TEST REPORT

KCTL Inc.
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Suwon-si, Gyeonggi-do, 16677, Korea
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KCTL

1. Client

- Name : Intel Mobile Communications
- Address : 100 Center Point Circle, Suite 200 Columbia, South Carolina 29210 USA
- Date of Receipt : 2021-07-15

2. Use of Report : Class II Permissive Change

3. Name of Product / Model : WLAN and BT, 2x2 PCIe M.2 1216 SD adapter card / AX210D2W

4. Manufacturer / Country of Origin : Intel Mobile Communications / USA

5. Host Name of Product / Model : Notebook PC / NP950XDC

6. Host Manufacturer : Samsung Electronics Co., Ltd.

7. FCC ID : PD9AX210D2

8. Date of Test : 2021-10-09 to 2021-10-15

9. Location of Test : ■ Permanent Testing Lab ☐ On Site Testing
(Address:65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea)

10. Test method used: FCC Part 15 Subpart E, 15.407

11. Test Result : Refer to the test result in the test report

Affirmation	Tested by	Technical Manager
	Name : Taeyoung Kim (Signature)	Name : Seungyong Kim (Signature)

2021-10-15

KCTL Inc.

REPORT REVISION HISTORY

Date	Revision	Page No
2021-10-15	Originally issued	-

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General remarks for test reports

Statement concerning the uncertainty of the measurement systems used for the tests

(may be required by the product standard or client)

☐ **Internal procedure used for type testing through which traceability of the measuring uncertainty has been established:**

Procedure number, issue date and title:

Calculations leading to the reported values are on file with the testing laboratory that conducted the testing.

☒ **Statement not required by the standard or client used for type testing**

CONTENTS

1. General information

Client	:	Intel Mobile Communications
Address	:	100 Center Point Circle, Suite 200 Columbia, South Carolina 29210 USA
Manufacturer	:	Intel Mobile Communications
Address	:	100 Center Point Circle, Suite 200 Columbia, South Carolina 29210 USA
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 CAB Identifier: KR0040 ISED Number: 8035A KOLAS No.: KT231

2. Device information

Equipment under test	:	WLAN and BT, 2x2 PCIe M.2 1216 SD adapter card
Model	:	AX210D2W
Manufacturer	:	Intel Mobile Communications
Host name of Product	:	Notebook PC
Host Model	:	NP950XDC
Host Manufacturer	:	Samsung Electronics Co., Ltd.
Modulation Technique	:	OFDM, OFDMA
Power Source	:	DC 15.44 V

Antenna Peak Gain :

Chain A (Main)			Chain B (Aux)		
UNII-5	:	3.36 dBi	UNII-5	:	3.71 dBi
UNII-6	:	3.50 dBi	UNII-6	:	3.62 dBi
UNII-7	:	3.62 dBi	UNII-7	:	3.51 dBi
UNII-8	:	3.66 dBi	UNII-8	:	3.49 dBi

Frequency range	:	802.11a/n/ac/ax	UNII-5 Band (5 925.0 – 6 425.0 MHz) UNII-6 Band (6 425.0 – 6 525.0 MHz) UNII-7 Band (6 525.0 – 6 875.0 MHz) UNII-8 Band (6 875.0 – 7 125.0 MHz)
Software version	:	Windows 10	
Hardware version	:	Rev. 1.0	
Test device serial No.	:	Conducted(123490EN400015)	

2.1. Frequency/channel operations

This device contains the following capabilities: WiFi (802.11a/n/ac/ax)

UNII-5

Ch.	Frequency (MHz)
1	5 955
:	:
45	6 175
:	:
93	6 415

UNII-6

Ch.	Frequency (MHz)
97	6 435
:	:
105	6 475
:	:
113	6 515

UNII-7

Ch.	Frequency (MHz)
117	6 535
:	:
149	6 695
:	:
185	6 875

UNII-8

Ch.	Frequency (MHz)
189	6 895
:	:
209	6 995
:	:
233	7 115

Table 2.1-1. 802.11a/n_HT20, ac_VHT20, ax_HE20 mode

UNII-5

Ch.	Frequency (MHz)
3	5 965
:	:
43	6 165
:	:
91	6 405

UNII-6

Ch.	Frequency (MHz)
99	6 445
107	6 485
115	6 525

UNII-7

Ch.	Frequency (MHz)
123	6 565
:	:
147	6 685
:	:
179	6 845

UNII-8

Ch.	Frequency (MHz)
187	6 885
:	:
203	6 965
:	:
237	7 085

Table 2.1-2. 802.11n_HT40, ac_VHT40, ax_HE40 mode

UNII-5

Ch.	Frequency (MHz)
7	5 985
:	:
39	6 145
:	:
87	6 385

UNII-6

Ch.	Frequency (MHz)
103	6 465

UNII-7

Ch.	Frequency (MHz)
119	6 545
135	6 625
:	:
183	6 865

UNII-8

Ch.	Frequency (MHz)
199	6 945
215	7 025

Table 2.1-3. 802.11ac_VHT80, ax_HE80 mode

UNII-5

Ch.	Frequency (MHz)
15	6 025
47	6 185
79	6 345

UNII-6

Ch.	Frequency (MHz)
111	6 505

UNII-7

Ch.	Frequency (MHz)
143	6 665
175	6 825

UNII-8

Ch.	Frequency (MHz)
207	6 985

Table 2.1-4. 802.11ac_VHT160, ax_HE160 mode

3. Summary of tests

FCC Part section(s)	Parameter	Test Condition	Test results
15.407(d)(6)	Contention Based Protocol	Conducted	Pass

Notes:

1. The test procedure(s) in this report were performed in accordance as following.
   - ANSI C63.10 2013
   - KDB 987594 D02 U-NII 6 GHz EMC Measurement.

4. 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 of exceeds the U_{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 (±)
Conducted RF power	0.9 dB

5 Test results

5.1. Contention Based Protocol

Test Overview and Limit

Indoor access points, subordinate devices and client devices operating in the 5.925-7.125 ㎓ band (herein referred to as unlicensed devices) are required to use technologies that include a contention-based protocol to avoid co-channel interference with incumbent devices sharing the band. To ensure incumbent co-channel operations are detected in a technology-agnostic manner, unlicensed devices are required to detect co-channel radio frequency energy (energy detect) and avoid simultaneous transmission.

Unlicensed low-power indoor devices must detect co-channel radio frequency power that is at least -62 ㏈m or lower. Upon detection of energy in the band, unlicensed low power indoor devices must vacate the channel (in which incumbent signal is transmitted) and stay off the incumbent channel as long as detected radio frequency power is equal to or greater than the threshold (-62 ㏈m). The -62 ㏈m (or lower) threshold is referenced to a 0 dBi antenna gain.

To ensure incumbent operations are reliably detected in the band, low power indoor devices must detect RF energy throughout their intended operating channel. For example, an 802.11 device that plans to transmit a 40 ㎒- wide signal (on a primary 20 MHz channel and a secondary 20 MHz channel) must detect energy throughout the entire 40 MHz channel. Additionally, low-power indoor devices must detect co-channel energy with 90% or greater certainty.

Test Procedure

a) Simulating Incumbent Signal

The incumbent signal is assumed to be noise-like. One example of such transmission could be Digital Video Broadcasting (DVB) systems that use Orthogonal Frequency Division Multiplexing (OFDM). Incumbent systems may also use different bandwidths for their transmissions. A 10 MHz-wide additive white Gaussian noise (AWGN) signal is selected to simulate and represent incumbent transmission.

b) Required number of tests

Incumbent and EUT (access point, subordinate or client) signals may occupy different portions of the channel. Depending on the EUT transmission bandwidth and incumbent signal center frequency (simulated by a 10 ㎒-wide AWGN signal), the center frequency of the EUT signal f_{c1} may fall within the incumbent's occupied bandwidth (Figure 1.a), or outside of it (Figure 1.b).

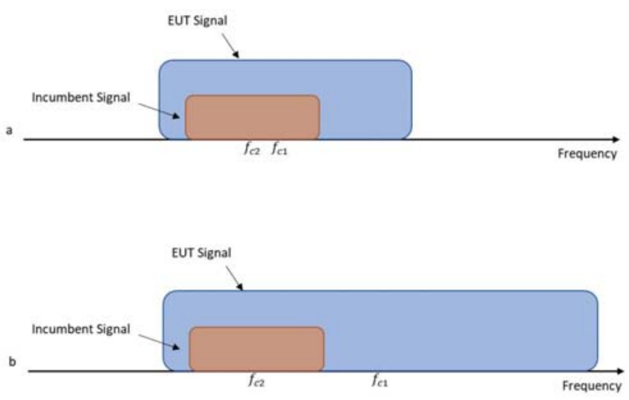


Figure 1. Two possible scenarios where a) center frequency of EUT transmission falls within incumbent's bandwidth, or b) outside of it

To ensure EUT reliably detects an incumbent signal in both scenarios shown in Figure 1, the detection threshold test may be repeated more than once with the incumbent signal (having center frequency f_{c2}) tuned to different center frequencies within the UT transmission bandwidth. The criteria specified in Table 1 determines how many times the detection threshold test must be performed;

Table 1. Criteria to determine number of times detection threshold test may be performed

If	Number of Tests	Placement of Incumbent Transmission
$BW_{EUT} \leq BW_{Inc}$	Once	Tune incumbent and EUT transmissions (f_{c1} = f_{c2})
$BW_{Inc} \leq BW_{EUT} \leq 2BW_{Inc}$	Once	Incumbent transmission is contained within BW_{EUT}
$2BW_{Inc} \leq BW_{EUT} \leq 4BW_{Inc}$	Twice. Incumbent transmission is contained within BW_{EUT}	Incumbent transmission is located as closely as possible to the lower edge and upper edge, respectively, of the EUT channel
$BW_{EUT} > 4BW_{Inc}$	Three times	Incumbent transmission is located as closely as possible to the lower edge of the EUT channel, in the middle of EUT channel, and as closely as possible to the upper edge of the EUT channel

where:
BW_{EUT}: Transmission bandwidth of EUT signal
BW_{Inc}: Transmission bandwidth of the simulated incumbent signal (10 ㎒ wide AWGN signal)
f_{c1}: Center frequency of EUT transmission
f_{c2}: Center frequency of simulated incumbent signal

c) Test Setup

To ensure the EUT is capable of detecting co-channel energy, the first step is to configure the EUT to transmit with a constant duty cycle.2 To simulate an incumbent signal, a signal generator (or similar source) that is capable of generating band-limited additive white Gaussian noise (AWGN) is required. Depending on the EUT antenna configuration, the AWGN signal can be provided to the EUT receiver via a conducted method (Figure 2) or a radiated method (Figure 3). Figure 2 shows the conducted test setup where a band-limited AWGN signal is generated at a very low power level and injected into the EUT's antenna port. The AWGN signal power level is then incrementally increased while the EUT transmission is monitored on a signal analyzer 2 to verify if the EUT can sense the AWGN signal and can subsequently cease its transmission. A triggered measurement, as shown in Figure 2, is optional, and assists with determining the time it takes the EUT to cease transmission (or vacate the channel) upon detecting RF energy. If the EUT has only one antenna port, then an AWGN signal source can be connected to the same antenna port.

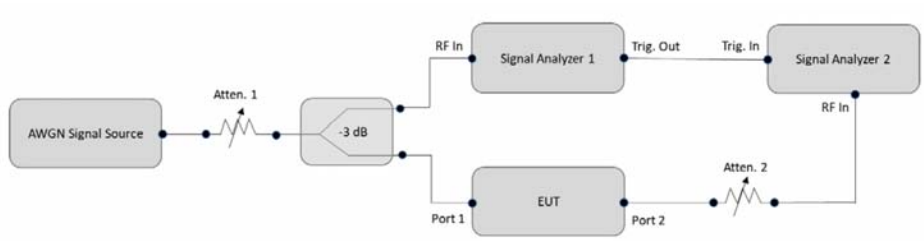


Figure 2. Contention-based protocol test setup, conducted method Step-by-Step Procedure, Conducted Setup

1) Configure the EUT to transmit with a constant duty cycle.
2) Set the operating parameters of the EUT including power level, operating frequency, modulation and bandwidth.
3) Set the signal analyzer center frequency to the nominal EUT channel center frequency. The span range of the signal analyzer shall be between two times and five times the OBW of the EUT. Connect the output port of the EUT to the signal analyzer 2, as shown in Figure 2. Ensure that the attenuator 2 provides enough attenuation to not overload the signal analyzer 2 receiver.
4) Monitoring the signal analyzer 2, verify the EUT is operating and transmitting with the parameters set at step two.
5) Using an AWGN signal source, generate (but do not transmit, i.e., RF OFF) a 10 ㎒-wide AWGN signal. Use Table 1 to determine the center frequency of the 10 ㎒ AWGN signal relative to the EUT's channel bandwidth and center frequency.
6) Set the AWGN signal power to an extremely low level (more than 20 dB below the -62 ㏈m threshold). Connect the AWGN signal source, via a 3-㏈ splitter, to the signal analyzer 1 and the EUT as shown in Figure 2.
7) Transmit the AWGN signal (RF ON) and verify its characteristics on the signal analyzer 1.
8) Monitor the signal analyzer 2 to verify if the AWGN signal has been detected and the EUT has ceased transmission. If the EUT continues to transmit, then incrementally increase the AWGN signal power level until the EUT stops transmitting.
9) (Including all losses in the RF paths) Determine and record the AWGN signal power level (at the EUT's antenna port) at which the EUT ceased transmission. Repeat the procedure at least 10 times to verify the EUT can detect an AWGN signal with 90% (or better) level of certainty.
10) Refer to Table 1 to determine number of times the detection threshold testing needs to be repeated. If testing is required more than once, then go back to step 5, choose a different center frequency for the AWGN signal and repeat the process.

Note.

1) KDB 987594 D02, contention based protocol was tested using an AWGN signal with a bandwidth of 10 ㎒. The amplitude of the signal was increased until detected by the EUT, signaled by the ceasing of transmission, marker indicates the point at which the AWGN signal is introduced.

2) Modified Detection Threshold Limit.

- Detection Threshold = -62.0 [㏈m] + G [㏈i]

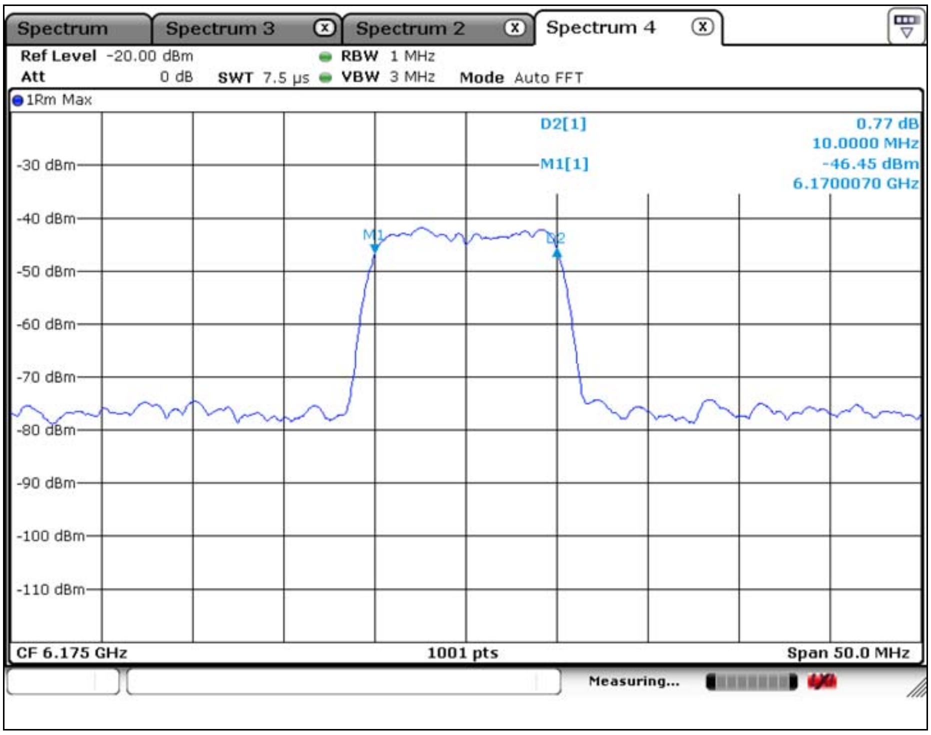
Band	Lowest Gain (㏈i)		Threshold Level (㏈m)
	Main	Aux	
UNII-5	-1.22	-1.20	-63.22
UNII-6	3.36	3.51	-58.64
UNII-7	1.48	2.23	-60.52
UNII-8	2.37	2.72	-59.63

3) The CBP measurement was performed by using the DRTU tool.

Test result

Band	BW [㎒]	Channel Freq. [㎒]	Incumbent Freq. [㎒]	Detection Power Level [dBm]	Detection Threshold Limit [dBm]	Margin [dB]	Number of AWGN	AWGN Detection Probability (%)	Limit Probability (%)
UNII 5	20	6 175	6 175	-69.0	-63.22	5.78	10	100	90
	160	6 185	6 110	-69.0	-63.22	5.78	10	100	90
			6 185	-70.0	-63.22	6.78	10	100	90
			6 260	-68.0	-63.22	4.78	10	100	90
UNII 6	20	6 475	6 475	-67.5	-58.64	8.86	10	100	90
	160	6 505	6 430	-67.5	-58.64	8.86	10	100	90
			6 505	-68.5	-58.64	9.86	10	100	90
			6 580	-65.5	-58.64	6.86	10	100	90
UNII 7	20	6 695	6 695	-67.5	-60.52	6.98	10	100	90
	160	6 665	6 590	-66.5	-60.52	5.98	10	100	90
			6 665	-68.5	-60.52	7.98	10	100	90
			6 740	-67.0	-60.52	6.48	10	100	90
UNII 8	20	6 995	6 995	-65.5	-59.63	5.87	10	100	90
	160	6 985	6 910	-66.5	-59.63	6.87	10	100	90
			6 985	-67.5	-59.63	7.87	10	100	90
			7 060	-64.0	-59.63	4.37	10	100	90

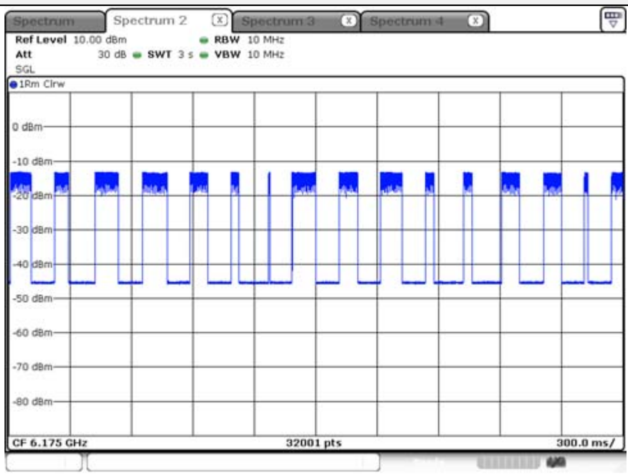
Plot of AWGN Sample Signal



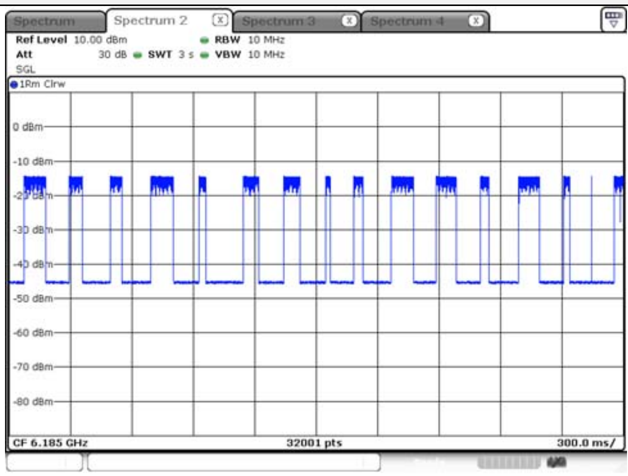
UNII-5

EUT Transmission

6 175 ㎒ (20 ㎒ bandwidth)

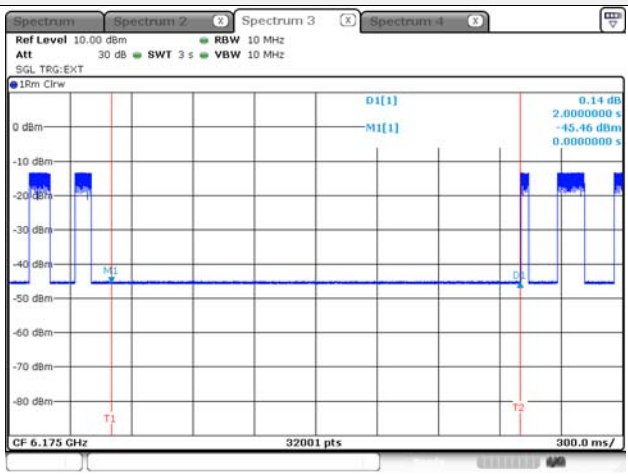


6 185 ㎒ (160 ㎒ bandwidth)

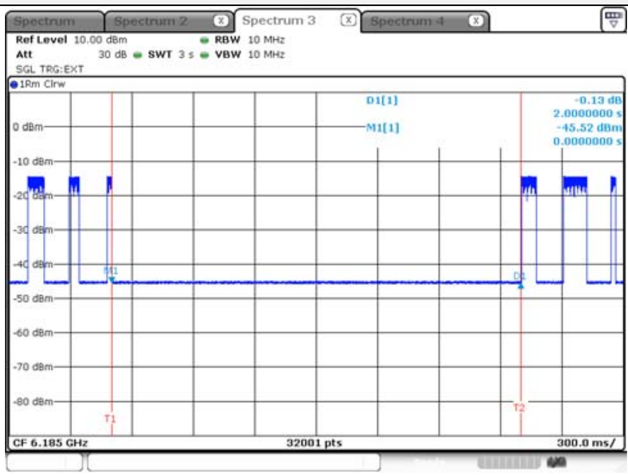


Injected Incumbent Signal

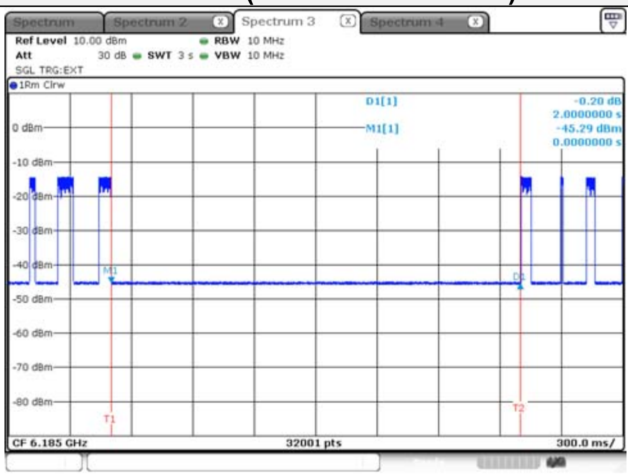
6 175 ㎒ (20 ㎒ bandwidth)



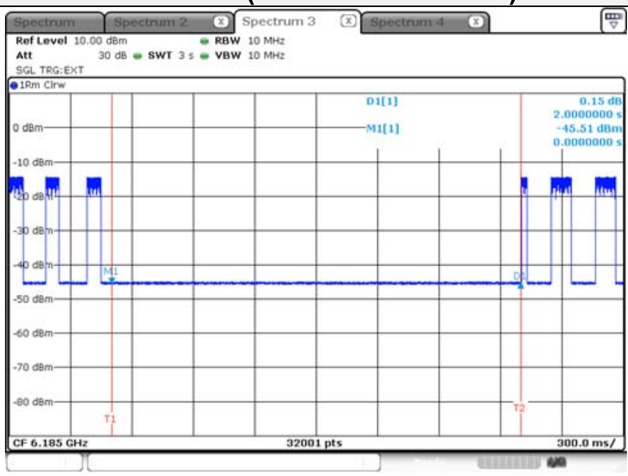
6 110 ㎒ (160 ㎒ bandwidth)



6 185 ㎒ (160 ㎒ bandwidth)



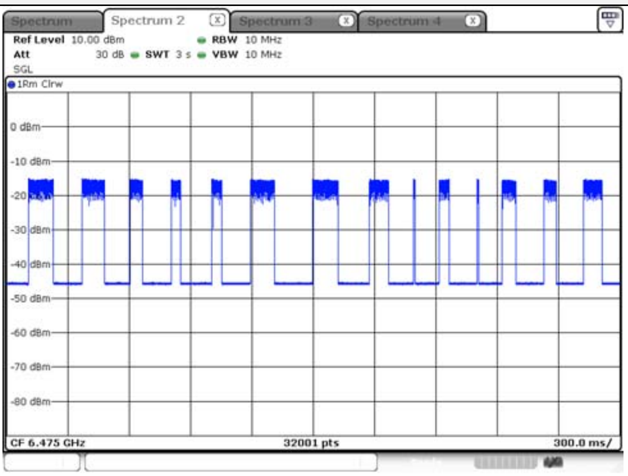
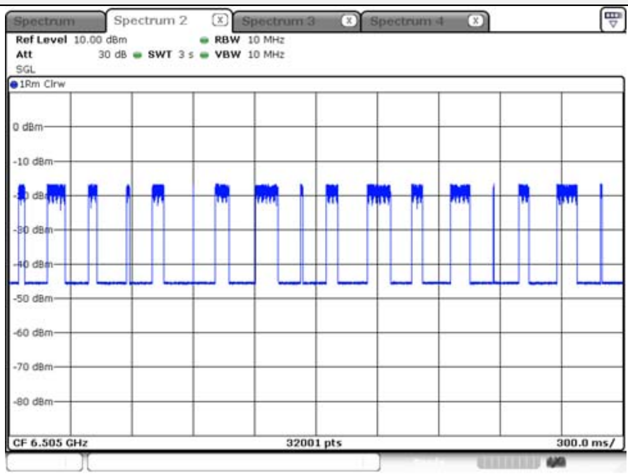
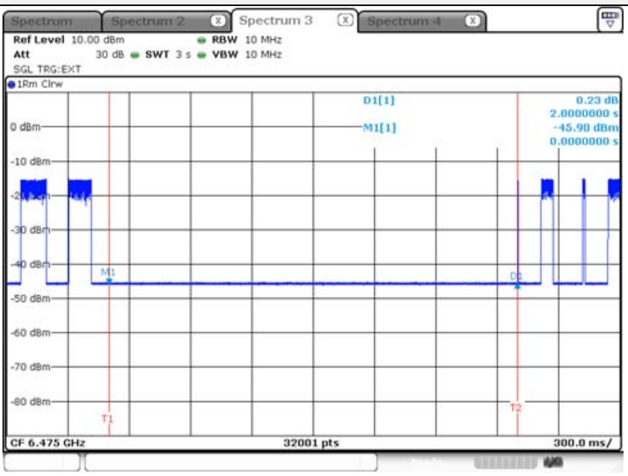
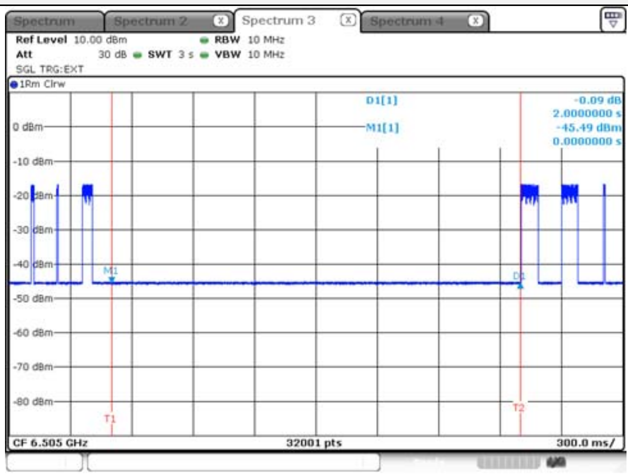
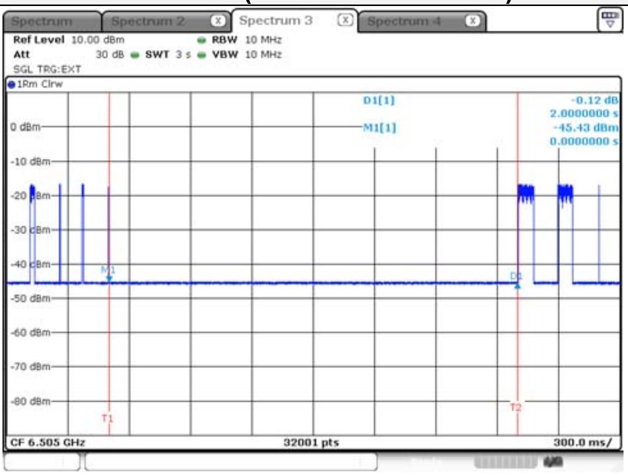
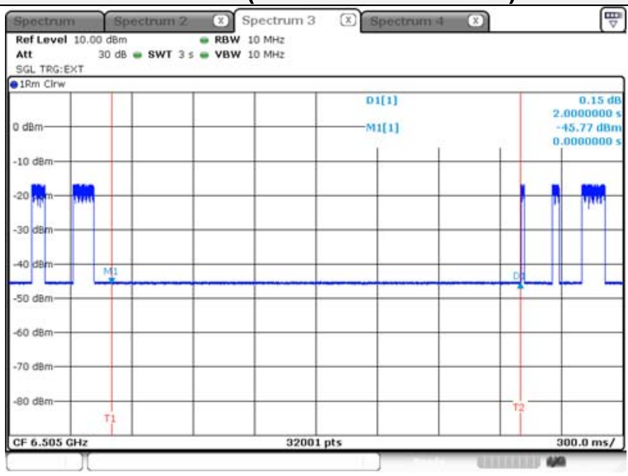
6 260 ㎒ (160 ㎒ bandwidth)



Note.

- M1: Injection of AWGN signal, D2: Removal of AWGN signal.

UNII-6

EUT Transmission	
6 475 ㎒ (20 ㎒ bandwidth)	6 505 ㎒ (160 ㎒ bandwidth)
	
Injected Incumbent Signal	
6 475 ㎒ (20 ㎒ bandwidth)	6 430 ㎒ (160 ㎒ bandwidth)
	
6 505 ㎒ (160 ㎒ bandwidth)	6 580 ㎒ (160 ㎒ bandwidth)
	

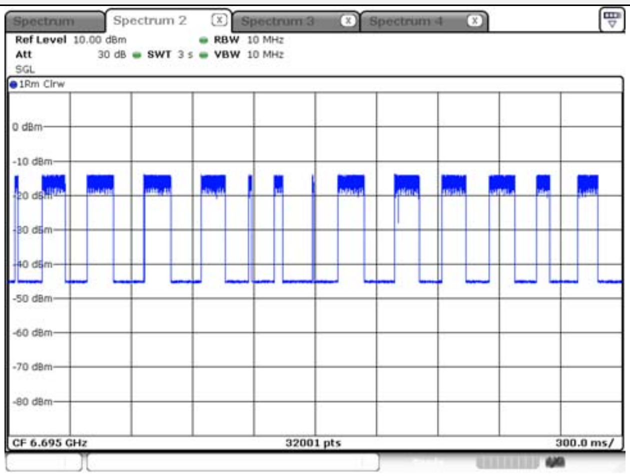
Note.

- M1: Injection of AWGN signal, D2: Removal of AWGN signal.

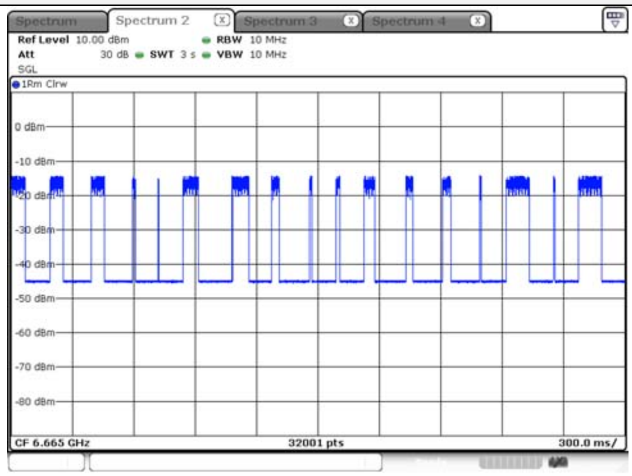
UNII-7

EUT Transmission

6 695 ㎒ (20 ㎒ bandwidth)

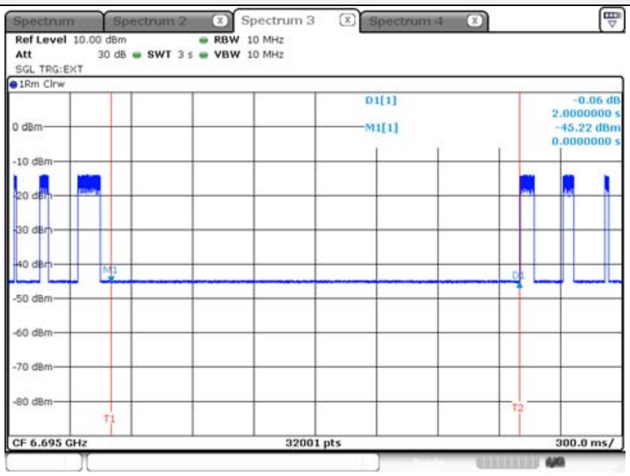


6 665 ㎒ (160 ㎒ bandwidth)

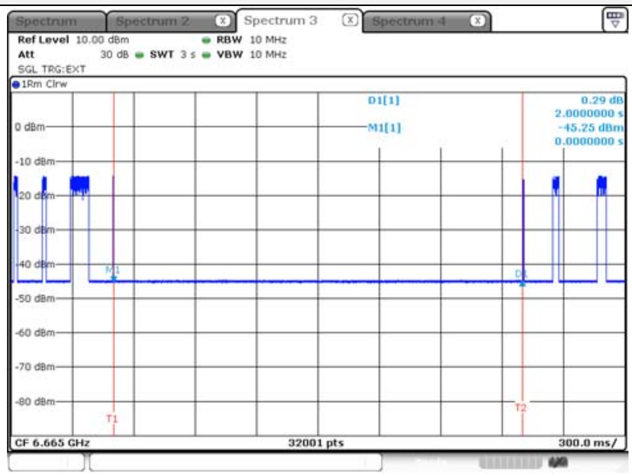


Injected Incumbent Signal

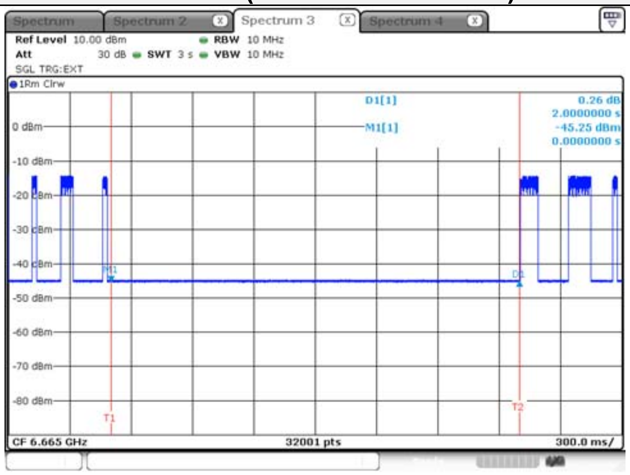
6 695 ㎒ (20 ㎒ bandwidth)



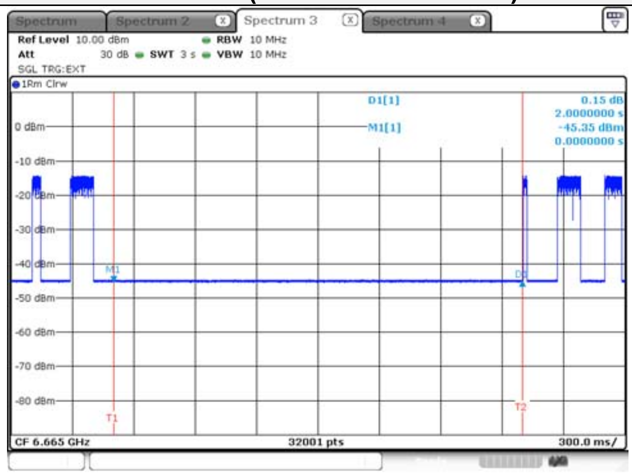
6 590 ㎒ (160 ㎒ bandwidth)



6 665 ㎒ (160 ㎒ bandwidth)



6 740 ㎒ (160 ㎒ bandwidth)



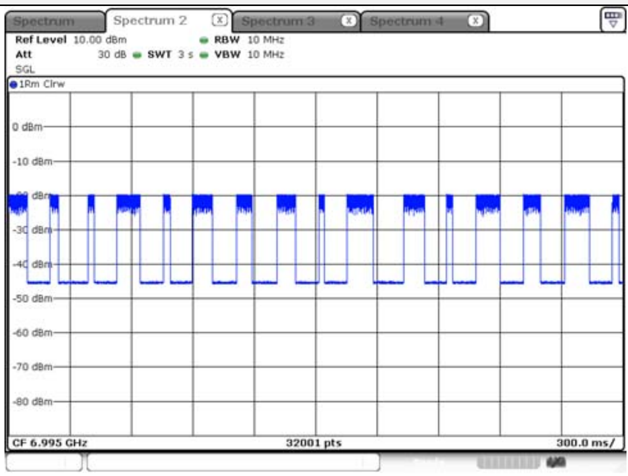
Note.

- M1: Injection of AWGN signal, D2: Removal of AWGN signal.

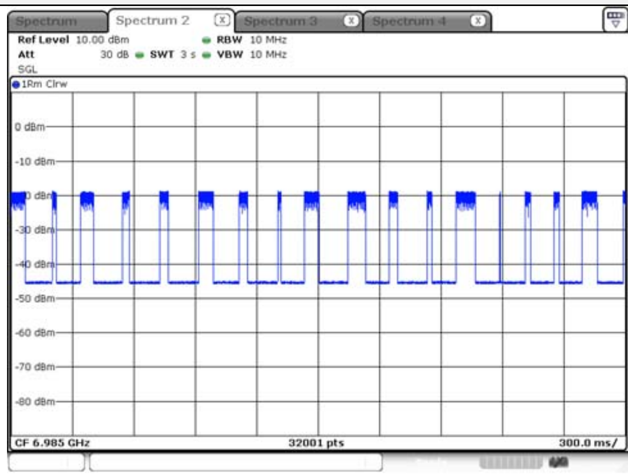
UNII-8

EUT Transmission

6 995 ㎒ (20 ㎒ bandwidth)

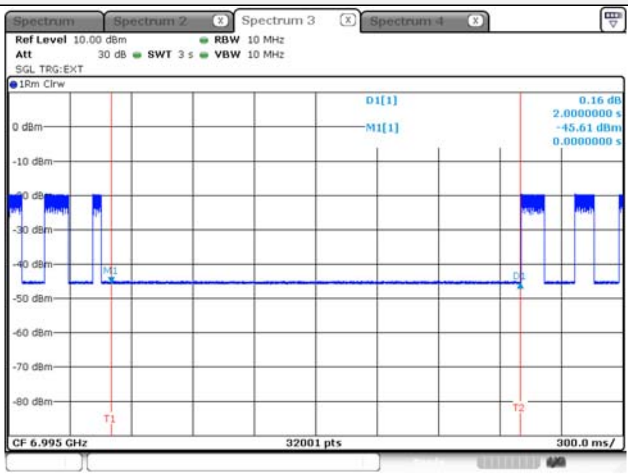


6 985 ㎒ (160 ㎒ bandwidth)

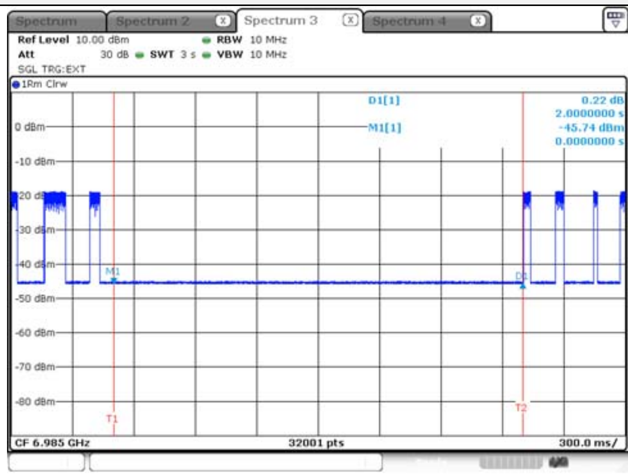


Injected Incumbent Signal

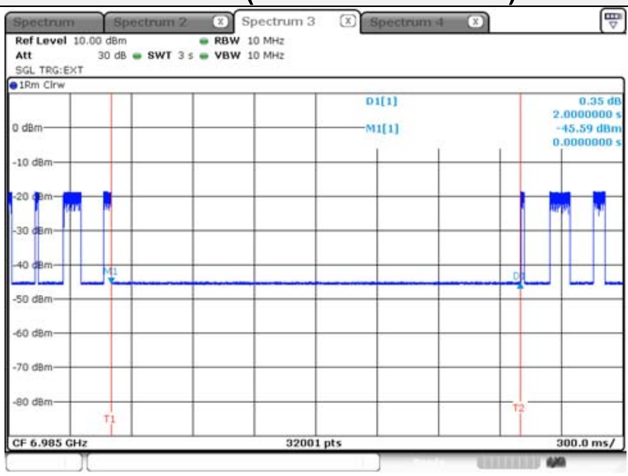
6 995 ㎒ (20 ㎒ bandwidth)



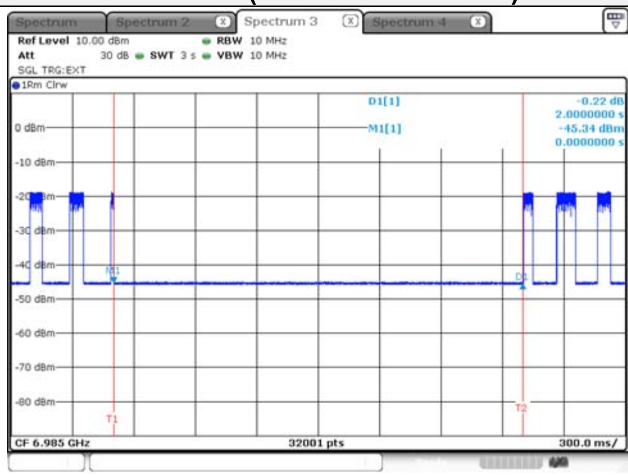
6 910 ㎒ (160 ㎒ bandwidth)



6 985 ㎒ (160 ㎒ bandwidth)



7 060 ㎒ (160 ㎒ bandwidth)



Note.
- M1: Injection of AWGN signal, D2: Removal of AWGN signal.

6. Measurement equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Spectrum Analyzer	R&S	FSV30	100807	22.07.27
SPLITTER	Mini-Circuits	ZX10-2-1252-S+	1633-1	22.01.20
SPLITTER	Mini-Circuits	ZX10-2-1252-S+	1633-2	22.01.20
Power Divider	Agilent	11636B	54456	21.12.31
Directional Coupler	KRYTAR	1850	63794	22.05.11
DC Power Supply	AGILENT	E3632A	MY40017108	22.05.10
Vector Signal Generator	R&S	SMW200A	109480	22.03.05

End of test report