

# TEST REPORT

<b>KCTL Inc.</b> 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea TEL: 82-31-285-0894 FAX: 82-505-299-8311 <a href="http://www.kctl.co.kr">www.kctl.co.kr</a>	Report No.: KR20-SRF0050 Page (1) of (61)	
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**1. Client**

- Name : HYUNDAI MOBIS CO., LTD.
- Address : 203, Teheran-ro, Gangnam-gu, Seoul, 06141, Korea
- Date of Receipt : 2019-09-20

**2. Use of Report** : Certification**3. Name of Product and Model** : WIDE AVN / ATC32HYAN**4. Manufacturer and Country of Origin** : Hyundai Mobis., Ltd. / Korea**5. FCC ID** : TQ8-ATC32HYAN**6. Date of Test** : 2019-10-01 to 2019-10-31**7. Test Standards** : FCC Part 15 Subpart C, 15.247**8. Test Results** : Refer to the test result in the test report

<b>Affirmation</b>	Tested by  Name : MyeongJun Kwon 	Technical Manager  Name : Heesu Ahn 
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2020-02-09

**KCTL Inc.**

As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by KCTL Inc.

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Suwon-si, Gyeonggi-do, 16677, Korea  
TEL: 82-31-285-0894 FAX: 82-505-299-8311  
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Report No.:  
KR20-SRF0050

Page (2) of (61)

**Report revision history**

Date	Revision	Page No
2020-02-09	Initial report	-

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## CONTENTS

1. General information .....	4
2. Device information .....	4
2.1. Simultaneously transmission condition .....	5
2.2. Information about derivative model.....	5
2.3. Frequency/channel operations.....	6
3. Antenna requirement .....	7
4. Summary of tests.....	8
5. Measurement uncertainty .....	9
6. Measurement results explanation example .....	10
7 Test results .....	11
7.1. Maximum peak output power.....	11
7.2. Carrier frequency separation .....	13
7.3. 20dB channel bandwidth .....	17
7.4. Number of hopping channels .....	23
7.5. Time of occupancy(Dwell time).....	25
7.6. Radiated spurious emissions & band edge.....	29
7.7. Conducted Spurious Emission.....	57
8. Measurement equipment .....	61

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Page (4) of (61)

**1. General information**

Client : HYUNDAI MOBIS CO., LTD.  
Address : 203, Teheran-ro, Gangnam-gu, Seoul, 06141, Korea  
Manufacturer : Hyundai Mobis., Ltd  
Address : 95, Sayang 2-Gil, Munbaek-Myeon, Jincheon-Gun, Chungcheongbuk-Do 27862 Korea  
Laboratory : KCTL Inc.  
Address : 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea  
Accreditations : FCC Site Designation No: KR0040, FCC Site Registration No: 687132  
VCCI Registration No. : R-20080, G-20078, C-20059, T-20056  
Industry Canada Registration No. : 8035A  
KOLAS No.: KT231

**2. Device information**

Equipment under test : WIDE AVN  
Model : ATC32HYAN  
Derivative model : ATC32HCAN, ATC35HCAN  
Frequency range : 2 402 MHz ~ 2 480 MHz (Bluetooth(BDR/EDR))  
2 412 MHz ~ 2 462 MHz (802.11b/g/n\_HT20)  
UNII-1: 5 180 MHz ~ 5 240 MHz (802.11a/n\_HT20/ac\_VHT20)  
UNII-1: 5 190 MHz ~ 5 230 MHz (802.11n\_HT40/ac\_VHT40)  
UNII-1: 5 210 MHz (802.11ac\_VHT80)  
UNII-2A: 5 260 MHz ~ 5 320 MHz (802.11a/n\_HT20/ac\_VHT20)  
UNII-2A: 5 270 MHz ~ 5 310 MHz (802.11n\_HT40/ac\_VHT40)  
UNII-2A: 5 290 MHz (802.11ac\_VHT80)  
UNII-2C: 5 500 MHz ~ 5 720 MHz (802.11a/n\_HT20/ac\_VHT20)  
UNII-2C: 5 510 MHz ~ 5 710 MHz (802.11n\_HT40/ac\_VHT40)  
UNII-2C: 5 530 MHz ~ 5 690 MHz (802.11ac\_VHT80)  
UNII-3: 5 745 MHz ~ 5 825 MHz (802.11a/n\_HT20/ac\_VHT20)  
UNII-3: 5 755 MHz ~ 5 795 MHz (802.11n\_HT40/ac\_VHT40)  
UNII-3: 5 775 MHz (802.11ac\_VHT80)  
Modulation technique : Bluetooth(BDR/EDR)\_GFSK, π/4DQPSK, 8DPSK  
WIFI(802.11a/b/g/n20/n40/ac20/ac40/ac80)\_DSSS, OFDM  
Number of channels : Bluetooth(BDR/EDR)\_79ch  
2.4GHz WIFI (802.11b/g/n\_HT20)\_11ch  
UNII-1: 4 ch (20 MHz), 2 ch (40 MHz), 1 ch (80 MHz)  
UNII-2A: 4 ch (20 MHz), 2 ch (40 MHz), 1 ch (80 MHz)  
UNII-2C: 9 ch (20 MHz), 5 ch (40 MHz), 2 ch (80 MHz)  
UNII-3: 5 ch (20 MHz), 2 ch (40 MHz), 1 ch (80 MHz)  
Power source : DC 14.4 V

Antenna specification : WIFI/Bluetooth(BDR/EDR)\_Pattern Antenna  
Antenna gain : 2.4GHz WIFI (802.11b/g/n\_HT20) : -0.70 dB  
Bluetooth(BDR/EDR) : 0.29 dBi  
UNII-1 : 3.51 dBi, UNII-2A : 3.12 dBi  
UNII-2C : 2.28 dBi, UNII-3 : -0.84 dBi  
Software version : MQ4.USA.0000.V028.001.190821  
Hardware version : MQ4.USA.STD\_AVN\_G5\_WIDE.004.001  
Test device serial No. : N/A  
Operation temperature : -20 °C ~ 70 °C

## 2.1. Simultaneously transmission condition

Technology	Modulation	Test mode	Frequency (MHz)
WLAN 2.4 GHz	OFDM	802.11g	2 412
WLAN 5 GHz	OFDM	802.11a / UNII-2C	5 500
Bluetooth	GFSK	BDR	2 441

## 2.2. Information about derivative model

The difference between basic model and derivative models is:

The derivative models have a different product identification number.

ATC32HCAN(96560 P4720), ATC35HCAN(96560 P4920)

## **2.3. Frequency/channel operations**

This device contains the following capabilities:

WIFI(2.4GHz band 802.11b/g/n(HT20), 5GHz band 802.11a/n(HT20/HT40)/ac(VHT20/40/80)),  
Bluetooth(BDR/EDR)

Ch.	Frequency (MHz)
00	2 402
.	.
39	2 441
.	.
78	2 480

Table 2.3.1. Bluetooth(BDR/EDR) mode

15.247 Requirements for Bluetooth transmitter:

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:
  - 1) This system is hopping pseudo-randomly.
  - 2) Each frequency is used equally on the average by each transmitter.
  - 3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters
  - 4) The receiver shifts frequencies in synchronization with the transmitted signals.
    - 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.
    - 15.247(h): 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.

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Report No.:  
KR20-SRF0050

Page (7) of (61)



### **3. Antenna requirement**

Requirement of FCC part section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

- The transmitter has permanently attached Pattern Antenna (internal antenna) on board.
- The E.U.T Complies with the requirement of §15.203, §15.247.



#### **4. Summary of tests**

FCC Part section(s)	Parameter	Test results
15.247(b)(1),(4)	Maximum peak output power	Pass
15.247(a)(1)	Carrier frequency separation	Pass
15.247(a)(1)	20dB channel bandwidth	Pass
-	Occupied Bandwidth	Pass
15.247(a)(iii) 15.247(b)(1)	Number of hopping channel	Pass
15.247(a)(iii)	Time of occupancy(dwell time)	Pass
15.205(a), 15.209(a), 15.247(d)	Spurious emission Band-edge, restricted band	Pass
15.207(a)	Conducted Emissions	N/A( <sup>Note2</sup> )

**Notes:**

1. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2. This test is not applicable because the EUT falls into the automotive device and it's not to be connected to the public utility(AC) power line.
3. According to exploratory test no any obvious emission were detected from 9 kHz to 30 MHz. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
4. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z. It was determined that X orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in X orientation
5. The test procedure(s) in this report were performed in accordance as following.
  - ◆ ANSI C63.10-2013
  - ◆ KDB 558074 D01 v05r02

## 5. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of  $k=2$  to indicated a 95 % level of confidence. The measurement data shown herein meets or exceeds the  $U_{\text{CISPR}}$  measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded uncertainty ( $\pm$ )	
Conducted RF power	1.76 dB	
Conducted spurious emissions	4.03 dB	
Radiated spurious emissions	9 kHz ~ 30 MHz	2.28 dB
	30 MHz ~ 300 MHz	4.98 dB
	300 MHz ~ 1 000 MHz	5.14 dB
	1 GHz ~ 6 GHz	6.70 dB
	Above 6 GHz	6.60 dB
Conducted emissions	9 kHz ~ 150 kHz	3.66 dB
	150 kHz ~ 30 MHz	3.26 dB



## 6. Measurement results explanation example

The offset level is set in the spectrum analyzer to compensate the RF cable loss 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.

Frequency (MHz)	Factor(dB)	Frequency (MHz)	Factor(dB)
30	6.15	9 000	8.23
50	6.18	10 000	8.61
100	6.23	11 000	8.47
200	6.35	12 000	8.54
300	6.44	13 000	9.15
400	6.53	14 000	9.86
500	6.61	15 000	9.51
600	6.69	16 000	9.71
700	6.75	17 000	9.89
800	6.83	18 000	10.17
900	6.92	19 000	9.94
1 000	6.90	20 000	10.04
2 000	7.79	21 000	10.17
3 000	7.90	22 000	10.70
4 000	8.01	23 000	11.58
5 000	8.05	24 000	10.64
6 000	8.16	25 000	11.48
7 000	8.30	26 000	10.66
8 000	8.37	26 500	10.58

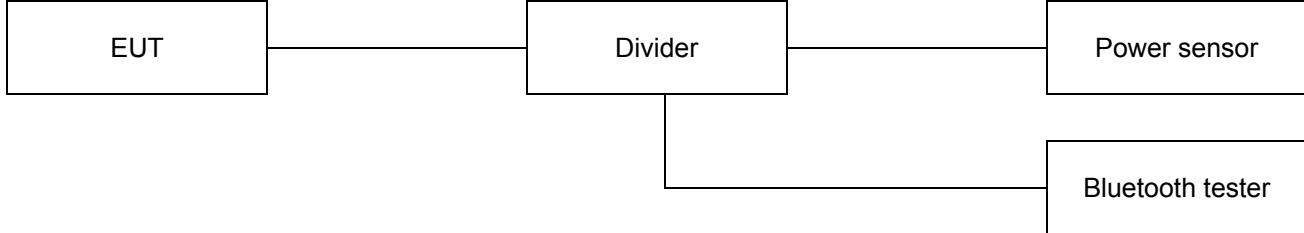
**Note.**

Offset(dB) = RF cable loss(dB) + Power Divider(dB)

## **7 Test results**

### **7.1. Maximum peak output power**

#### Test setup



#### Limit

According to §15.247(b)(1), for frequency hopping systems operating in the 2 400-2 483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725-5 850 MHz band: 1 watt. For all other frequency hopping systems in the 2 400-2 483.5 MHz band: 0.125 watts.

According to §15.247(b)(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. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### Test procedure

ANSI C63.10-2013 - Section 7.8.5

#### Test settings

The test follows ANSI C63.10-2013 – Section 7.8.5. Using the power sensor instead of a spectrum analyzer.

#### Notes:

A peak responding power sensor is used, where the power sensor system video bandwidth is greater than the occupied bandwidth of the EUT.

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Report No.:  
KR20-SRF0050  
Page (12) of (61)

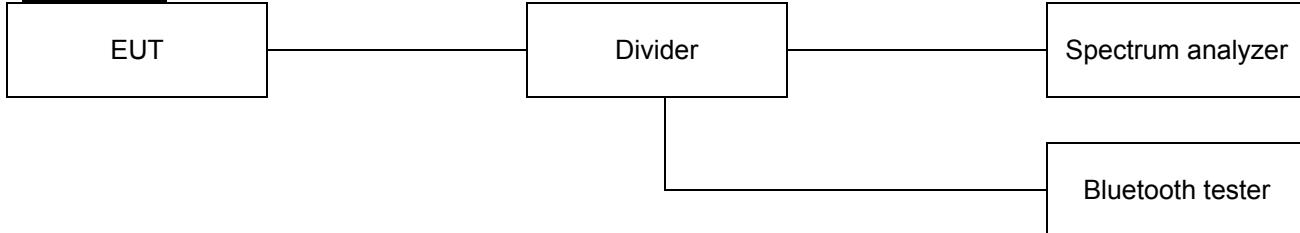
**Test results**

Frequency(MHz)	Data rate(Mbps)	Measured output power(dBm)		Limit(dBm)
		Peak	Average	
2 402	1	3.13	2.35	30.00
2 441	1	3.70	3.11	
2 480	1	3.60	2.96	
2 402	2	0.91	-2.50	30.00
2 441	2	1.74	-1.52	
2 480	2	1.82	-1.52	
2 402	3	1.11	-2.44	30.00
2 441	3	1.81	-1.52	
2 480	3	1.85	-1.50	



## 7.2. Carrier frequency separation

### Test setup



### Limit

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 MHz band 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, provided the systems operate with an output power no greater than 125 mW.

### Test procedure

ANSI C63.10-2013 - Section 7.8.2

### Test settings

- a) Span: Wide enough to capture the peaks of two adjacent channels.
- b) 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.
- c) Video (or average) bandwidth (VBW)  $\geq$  RBW.
- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.
- g) 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.

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Report No.:  
KR20-SRF0050  
Page (14) of (61)

**Test results**

Frequency(MHz)	Data rate(Mbps)	Carrier frequency separation(MHz)
2 402	1	1.001
2 441	1	1.007
2 480	1	1.004
2 402	2	1.007
2 441	2	1.001
2 480	2	1.001
2 402	3	1.001
2 441	3	1.001
2 480	3	1.001



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Report No.:  
KR20-SRF0050

Page (15) of (61)

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## GFSK / Low ch.



## $\pi/4$ DQPSK / Low ch.



## GFSK / Mid ch.



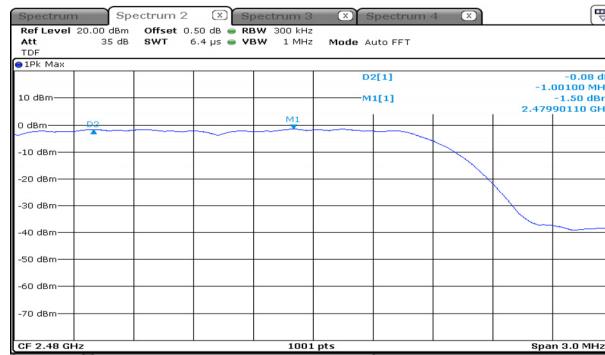
## $\pi/4$ DQPSK / Mid ch.



## GFSK / High ch.



## $\pi/4$ DQPSK / High ch.



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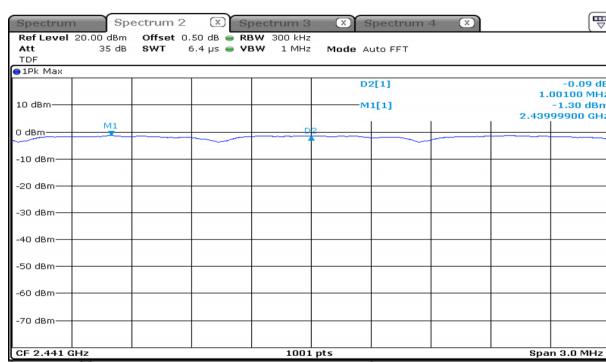
Page (16) of (61)

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## 8DPSK / Low ch.



## 8DPSK / Mid ch.



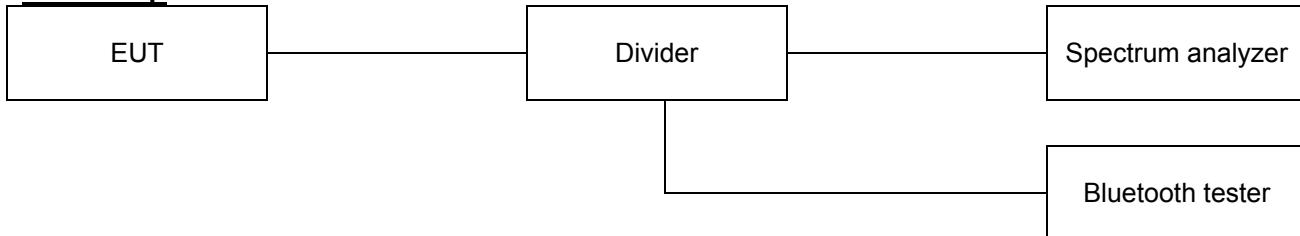
## 8DPSK / High ch.



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### 7.3. 20dB channel bandwidth

#### Test setup



#### Limit

According to §15.247(a), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 MHz band 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, provided the systems operate with an output power no greater than 125 mW.

#### Test procedure

ANSI C63.10-2013 - Section 6.9.2

#### 20dB channel bandwidth and Occupied bandwidth

#### Test settings

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are -6 dB, -20 dB, and -26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this subclause, the ratio is designated by “-xx dB.” The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the “-xx dB” bandwidth; other requirements might specify that the “-xx dB” bandwidth be entirely contained within the authorized or designated frequency band.

- a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.
- b) Span: Two times and five times the OBW.
- c) RBW = 1 % to 5 % of the OBW and VBW  $\geq 3 \times$  RBW
- d) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “-xx dB down” requirement; that is, if the requirement calls for measuring the -20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.
- f) Detector: peak
- g) Trace mode: max hold.
- h) Allow the trace to stabilize.
- i) Determine the “-xx dB down amplitude” using ((reference value) - xx). Alternatively, this calculation may be made by using the marker-delta function of the instrument.
- j) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow

the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

- k) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “-xx dB down amplitude” determined in step h). If a marker is below this “-xx dB down amplitude” value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “-xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

### Test results

#### **20 dB Bandwidth**

Frequency(MHz)	Data rate (Mbps)	20 dB Bandwidth (MHz)
2 402	1	1.046
2 441	1	0.890
2 480	1	1.406
2 402	2	1.343
2 441	2	1.349
2 480	2	1.346
2 402	3	1.307
2 441	3	1.343
2 480	3	1.310

#### **99% Bandwidth**

Frequency(MHz)	Data rate (Mbps)	99% bandwidth(MHz)
2 402	1	0.935
2 441	1	0.911
2 480	1	0.914
2 402	2	1.202
2 441	2	1.208
2 480	2	1.205
2 402	3	1.202
2 441	3	1.214
2 480	3	1.202

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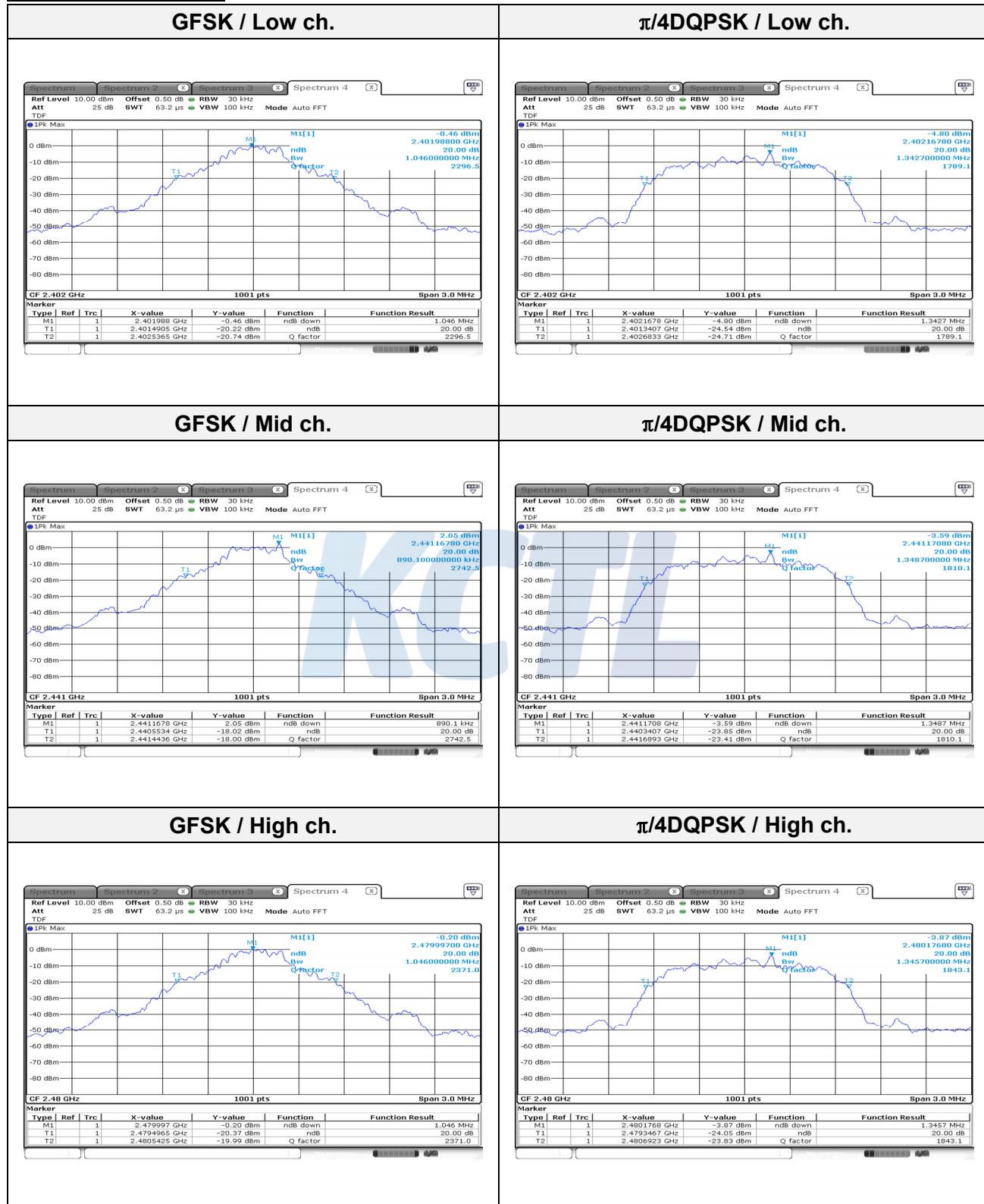
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Report No.:  
KR20-SRF0050

Page (19) of (61)

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## 20 dB bandwidth(MHz)



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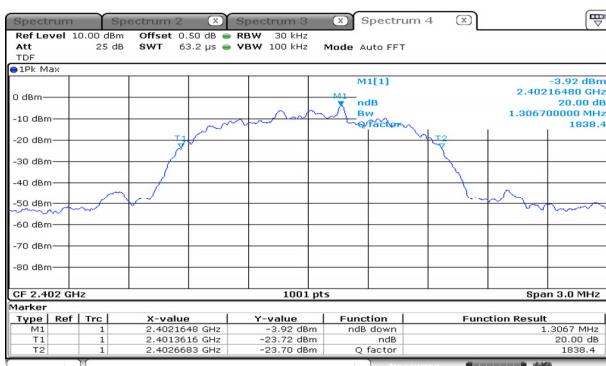
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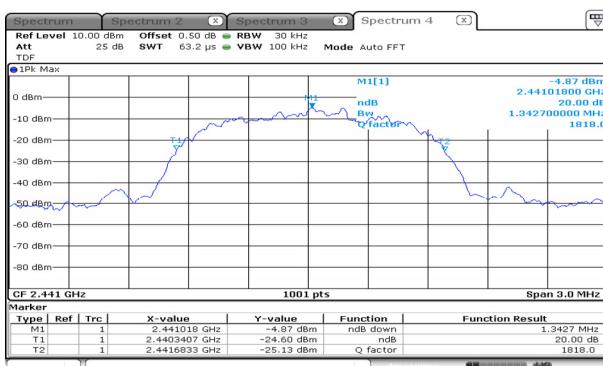
Page (20) of (61)

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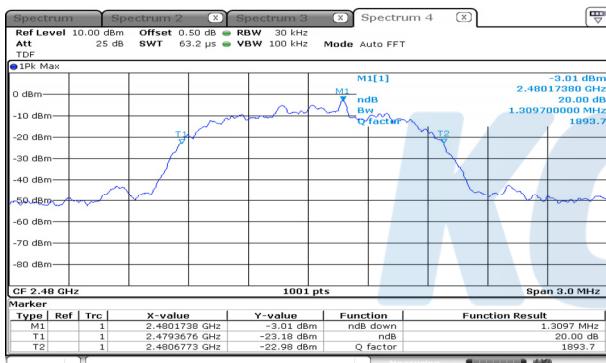
## 8DPSK / Low ch.



## 8DPSK / Mid ch.



## 8DPSK / High ch.



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Report No.:  
KR20-SRF0050

Page (21) of (61)

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**99 % bandwidth**

**GFSK / Low ch.**



**$\pi/4$ DQPSK / Low ch.**



**GFSK / Mid ch.**



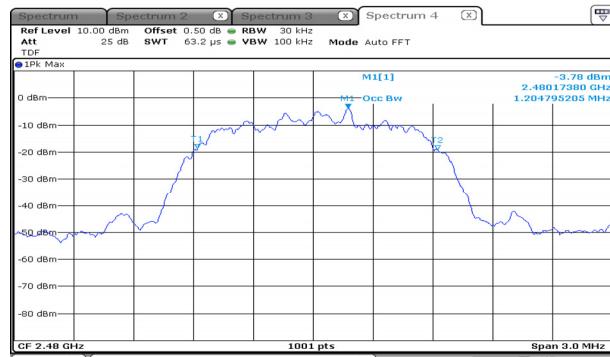
**$\pi/4$ DQPSK / Mid ch.**



**GFSK / High ch.**



**$\pi/4$ DQPSK / High ch.**

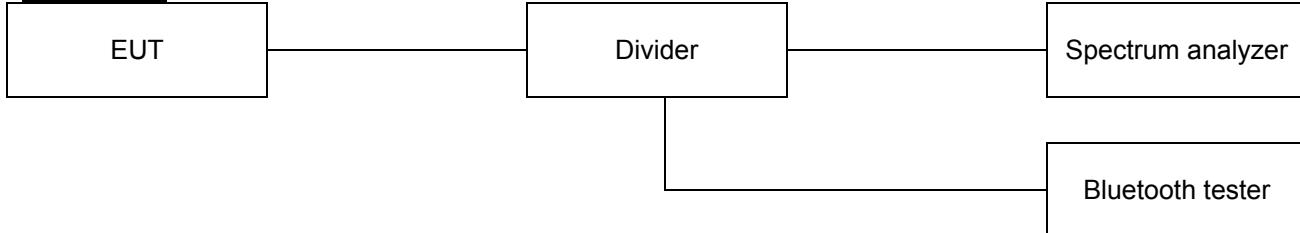


**8DPSK / Low ch.****8DPSK / Mid ch.****8DPSK / High ch.**

Blank

## **7.4. Number of hopping channels**

### **Test setup**



### **Limit**

According to §15.247(a)(1)(iii), frequency hopping systems in the 2 400-2 483.5 MHz band shall use at least 15 channels.

### **Test procedure**

ANSI C63.10-2013 - Section 7.8.3

### **Test settings**

- a) 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.
- b) 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.
- c) VBW  $\geq$  RBW.
- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.
- g) Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

### **Test results**

Mode	Number of hopping channel	Limit
GFSK	79	$\geq 15$
$\pi/4$ DQPSK	79	$\geq 15$
8DPSK	79	$\geq 15$

### **Note :**

In case of AFH mode, minimum number of hopping channels is 20.

# KCTL Inc.

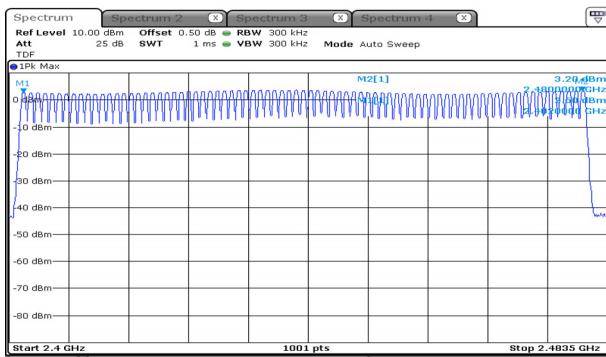
65, Sinwon-ro, Yeongtong-gu,  
Suwon-si, Gyeonggi-do, 16677, Korea  
TEL: 82-31-285-0894 FAX: 82-505-299-8311  
[www.kctl.co.kr](http://www.kctl.co.kr)

Report No.:  
KR20-SRF0050

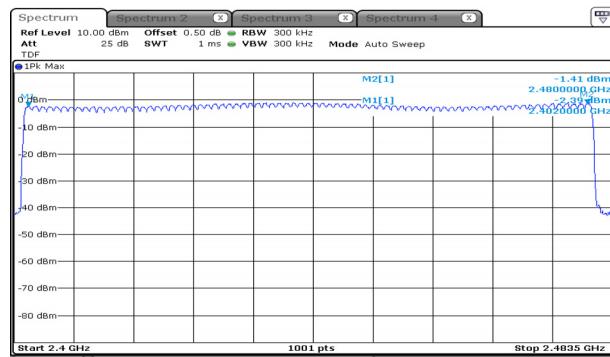
Page (24) of (61)

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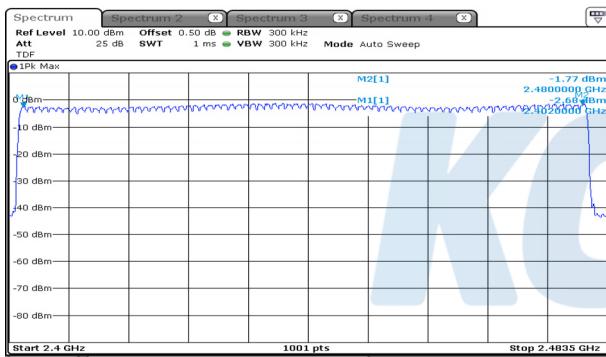
## GFSK



## $\pi/4$ DQPSK



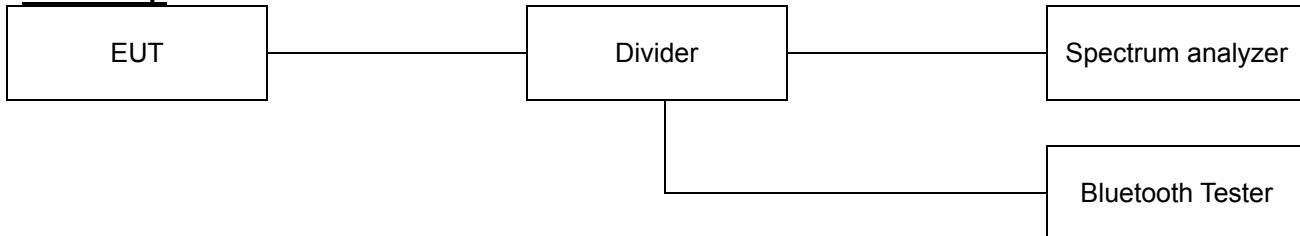
## 8DPSK



Blank

## 7.5. Time of occupancy(Dwell time)

### Test setup



### Limit

According to §15.247(a)(1)(iii), frequency hopping systems in the 2 400-2 483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

### Test procedure

ANSI C63.10-2013 - Section 7.8.4

### Test settings

- a) Span: Zero span, centered on a hopping channel.
- b) RBW  $\leq$  channel spacing and  $\gg 1 / T$ , 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.
- f) 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.

**Test results****- Non-AFH**

Modulation	Frequency (MHz)	Pulse Width (ms)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.381	800.000	79	0.122	0.400
DH3	2 441	1.632	400.000	79	0.261	0.400
DH5	2 441	2.883	266.667	79	0.307	0.400
2-DH1	2 441	0.387	800.000	79	0.124	0.400
2-DH3	2 441	1.633	400.000	79	0.261	0.400
2-DH5	2 441	2.883	266.667	79	0.307	0.400
3-DH1	2 441	0.388	800.000	79	0.124	0.400
3-DH3	2 441	1.633	400.000	79	0.261	0.400
3-DH5	2 441	2.883	266.667	79	0.307	0.400

**- AFH**

Modulation	Frequency (MHz)	Pulse Width (ms)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.381	400.000	20	0.061	0.400
DH3	2 441	1.632	200.000	20	0.131	0.400
DH5	2 441	2.883	133.333	20	0.154	0.400
2-DH1	2 441	0.387	400.000	20	0.062	0.400
2-DH3	2 441	1.633	200.000	20	0.131	0.400
2-DH5	2 441	2.883	133.333	20	0.154	0.400
3-DH1	2 441	0.388	400.000	20	0.062	0.400
3-DH3	2 441	1.633	200.000	20	0.131	0.400
3-DH5	2 441	2.883	133.333	20	0.154	0.400

**Notes:****1. Non-AFH**

- Period Time: 0.4 sec x 79 channels = 31.6 sec
- Result (s)= (Hopping rate (hop/s/slot) / 79 channels) x 31.6 sec x Pulse width (ms)

**2. AFH**

- Period Time: 0.4 sec x 20 channels = 8 sec
- Result (s)= (Hopping rate (hop/s/slot) / 20 channels) x 8 sec x Pulse width (ms)

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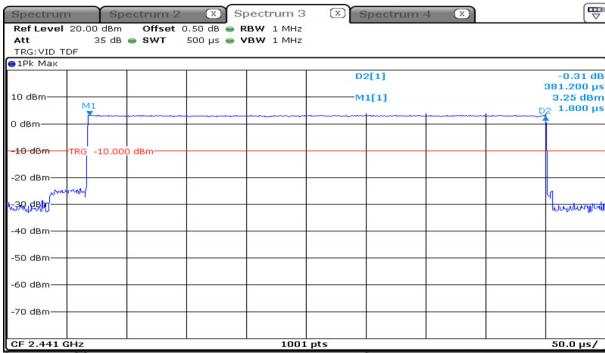
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Suwon-si, Gyeonggi-do, 16677, Korea  
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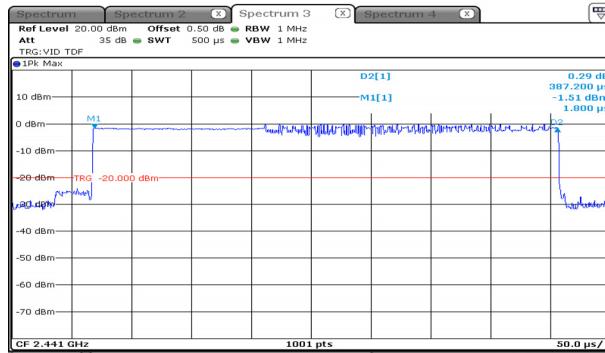
Page (27) of (61)

**KCTL**

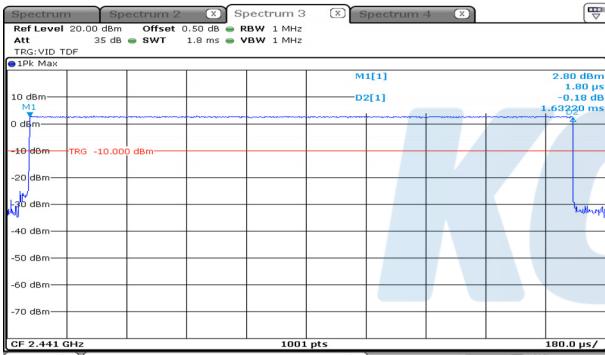
## GFSK / DH1



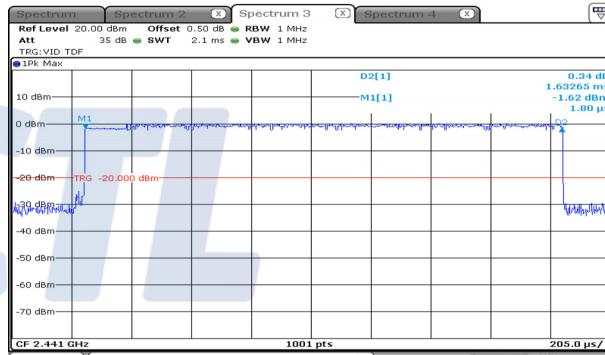
## $\pi/4$ DQPSK / 2-DH1



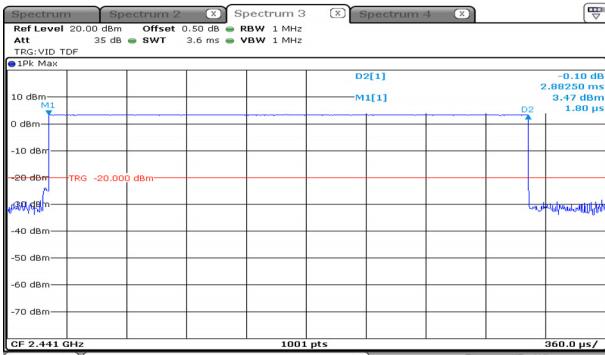
## GFSK / DH3



## $\pi/4$ DQPSK / 2-DH3



## GFSK / DH5



## $\pi/4$ DQPSK / 2-DH5

