Date of issue	2021.10.07

Issued to
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Test and report completed by :	**Report approval by :**
	
Gu-Bong, Kang Test engineer	Young-Jin, Lee Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2021.10.07	KES-RF1-21T0184	Initial

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1. General information

Applicant:	Glosys Inc.
Applicant address:	510 Venture Valley B/D, 40 Omokcheon-Ro 152 Beon-Gil, Gwonseon-Gu, Suwon-Si, Gyeonggi-do, Republic of Korea
Test site:	KES Co., Ltd.
Test site address:	☐ 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea ☒ 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Test Facility	FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s):	15.247
FCC ID:	YE4XSG4V2
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	In-vehicle Infotainment System
Frequency range	2 402 ㎒ ~ 2 480 ㎒ (BDR / EDR)
Model	XS90116CA
Derivative Model	XS90116C
Modulation technique	GFSK, π/4DQPSK, 8DPSK
Number of channels	2 402 ㎒ ~ 2 480 ㎒ (BDR / EDR) : 79ch
Antenna specification	Antenna type : PCB Antenna // Peak gain: -7.70 ㏈i
Power source	DC 12 V
H/W version (XS90116CA)	G4_AV_V2.2, G4_MEDIA_V2.1
S/W version (XS90116CA)	2.9.3(L910), MICOM = GX4A8012-00(L830)
H/W version (XS90116C)	G4_AV_V2.2, G4_MEDIA_V2.1
S/W version (XS90116C)	2.6.9(L712), MICOM = GX4A8012-00(L830)

1.2. Requirements for Bluetooth transmitter

15.247(a)(1) that the rx input bandwidths shift frequencies in synchronization with the transmitted signals.

Pseudorandom frequency hopping sequence
The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

Equal hopping frequency use
The channels of this system will be used equally over the long-term distribution of the hopsets.

Example of a 79 hopping sequence in data mode:
45, 20, 55, 21, 30, 59, 39, 2, 24, 4, 18, 46, 23, 71, 73, 44, 53, 64, 68, 72, 33, 11, 50, 37, 70, 65, 3, 34, 66, 54, 51, 77, 35, 56, 38, 69, 19, 75, 58, 74, 12, 9, 8, 13, 28, 6, 29, 42, 61, 22, 52, 1, 15, 47, 10, 49, 17, 31, 26, 14, 32, 5, 76, 60, 7, 62, 63, 41, 67, 40, 43, 00

System receiver input bandwidth
Each channel bandwidth is 1 ㎒.
The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

1.3. Test configuration

The **Glosys Inc. // In-vehicle Infotainment System // XS90116CA // FCC ID: YE4XSG4V2** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Subpart C 15.247
KDB 558074 D01 V05r02
ANSI C63.10-2013

1.4. Information about derivative model

	XS90116CA	XS90116C
H/W Difference	-	**GPS Module** M8l ->M8Q : GPS+ADR Module is changed to simple GPS module **Remove Wheel Tick Circuit** The wheel tick circuit (TR + Resistor + Capacitor + 1p Wire), which is the vehicle speed recognition signal, has been removed. **Remove the CarPlay ALT Audio DAC circuit** CS4344, the DAC chip for ALT audio, has been removed by operating in CarPlay.
S/W Difference	This model have the CarPlay function.	This model does not have the CarPlay function.

1.5. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
-	-	-	-	-

1.6. Sample calculation

Where relevant, the following sample calculation is provided
For all conducted test items :

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Offset(㏈) = RF cable loss(㏈) + attenuator factor(㏈).
= 0.54 + 10 = 10.54 (㏈)

For Radiation test :
Field strength level (㏈㎶/m) = Measured level (㏈㎶) + Antenna factor (㏈) + Cable loss (㏈) – Amplifier gain (㏈)

1.7. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.46 dB
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1㎓	4.40 dB
	Above 1㎓	5.94 dB
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

1.8. Frequency/channel operations

Ch.	Frequency (㎒)	Rate(Mbps)
00	2402	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps
. .	. .	. .
40	2442	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps
. .	. .	. .
78	2480	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps

2. Summary of tests

Reference	Test description	Test results
15.247(a)(1)(iii)	20 dB bandwidth	Pass
15.247(b)(1)	Output power	Pass
15.247(a)(1)	Channel separation	Pass
15.247(a)(1)(iii)	Number of channels	Pass
15.247(a)(1)(iii)	Time of occupancy	Pass
15.205, 15.209	Radiated restricted band and emission	Pass
15.207(a)	AC conducted emissions	N/A(1)
15.207(d)	Conducted band edge and out of band emissions	Pass

Note.

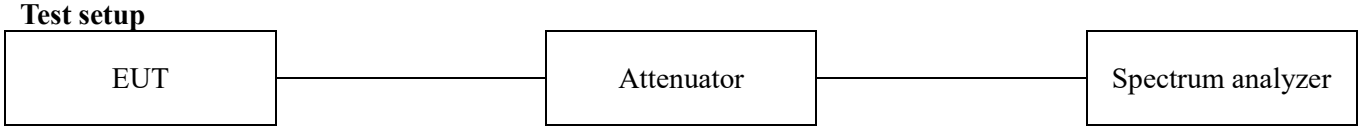
1. This device is a vehicle appliance and operates at DC 12 V and does not have an AC conducted emissions test.

3. Test results

3.1. 20 dB bandwidth

Test procedure
ANSI 63.10-2013

Test setup

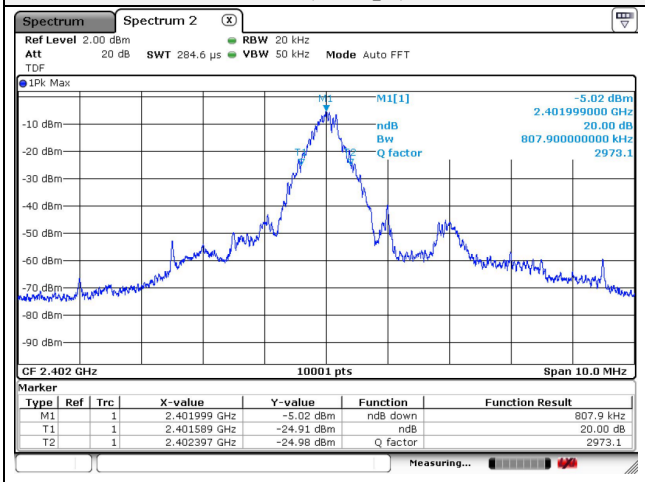


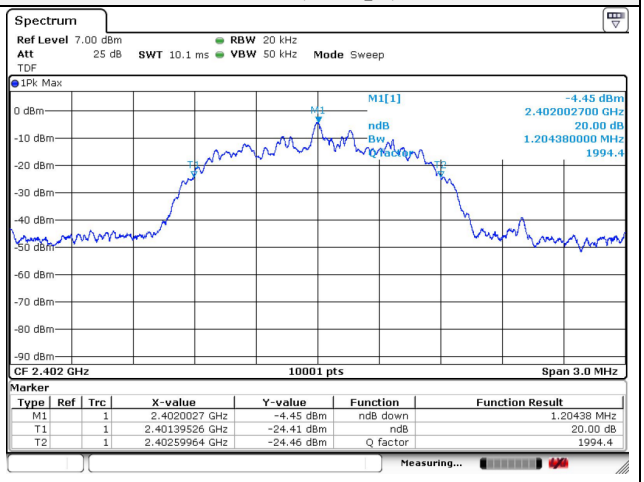
Test setting
1. Span = Set between two times and five times the OBW
2. RBW ≥ 1 % to 5 %of the OBW
3. VBW ≥ 3 * RBW
4. Sweep = Auto
5. Detector function = Peak
6. Sweep = Auto couple
7. Trace mode = Max hold
8. All the trace to stabilize

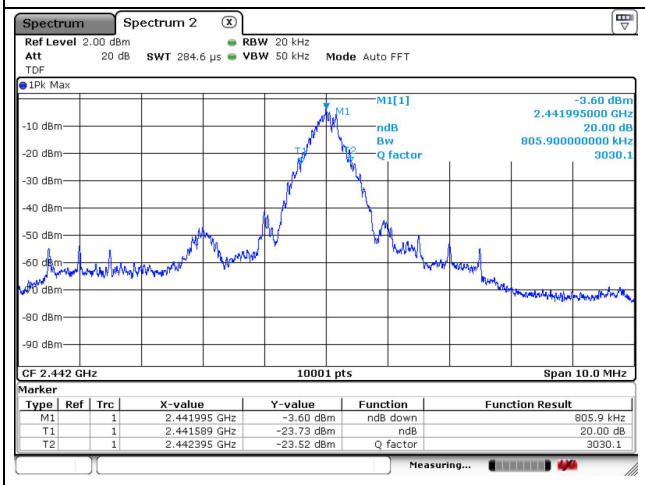
Limit
Not applicable

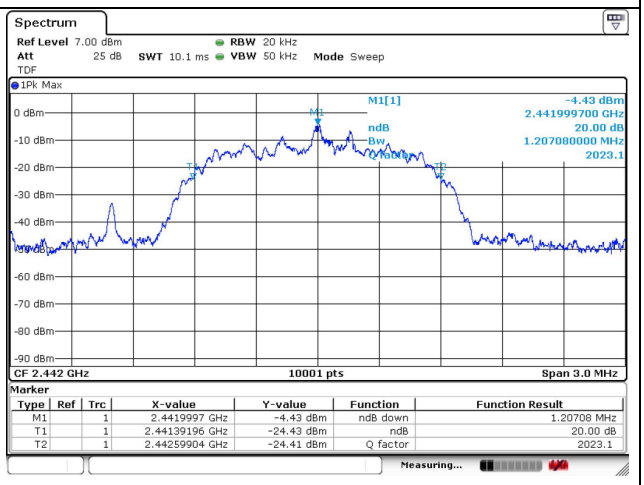
Frequency(㎒)	Channel no.	Data rate(Mbps)	Measured bandwidth(㎒)
2 402	00	BDR 1 Mbps	0.808
2 442	40		0.806
2 480	78		0.805
2 402	00	EDR 2 Mbps	1.204
2 442	40		1.207
2 480	78		1.185
2 402	00	EDR 3 Mbps	1.203
2 442	40		1.207
2 480	78		1.204

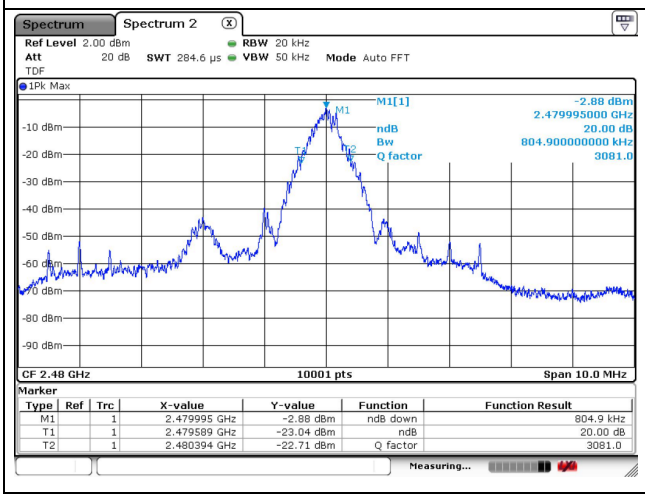
BDR(1Mbps)	EDR(2Mbps)

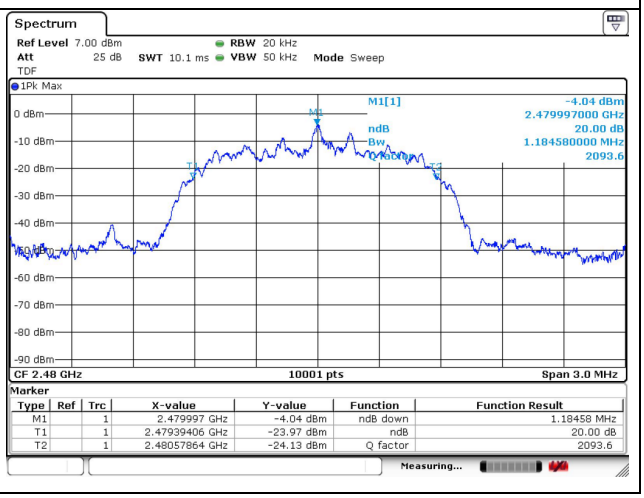




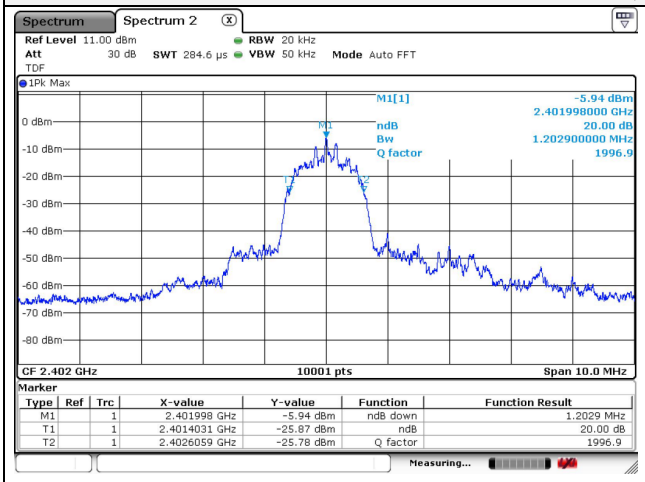


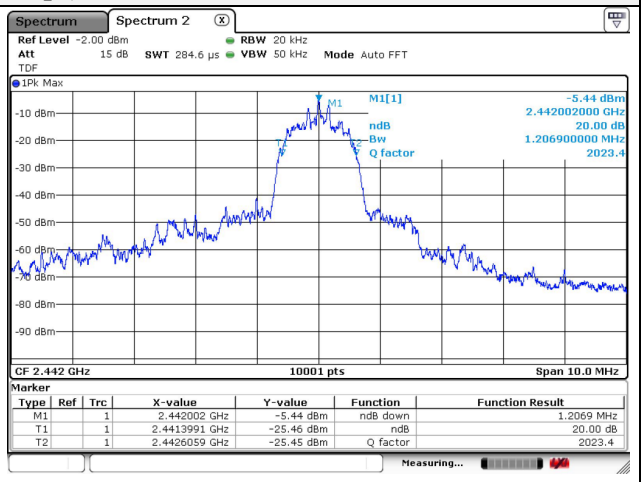


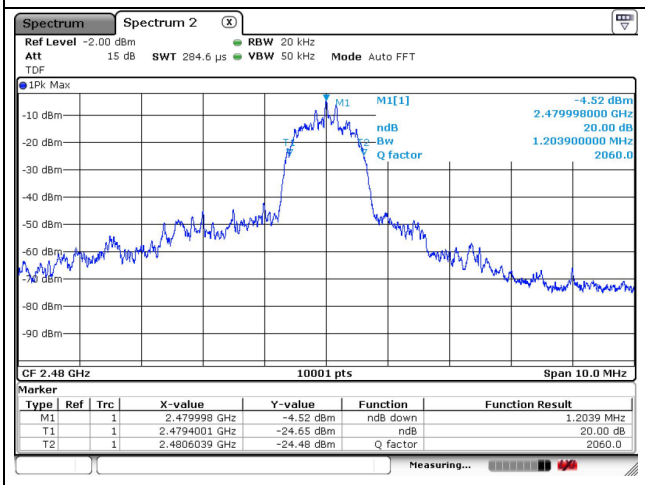




EDR(3Mbps)







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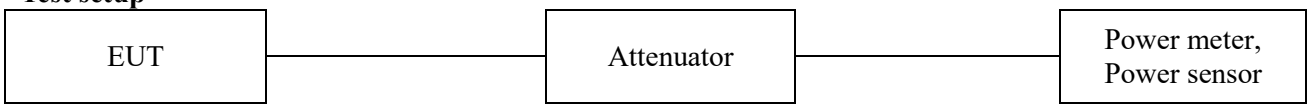
3.2. Output power

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013 – Section 11.9.2.1 and 11.9.2.3.2

Test setup



Test setting

Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

Limit

According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

According to §15.247(b)(1), For frequency hopping systems operating in the 2 400 ~ 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 ~ 5 805 ㎒ band: 1 Watt.

According to §15.247(a)(4), The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

Test results

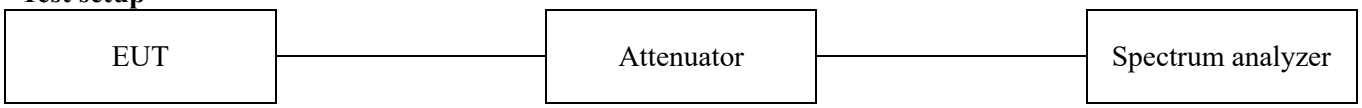
Frequency(㎒)	Channel no.	Data rate(Mbps)	Average Power (dBm)	Peak Power (dBm)	Power Limit (dBm)
2 402	00	BDR 1 Mbps	0.25	0.50	20.97
2 442	40		0.84	1.12	20.97
2 480	78		1.09	1.35	20.97
2 402	00	EDR 2 Mbps	-2.42	-0.24	20.97
2 442	40		-1.91	0.40	20.97
2 480	78		-3.12	0.19	20.97
2 402	00	EDR 3 Mbps	-2.35	0.01	20.97
2 442	40		-1.91	0.63	20.97
2 480	78		-2.25	0.36	20.97

3.3. Carrier frequency separation

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013

Test setup



Test Setting

1. The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
2. Span = wide enough to capture the peaks of two adjacent channels
3. RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
4. Video (or Average) Bandwidth (VBW) ≥ RBW
5. Sweep = auto
6. Detector function = peak
7. Trace = max hold
8. Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

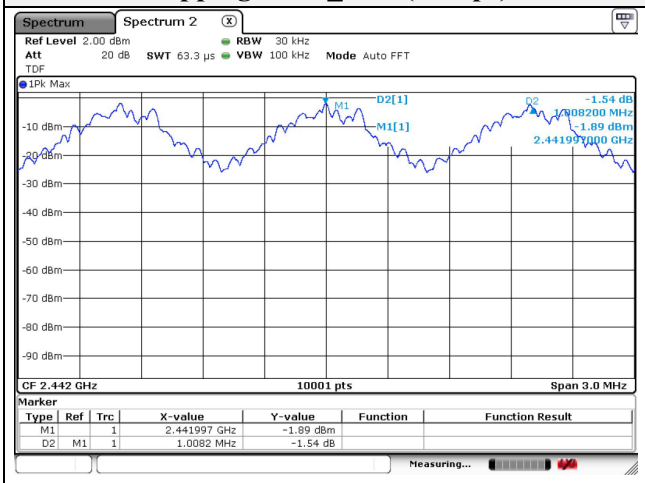
Limit

According to 15.247(a)(1), frequency hopping system operating in 2 400 ~ 2 483.5 ㎒. Band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-third of 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

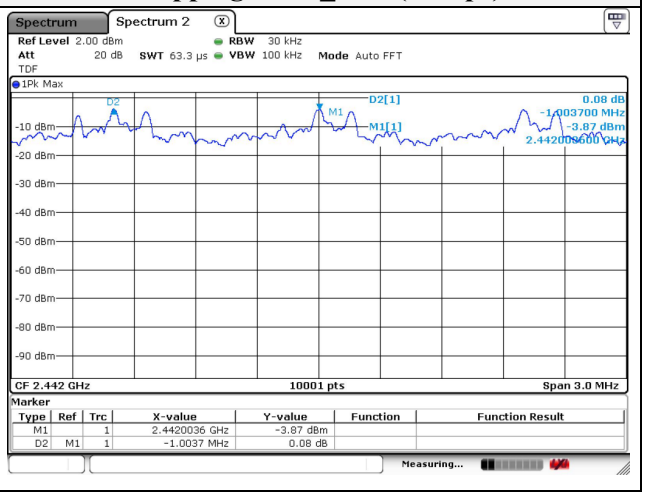
Test results

Frequency(㎒)	Channel no.	Data rate(Mbps)	Channel Separation (㎒)	Limit (㎒)
2 442	40	BDR 1 Mbps	**1.008**	≥ 0.537
2 442	40	EDR 3 Mbps	**1.004**	≥ 0.805

Hopping mode_BDR(1Mbps)



Hopping mode_EDR(3Mbps)

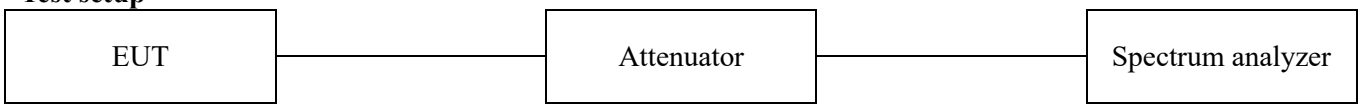


3.4. Number of hopping frequency

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013

Test setup



Test setting

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings.

1. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
2. 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.
3. VBW ≥ RBW.
4. Sweep = auto
5. Detector function = peak
6. Trace = max hold

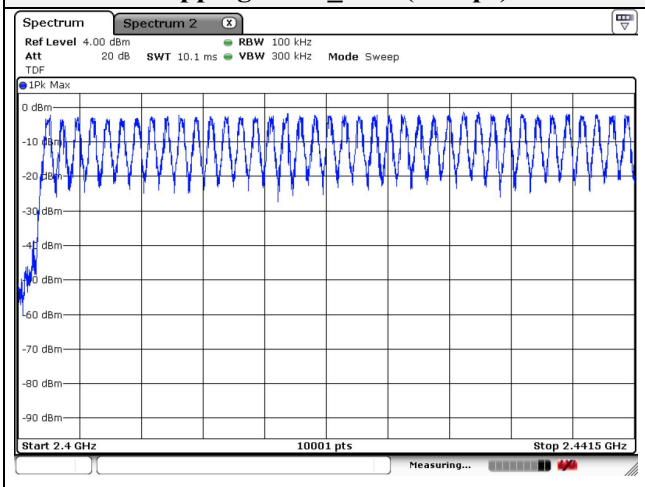
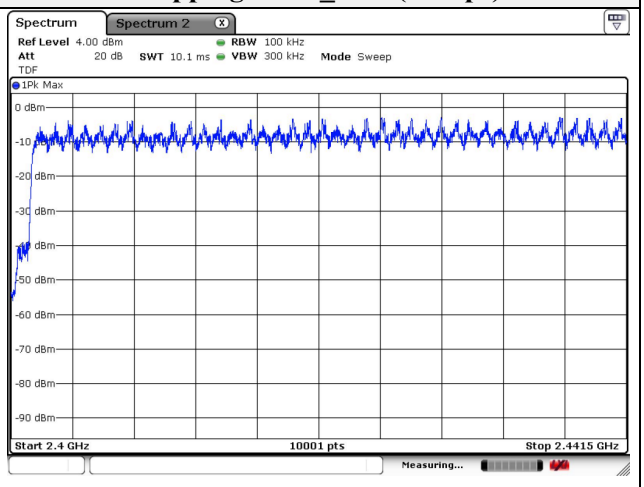
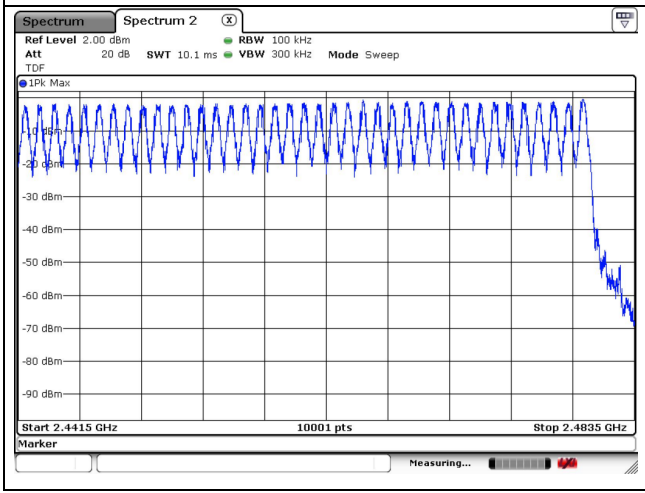
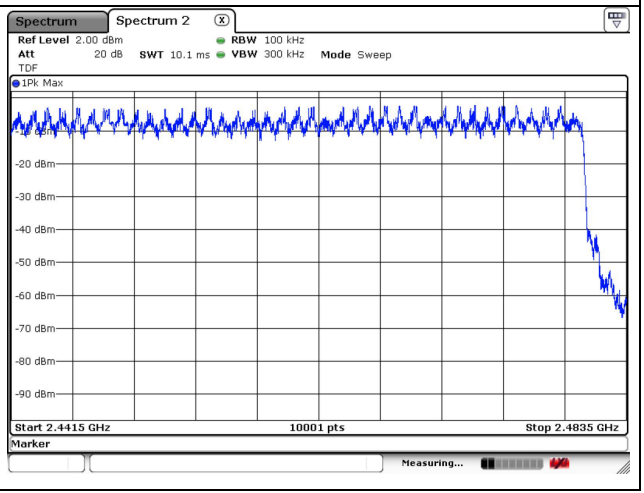
All the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Limit

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ bands shall use at least 15 hopping frequencies.

Test results

Frequency	Data rate(Mbps)	Number of hopping frequency	Limit
2402 ~ 2480 ㎒	BDR 1 Mbps	79	≥ 15
2402 ~ 2480 ㎒	EDR 3 Mbps	79	≥ 15

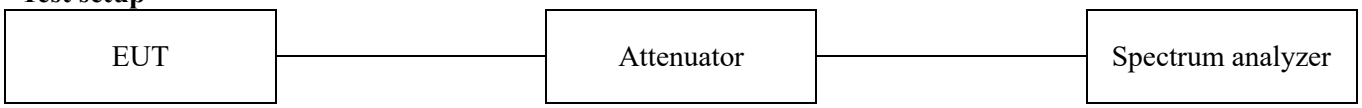
Hopping mode_BDR(1Mbps)	Hopping mode_EDR(3Mbps)
	
	

3.5. Time of occupancy

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013

Test setup



Test setting

1. The EUT must have its hopping function enabled.
2. Span = zero span, centered on a hopping channel
3. RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
4. 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.
5. Detector function = peak
6. Trace = max hold

Limit

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = 0.4(s) × 79 = 31.6(s)

Time of occupancy on the TX channel in 31.6 sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 31.6

Operation mode: GFSK , π/4-DQPSK, 8DPSK

Packet type	Frequency (㎒)	Dwell time (ms)	Time of occupancy on the Tx channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx channel in 31.6 sec (ms)
DH1	2 442	0.520	166.40	400
DH3	2 442	1.777	284.32	400
DH5	2 442	3.030	323.20	400
2-DH1	2 442	0.532	170.24	400
2-DH3	2 442	1.787	285.92	400
2-DH5	2 442	3.037	323.95	400
3-DH1	2 442	0.532	170.24	400
3-DH3	2 442	1.787	285.92	400
3-DH5	2 442	3.037	323.95	400

Note:
Normal Mode
DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 166.40 (ms)
DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 284.32 (ms)
DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 323.20 (ms)
2-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 170.24 (ms)
2-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 285.92 (ms)
2-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 323.95 (ms)
3-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 170.24 (ms)
3-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 285.92 (ms)
3-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 323.95 (ms)

BDR(1Mbps)	EDR(2Mbps)