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MEASUREMENT REPORT FCC PART 15.247 ZigBee

Applicant Name:
Samsung Electronics Co., Ltd.
129, Samsung-ro,
Yeongtong-gu, Suwon-si
Gyeonggi-do, 16677, Korea


Date of Testing:
1/30-3/3/2017
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
1M1705180170-08.A3L

FCC ID:	A3LETWV521
APPLICANT:	Samsung Electronics Co., Ltd.

Application Type: Certification
Model: ET-WV521
EUT Type: Indoor Access Point
Max. RF Output Power: 68.39mW (18.35dBm) Peak Conducted
Frequency Range: 2405 – 2480MHz
FCC Classification: Digital Transmission System (DTS)
FCC Rule Part(s): Part 15.247
Test Procedure(s): KDB 558074 D01 v04

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.


Randy Ortanez
President







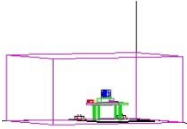
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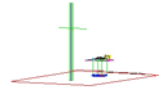
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MEASUREMENT REPORT

FCC Part 15.247

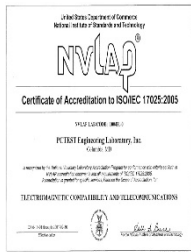
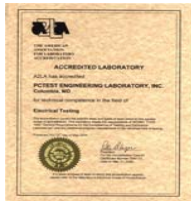


§ 2.1033 General Information



APPLICANT: Samsung Electronics Co., Ltd.
APPLICANT ADDRESS: 129, Samsung-ro,
 Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
TEST SITE: PCTEST ENGINEERING LABORATORY, INC.
TEST SITE ADDRESS: 7185 Oakland Mills Road, Columbia, MD 21046 USA
FCC RULE PART(S): Part 15.247
BASE MODEL: ET-WV521
FCC ID: A3LETWV521
FCC CLASSIFICATION: Digital Transmission System (DTS)
Test Device Serial No.: 20JAN-2, 20JAN-3, Production Pre-Production Engineering
 20JAN-5
DATE(S) OF TEST: 1/30-3/3/2017
TEST REPORT S/N: 1M1705180170-08.A3L

Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Columbia, MD 21046, U.S.A.



- PCTEST facility is an FCC registered (PCTEST Reg. No. 159966) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (2451B-1).
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing Aid Compatibility (HAC) testing, CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.
- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and Industry Canada Standards (RSS).
- PCTEST facility is an IC registered (2451B-1) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS, CDMA, and EvDO wireless devices and for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO, and CDMA 1xRTT.

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1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Industry Canada Certification and Engineering Bureau.

1.2 PCTEST Test Location

The map below shows the location of the PCTEST LABORATORY, its proximity to the FCC Laboratory, the Columbia vicinity, the Baltimore-Washington Internt'l (BWI) airport, the city of Baltimore and the Washington, DC area. (See Figure 1-1).

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The site coordinates are 39° 10'23" N latitude and 76° 49'50" W longitude. The facility is 0.4 miles North of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4-2014 on January 22, 2015.

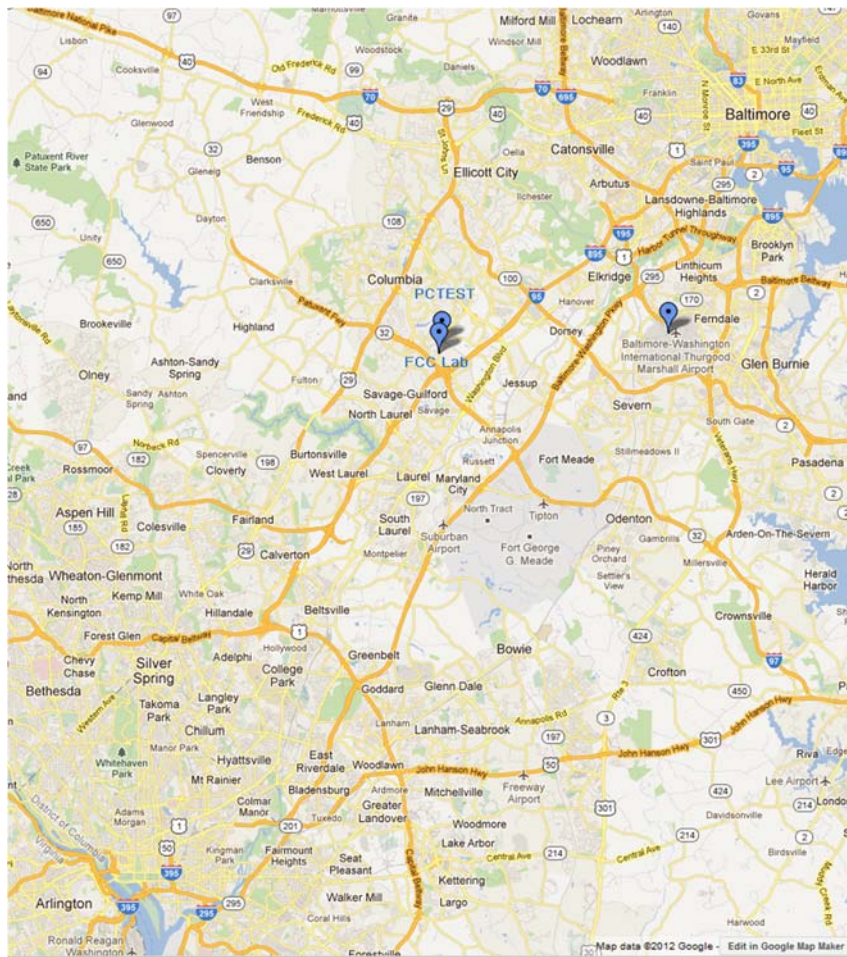


Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Indoor Access Point FCC ID: A3LETWV521**. The test data found in this report was taken with the EUT operating in Zigbee mode.

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n WLAN, 802.11a/n/ac UNII, Bluetooth (LE), Zigbee, Zwave

Ch.	Frequency (MHz)
11	2405
:	:
18	2440
:	:
26	2480



Table 2-1. Frequency/ Channel Operations

2.3 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013. ANSI C63.10-2013 was also used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups, and 7.2, 7.3, 7.4, 7.5, and 7.6 for antenna port conducted emissions test setups.

2.4 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

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3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 v04 were used in the measurement of the **Samsung Indoor Access Point FCC ID: A3LETWV521**.

Deviation from measurement procedure.....None



3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 10'x16'x9' shielded enclosure. The shielded enclosure is manufactured by ETS Lindgren RF Enclosures. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-5. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50μH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is an ETS Lindgren Model LPRX-4X30 (100dB Attenuation, 14kHz-18GHz) and the two EMI/RFI filters are ETS Lindgren Model LRW-2030-S1 (100dB Minimum Insertion Loss, 14kHz – 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference groundplane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions is used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

Line conducted emissions test results are shown in Section 7.10. The EMI Receiver mode of the Agilent MXE was used to perform AC line conducted emissions testing.

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3.3 Radiated Emissions



The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. A 72.4cm high PVC support structure is placed on top of the turntable. A 3" (~7.6cm) sheet of high density polystyrene is used as the table top and is placed on top of the PVC supports to bring the total height of the table to 80cm. For measurements above 1GHz, a high density expanded polystyrene block is placed on top of the test table to bring the total table height to 1.5m.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33(b)(1) depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

3.4 Environmental Conditions

The temperature is controlled within range of 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

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4.0 ANTENNA REQUIREMENTS



Excerpt from §15.203 of the FCC Rules/Regulations:

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antennas of the EUT are **permanently attached**.
- There are no provisions for connection to an external antenna.

Conclusion:



The EUT complies with the requirement of §15.203.

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5.0 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 indicate a 95% level of confidence. The measurement data shown herein meets or 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.

Contribution	Expanded Uncertainty (\pm dB)
Conducted Bench Top Measurements	1.13
Conducted Disturbance	3.09
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09



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6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2006.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	WL25-1	Conducted Cable Set (25GHz)	4/11/2016	Annual	4/11/2017	WL25-1
-	RE1	Radiated Emissions Cable Set (UHF/EHF)	7/11/2016	Annual	7/11/2017	RE1
Agilent	N9030A	PXA Signal Analyzer (26.5GHz)	7/20/2016	Annual	7/20/2017	MY49432391
Agilent	N9038A	MXE EMI Receiver	4/21/2016	Annual	4/21/2017	MY51210133
Anritsu	ML2495A	Power Meter	10/16/2015	Biennial	10/16/2017	941001
Anritsu	MA2411B	Pulse Power Sensor	10/14/2015	Biennial	10/14/2017	846215
Com-Power	AL-130	9kHz - 30MHz Loop Antenna	7/30/2015	Biennial	7/30/2017	121034
Com-Power	PAM-103	Pre-Amplifier (1-1000MHz)	7/6/2016	Annual	7/6/2017	441119
Com-Power	PAM-118A	PREAMPLIFIER 500MHZ TO 18GHZ	7/26/2016	Annual	7/26/2017	551079
EMCO	3160-09	Small Horn (18 - 26.5GHz)	8/23/2016	Biennial	8/23/2018	135427
Emco	3115	Horn Antenna (1-18GHz)	3/10/2016	Biennial	3/10/2018	9704-5182
Pasternack	NMLC-1	Line Conducted Emissions Cable (NM)	4/28/2015	Biennial	4/28/2017	NMLC-1
PCTEST	-	EMC Switch System	7/6/2016	Annual	7/6/2017	NM2
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	7/15/2016	Annual	7/15/2017	100348
Rohde & Schwarz	FSW67	Signal / Spectrum Analyzer	7/27/2016	Annual	7/27/2017	103200
Rohde & Schwarz	TS-PR18	1-18 GHz Pre-Amplifier	3/7/2016	Annual	3/7/2017	100071
Rohde & Schwarz	TS-PR26	18-26.5 GHz Pre-Amplifier	3/7/2016	Annual	3/7/2017	100040
Solar Electronics	8012-50-R-24-BNC	Line Impedance Stabilization Network	7/30/2015	Biennial	7/30/2017	310233
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	3/14/2016	Biennial	3/14/2018	A051107

Table 6-1. Annual Test Equipment Calibration Schedule

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7.0 TEST RESULTS

7.1 Summary



Company Name: Samsung Electronics Co., Ltd.
 FCC ID: A3LETWV521
 Method/System: Digital Transmission System (DTS)
 Number of Channels: 16

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(2)	6dB Bandwidth	N/A	CONDUCTED	PASS	Section 7.2
15.247(b)(3)	Transmitter Output Power	< 1 Watt		PASS	Section 7.3
15.247(e)	Transmitter Power Spectral Density	> 8dBm / 3kHz		PASS	Section 7.4
15.247(d)	Band Edge / Out-of-Band Emissions	Conducted > 20dBc		PASS	Section 7.5, Section 7.6
15.205 15.209	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209	RADIATED	PASS	Section 7.7, Section 7.8, Section 7.9
15.207	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits	LINE CONDUCTED	PASS	Section 7.10

Table 7-1. Summary of Test Results

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) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables, directional couplers, and attenuators used as part of the system to maintain a link between the call box and the EUT at all frequencies of interest.
- 3) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables, attenuators, and couplers.
- 4) For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "BT Auto," Version 3.3.
- 5) For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Chamber Automation," Version 1.1.5.

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7.2 6dB Bandwidth Measurement

§15.247 (a.2)

Test Overview and Limit

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the transmitter antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible 6dBm bandwidth is 500 kHz.

Test Procedure Used

KDB 558074 D01 v04 -Section 8.2 Option 2

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100kHz
3. VBW $\geq 3 \times$ RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

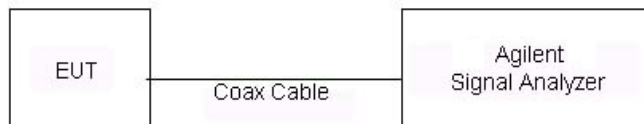




Figure 7-1. Test Instrument & Measurement Setup

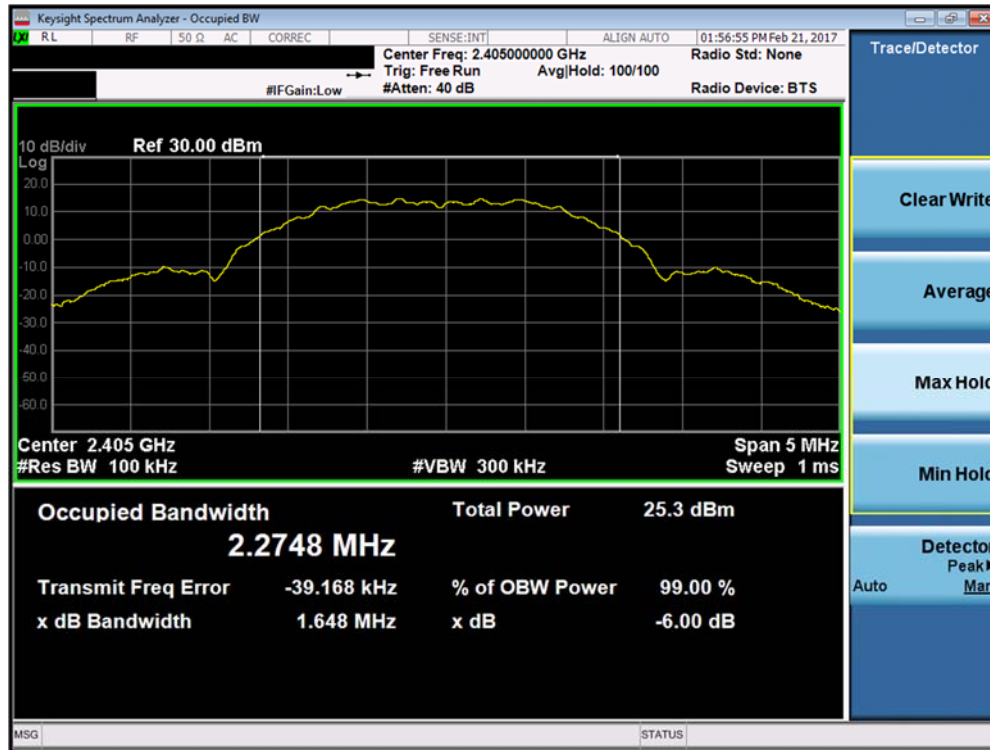
Test Notes

None

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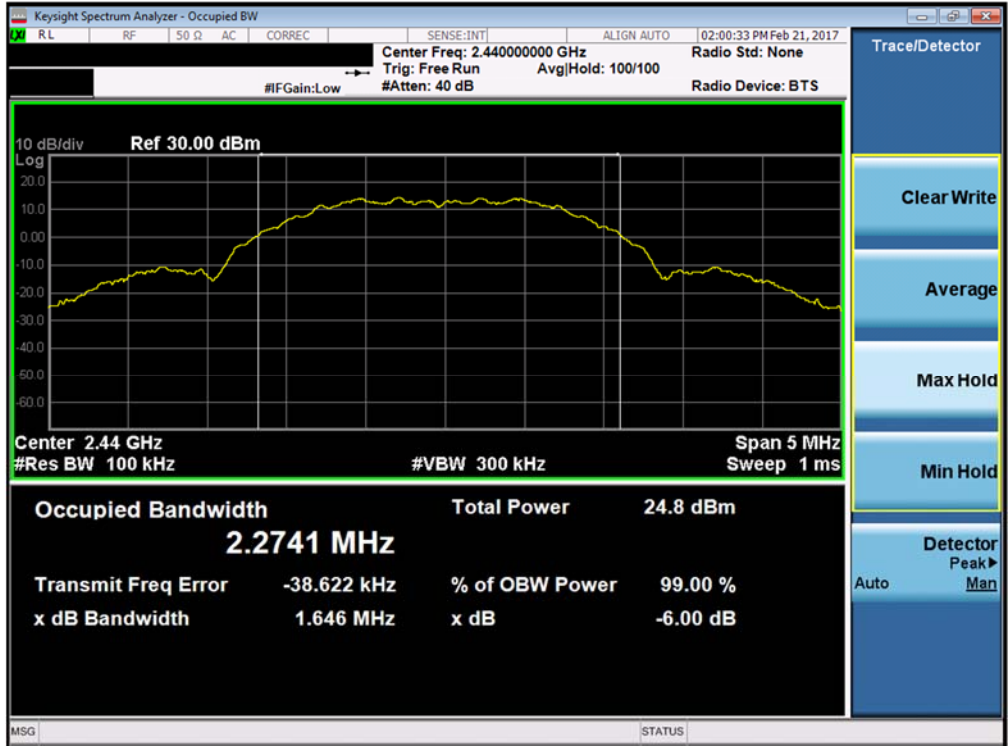
Frequency [MHz]	Channel No.	Measured Bandwidth [kHz]	Minimum Bandwidth [kHz]	Pass / Fail
2405	11	1648.0	500	Pass
2440	18	1646.0	500	Pass
2480	26	1644.0	500	Pass

Table 7-2. Conducted 20dB Bandwidth Measurements

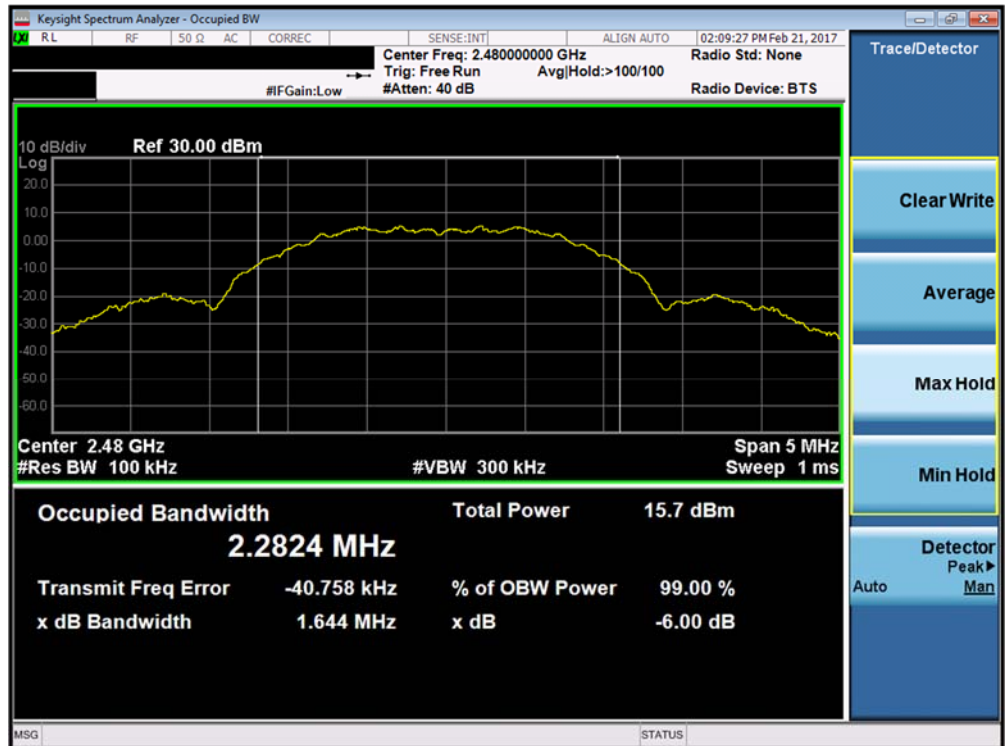


Plot 7-1. 6dB Bandwidth Plot (Zigbee – Ch. 11)

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Plot 7-2. 6dB Bandwidth Plot (Zigbee – Ch. 18)



Plot 7-3. 6dB Bandwidth Plot (Zigbee – Ch. 26)

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7.3 Output Power Measurement

§15.247 (b.3)

Test Overview and Limits

The transmitter antenna terminal of the EUT is connected to the input of a spectrum analyzer. Measurements are made while the EUT is operating at maximum power and at the appropriate frequencies.

The maximum permissible output power is 1 Watt.

Test Procedure Used

KDB 558074 D01 v04 – Section 9.1.1

Test Settings

Peak Power Measurement

1. RBW > 6dB bandwidth of emission being measured
2. VBW $\geq 3 \times$ RBW
3. Span $\geq 3 \times$ RBW
4. Sweep = auto couple
5. Detector = peak
6. Trace mode = max hold
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

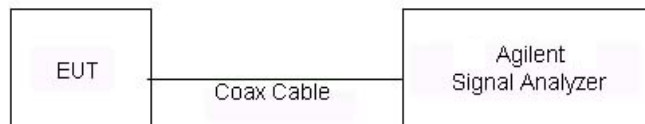




Figure 7-2. Test Instrument & Measurement Setup



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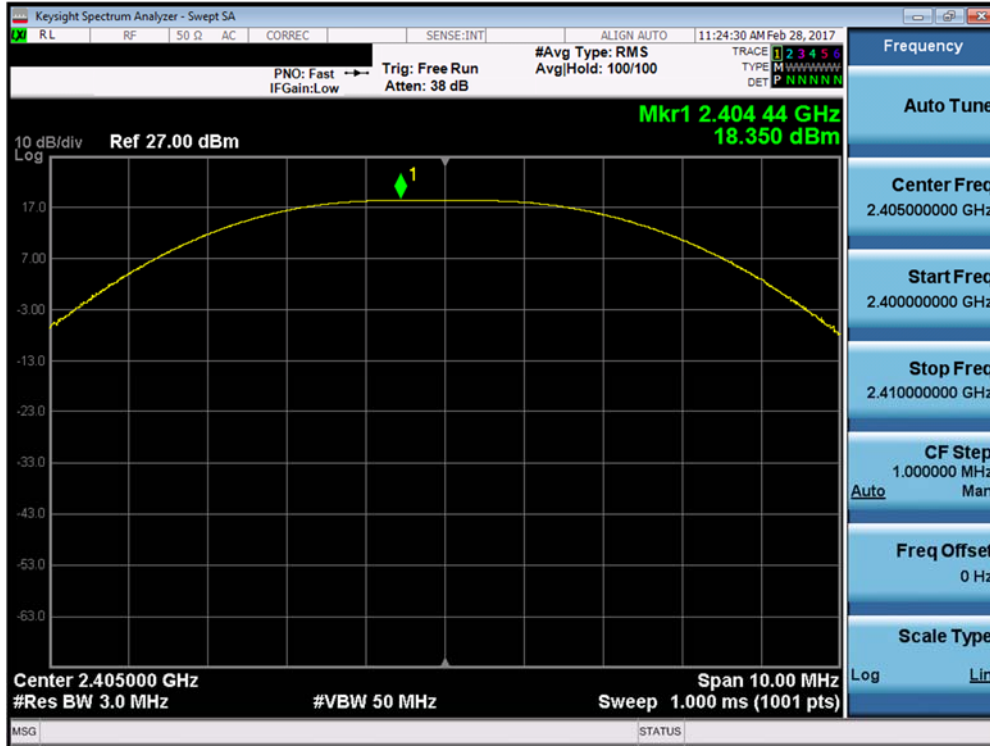
Final results were obtained using calibrated couplers, attenuators and cables. The following formula was used:

$$\text{Output Power (dBm)} = \text{Raw Analyzer Level (dBm)} + \text{Cable Loss (dB)} + \text{Loss in Directional Coupler/Insertion Loss (dB)}$$

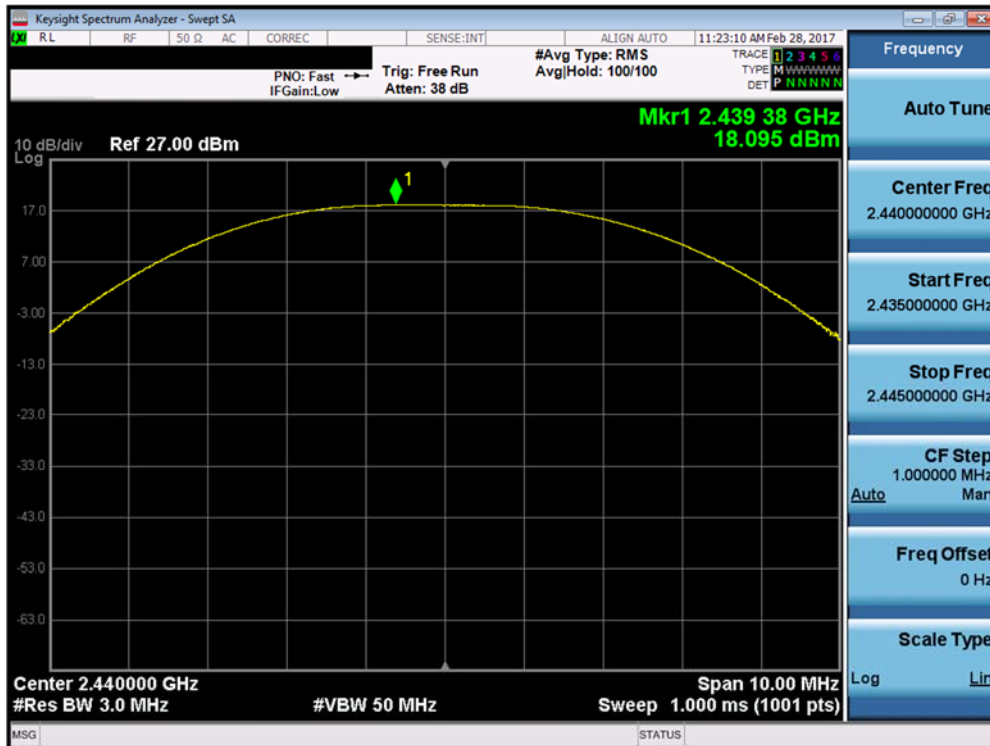
Frequency [MHz]	Channel No.	Peak Conducted Power	
		[dBm]	[mW]
2405	11	18.35	68.391
2440	18	18.10	64.491
2475	25	18.07	64.121
2480	26	8.92	7.805

Table 7-3. Conducted Output Power Measurements

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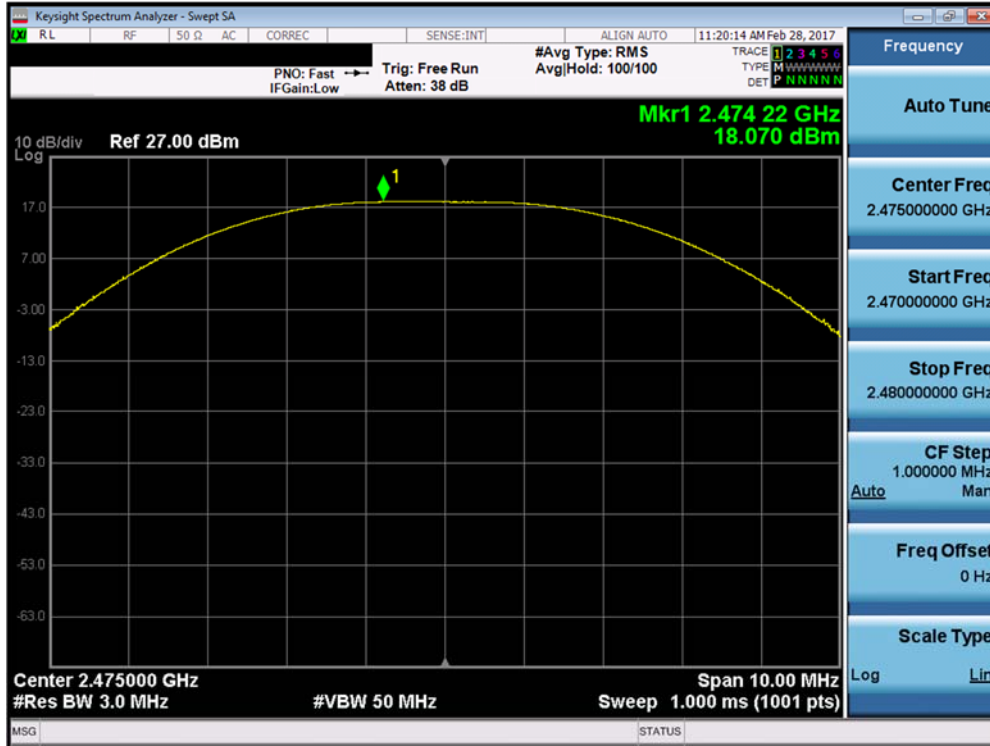


Plot 7-4. Peak Conducted Power (ZigBee – Ch. 11)

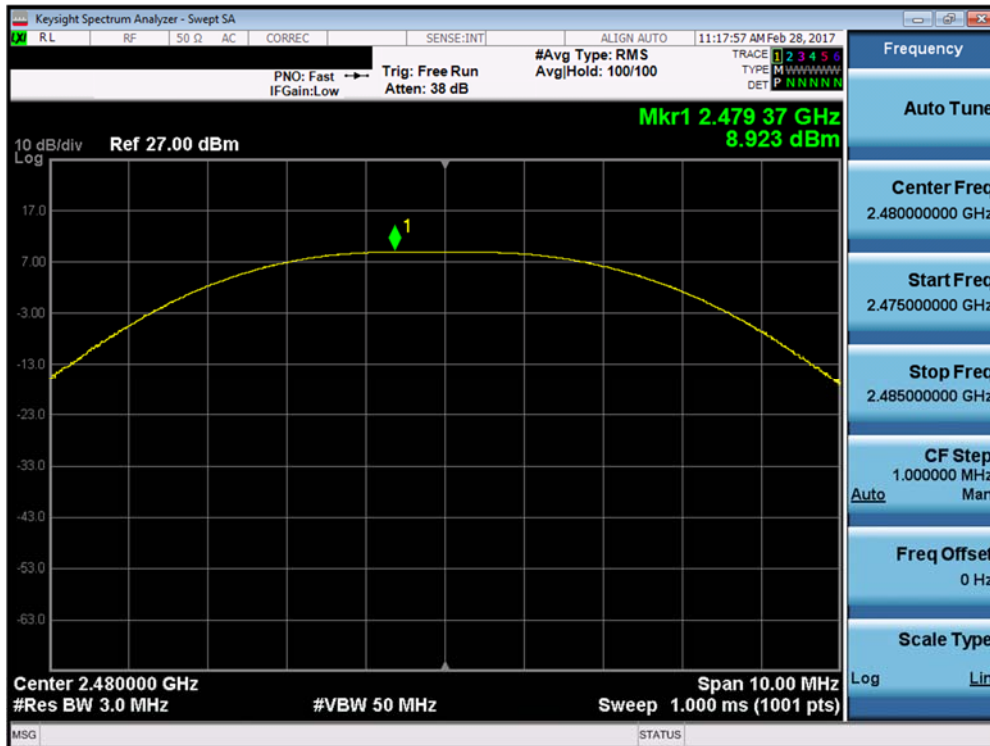


Plot 7-5. Peak Conducted Power (ZigBee – Ch. 18)

FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Plot 7-6. Peak Conducted Power (ZigBee – Ch. 25)



Plot 7-7. Peak Conducted Power (ZigBee – Ch. 26)

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7.4 Power Spectral Density

§15.247(e)

Test Overview and Limit

The peak power density is measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies.

The maximum permissible power spectral density is 8 dBm in any 3 kHz band.

Test Procedure Used

KDB 558074 D01 v04 – Section 10.2 Method PKPSD

Test Settings

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 10kHz
4. VBW = 1MHz
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

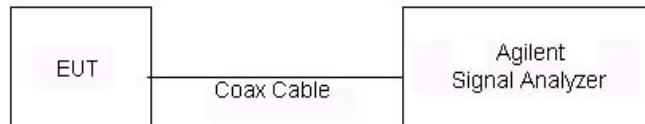




Figure 7-3. Test Instrument & Measurement Setup

Test Notes

None

FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Frequency [MHz]	Channel No.	Measured Power Spectral Density [dBm]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
2405	11	7.40	8.0	-0.60
2440	18	6.87	8.0	-1.13
2475	25	6.92	8.0	-1.08
2480	26	-2.23	8.0	-10.23

Table 7-4. Conducted Power Density Measurements

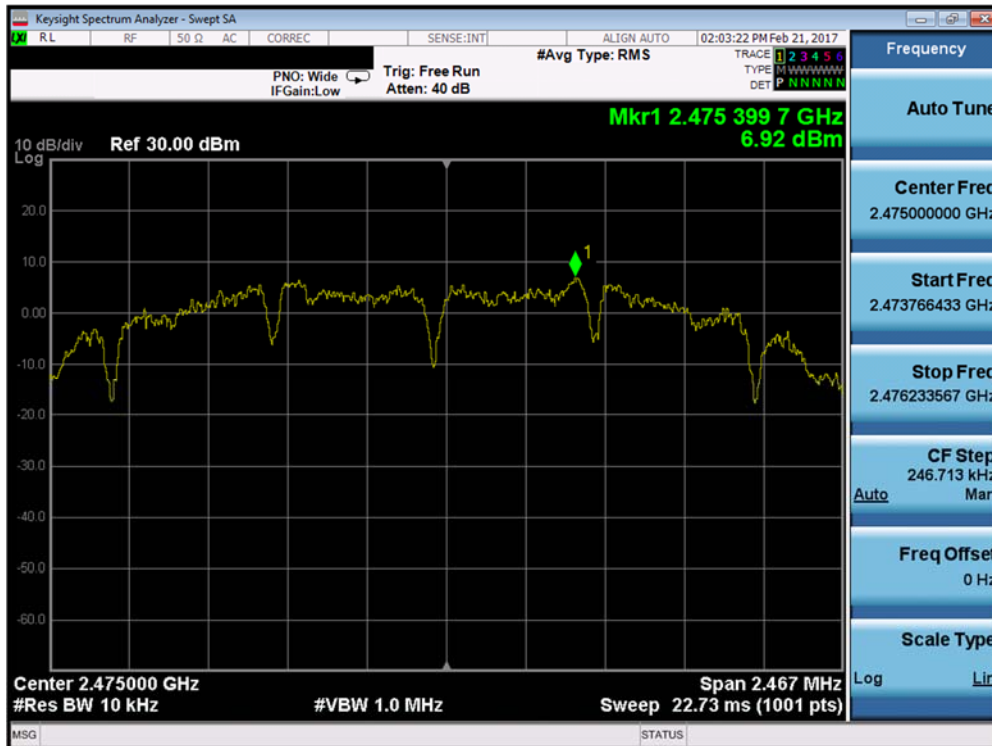


Plot 7-8. Power Spectral Density Plot (ZigBee – Ch. 11)

FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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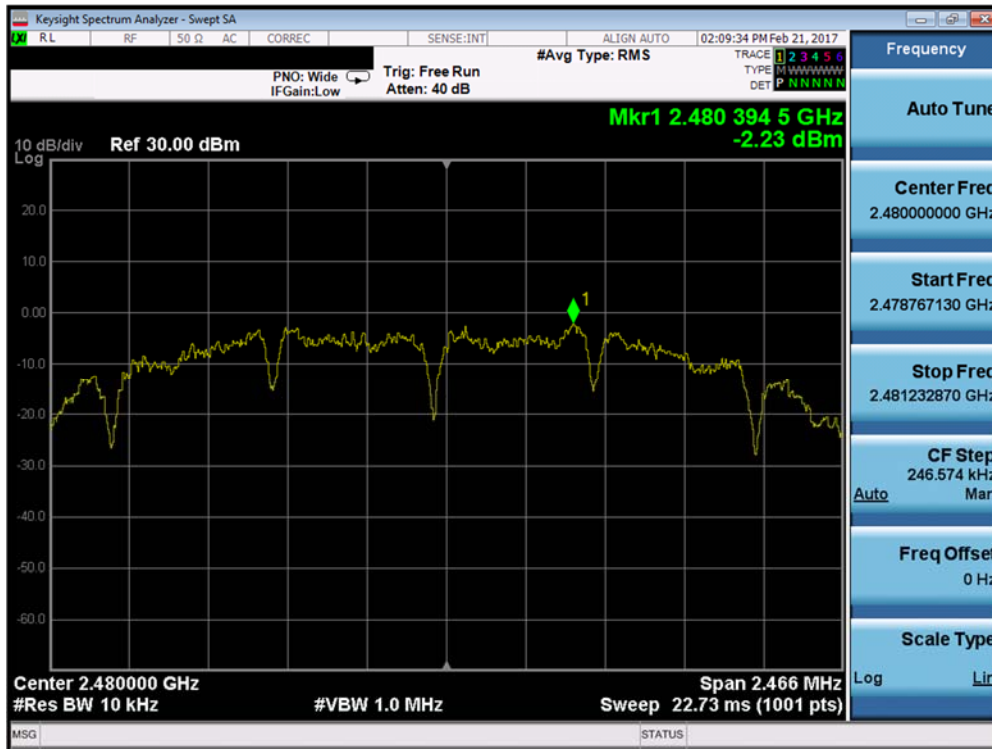


Plot 7-9. Power Spectral Density Plot (ZigBee – Ch. 18)



Plot 7-10. Power Spectral Density Plot (ZigBee – Ch. 25)

FCC ID: A3LETWV521	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)	SAMSUNG	Approved by: Quality Manager
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Plot 7-11. Power Spectral Density Plot (ZigBee – Ch. 26)

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7.5 Band Edge Compliance

§15.247 (d)

Test Overview and Limits

For the following out of band conducted spurious emissions plots at the band edge, the EUT was set to transmit at maximum power with the largest packet size available. These settings produced the worst-case emissions.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth.

Test Procedure Used

KDB 558074 D01 v04 – Section 11.3

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW = 100kHz
4. VBW = 300kHz
5. Detector = Peak
6. Number of sweep points $\geq 2 \times \text{Span/RBW}$
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

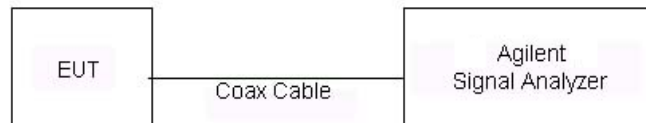


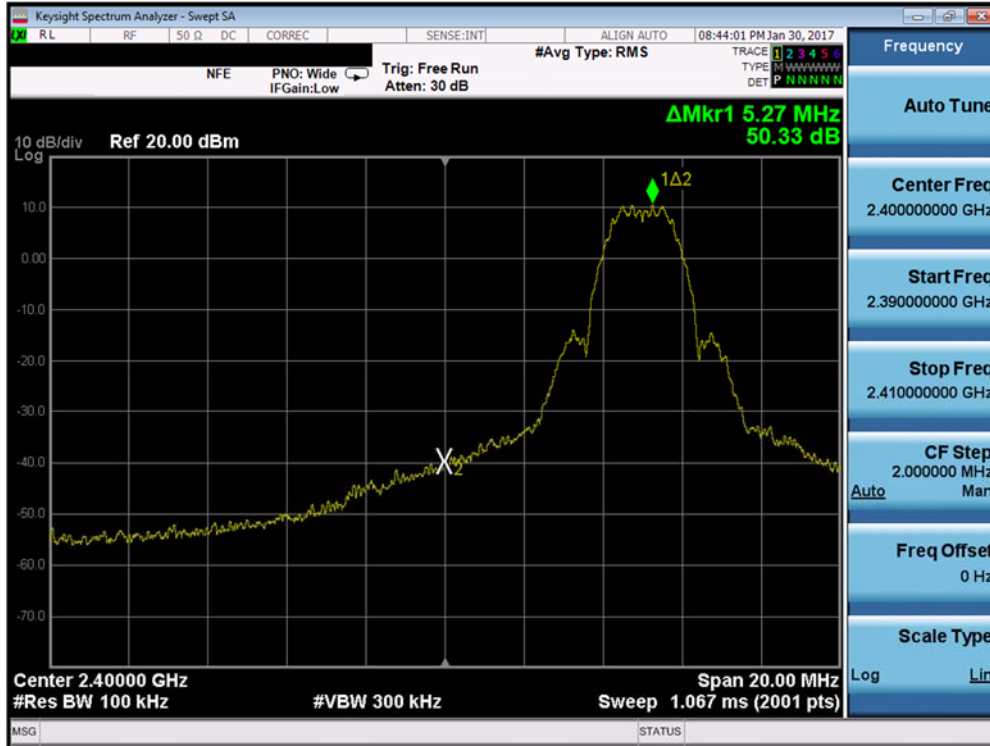


Figure 7-4. Test Instrument & Measurement Setup

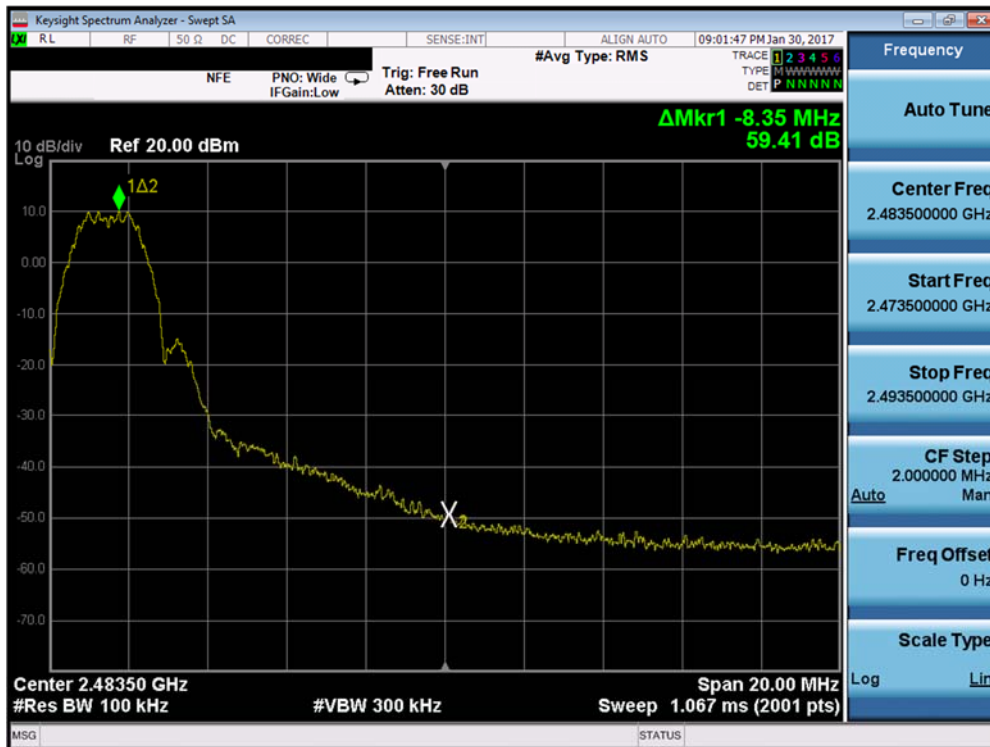
Test Notes

None.

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Plot 7-12. Band Edge Plot (ZigBee – Ch. 11)



Plot 7-13. Band Edge Plot (ZigBee – Ch. 25)

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Plot 7-14. Band Edge Plot (ZigBee – Ch. 26)

FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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7.6 Conducted Spurious Emissions

§15.247 (d)

Test Overview and Limit

For the following out of band conducted spurious emissions plots, the EUT was set to transmit at maximum power with the largest packet size available. The worst case spurious emissions were found in this configuration.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 11.1 of KDB 558074 D01 v04.

Test Procedure Used

KDB 558074 D01 v04 – Section 11.3

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 25GHz (separated into two plots per channel)
2. RBW = 1MHz* (See note below)
3. VBW = 3MHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

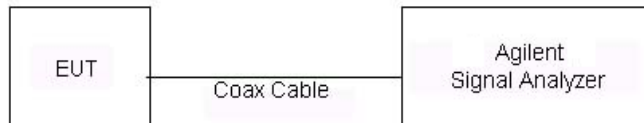


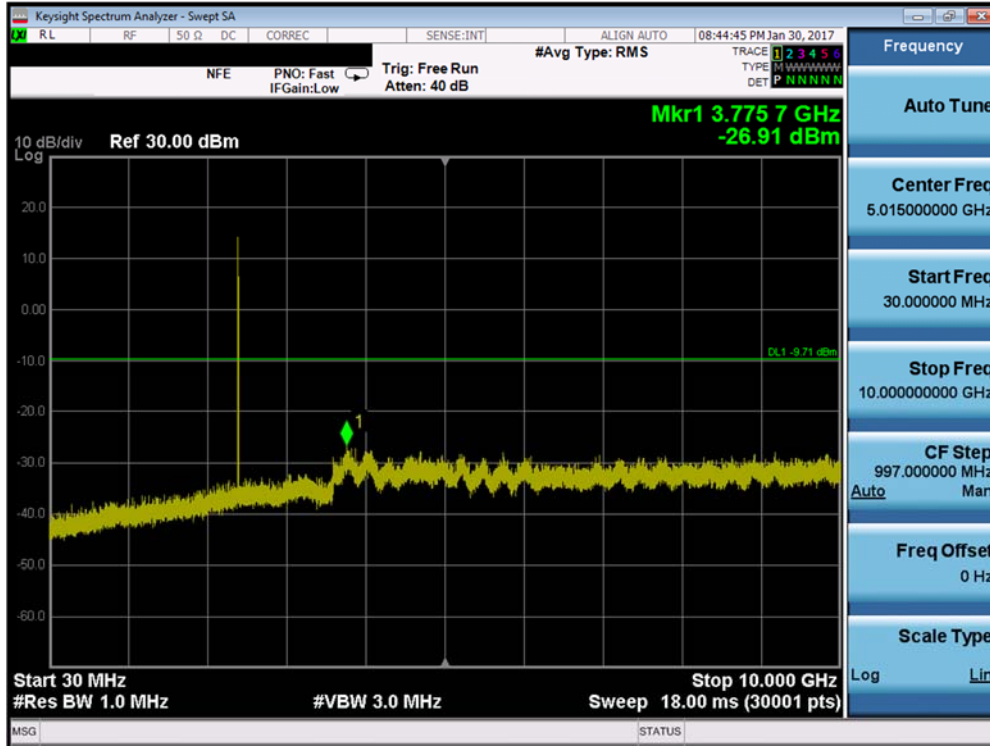


Figure 7-5. Test Instrument & Measurement Setup

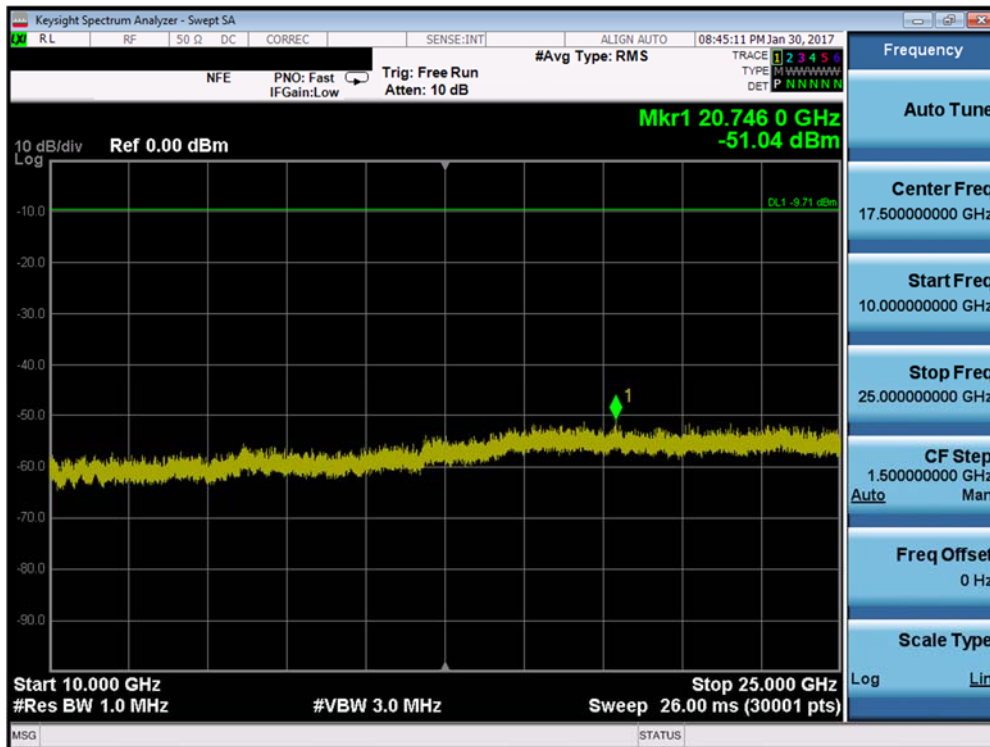
Test Notes

1. RBW was set to 1MHz rather than 100kHz in order to increase the measurement speed.
2. The display line shown in the following plots denotes the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, since the traces in the following plots are measured with a 1MHz RBW, the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.
3. For plots showing conducted spurious emissions near the limit, the frequencies were investigated with a reduced RBW to ensure that no emissions were present.

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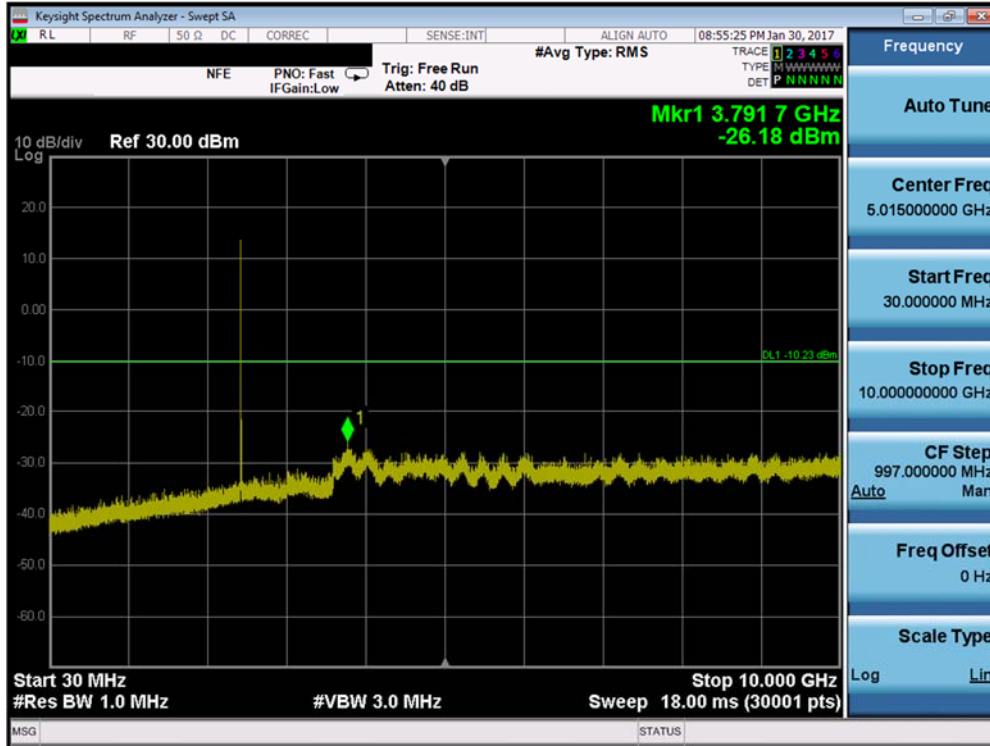


Plot 7-15. Conducted Spurious Plot (ZigBee – Ch. 11)

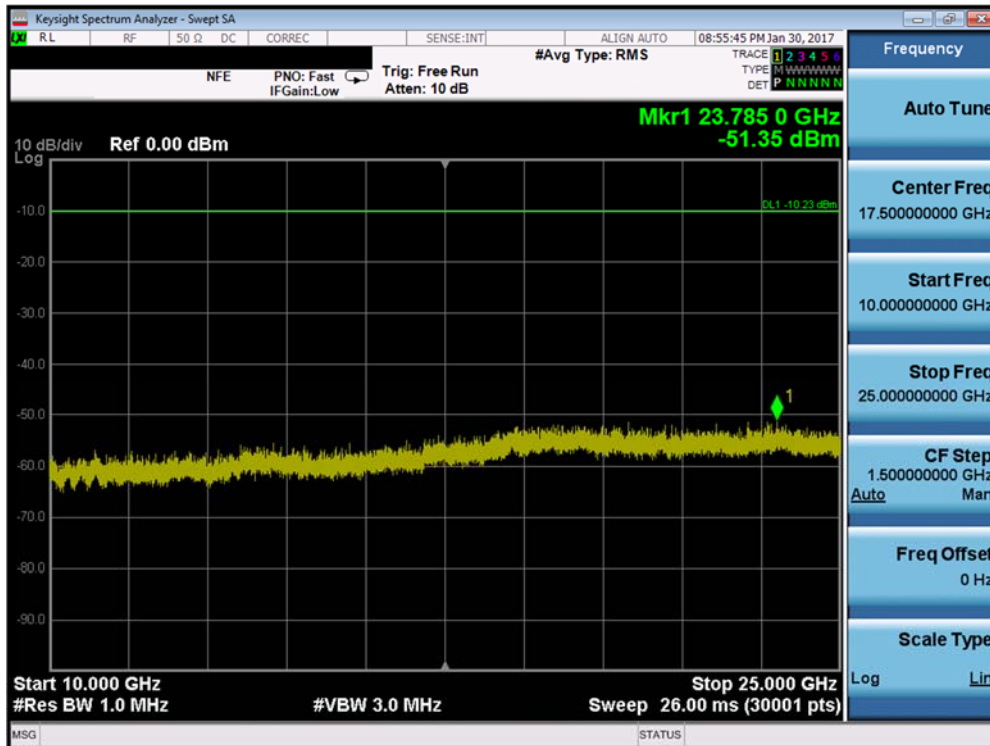


Plot 7-16. Conducted Spurious Plot (ZigBee – Ch. 11)

FCC ID: A3LETWV521	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)	SAMSUNG	Approved by: Quality Manager
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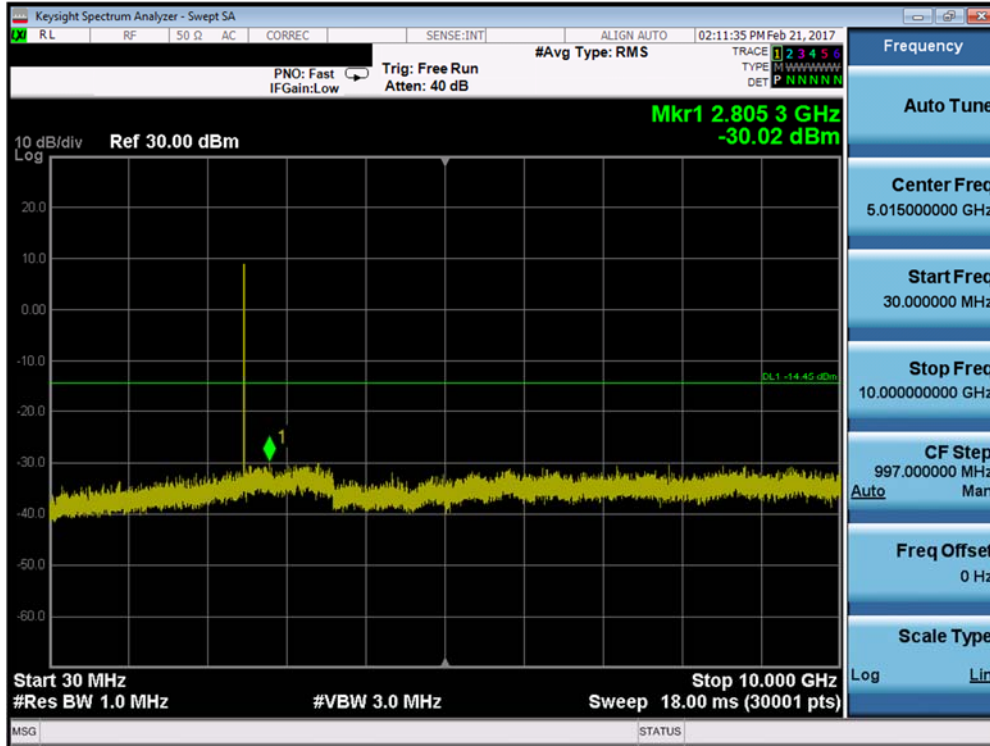


Plot 7-17. Conducted Spurious Plot (ZigBee – Ch. 18)

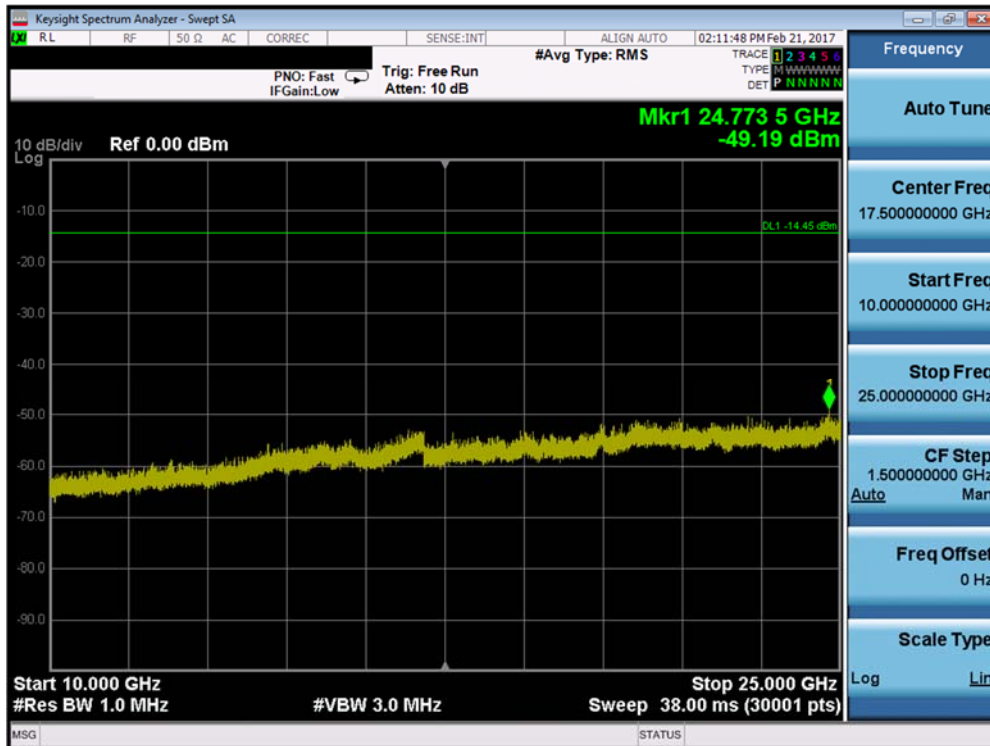


Plot 7-18. Conducted Spurious Plot (ZigBee – Ch. 18)

FCC ID: A3LETWV521	PCTEST ENGINEERING LABORATORY, INC.	FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)	SAMSUNG	Approved by: Quality Manager
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Plot 7-19. Conducted Spurious Plot (ZigBee – Ch. 25)



Plot 7-20. Conducted Spurious Plot (ZigBee – Ch. 25)

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7.7 Radiated Spurious Emission Measurements – Above 1GHz

§15.205 §15.209 §15.247 (d)

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power and at the appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-5 per Section 15.209.

Frequency	Field Strength [μ V/m]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 7-5. Radiated Limits



Test Procedures Used

KDB 558074 D01 v04 – Section 12.1, 12.2.7

Test Settings

Average Field Strength Measurements per Section 12.2.5.3 of KDB 558074 D01 v04

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3kHz > 1/T
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to run for at least 50 times (1/duty cycle) traces

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Peak Field Strength Measurements per Section 12.2.4 of KDB 558074 D01 v04

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW is set depending on measurement frequency, as specified in Table 7-6 below
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Frequency	RBW
9 – 150kHz	200 – 300Hz
0.15 – 30MHz	9 – 10kHz
30 – 1000MHz	100 – 120kHz
> 1000MHz	1MHz

Table 7-6. RBW as a Function of Frequency

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

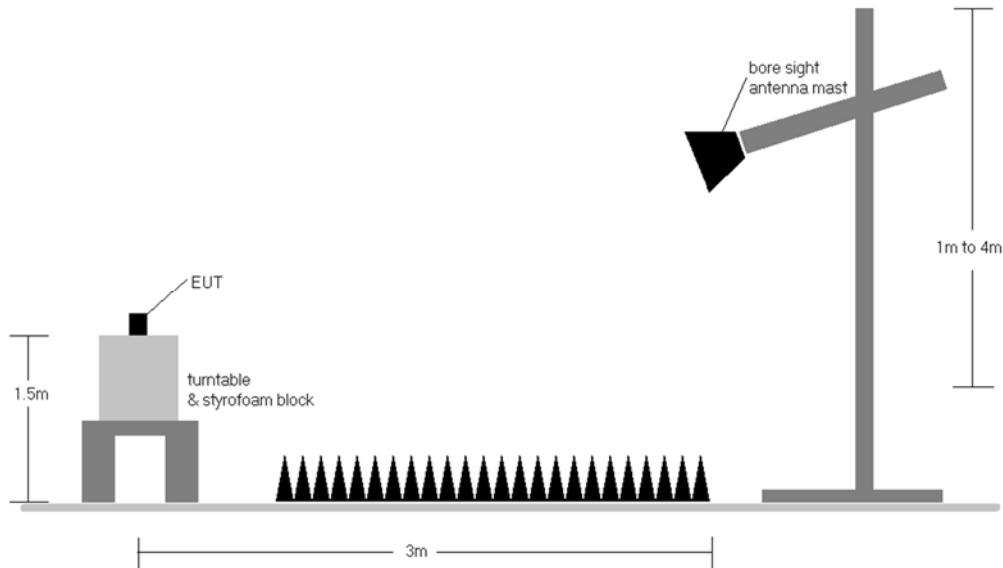




Figure 7-6. Radiated Test Setup >1GHz

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Test Notes

1. The optional test procedures for antenna port conducted measurements of unwanted emissions per the guidance of KDB 558074 D01 v04 were not used to evaluate this device for compliance to radiated limits. All radiated spurious emissions levels were measured in a radiated test setup.
2. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-5.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested while powered by an DC power source.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
6. Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
7. No significant radiated band edge emissions were found in the 2310 – 2390MHz restricted band.

Sample Calculations



Determining Spurious Emissions Levels

- Field Strength Level $_{[dB\mu V/m]} = \text{Analyzer Level }_{[dBm]} + 107 + \text{AFCL }_{[dB/m]}$
- $\text{AFCL }_{[dB/m]} = \text{Antenna Factor }_{[dB/m]} + \text{Cable Loss }_{[dB]}$
- $\text{Margin }_{[dB]} = \text{Field Strength Level }_{[dB\mu V/m]} - \text{Limit }_{[dB\mu V/m]}$

Radiated Band Edge Measurement Offset

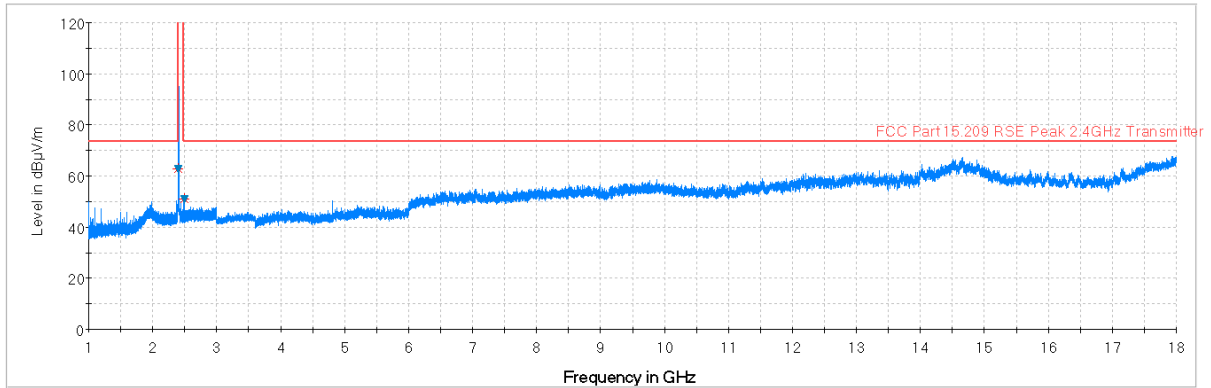
- The amplitude offset shown in the radiated restricted band edge plots in Section 7.8 was calculated using the formula:

$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + 10 \text{ dB Attenuator}) - \text{Preamplifier Gain}$$

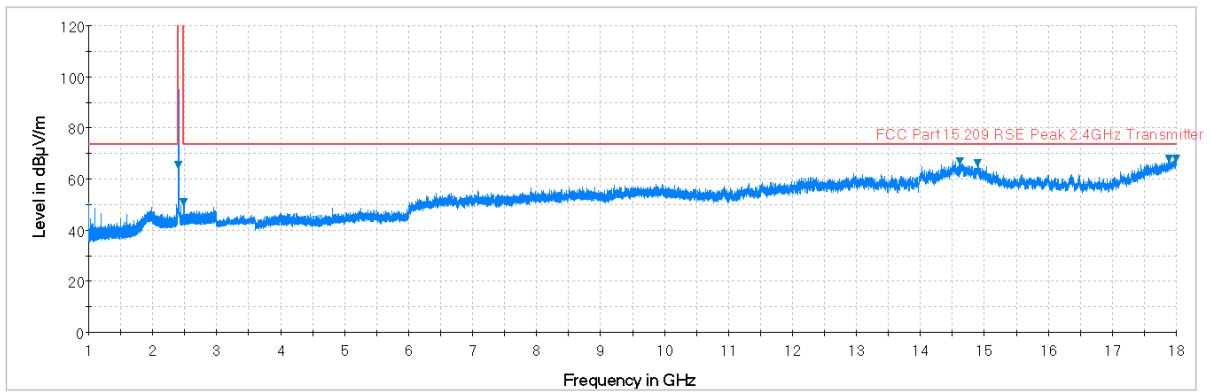
FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Radiated Spurious Emission Measurements

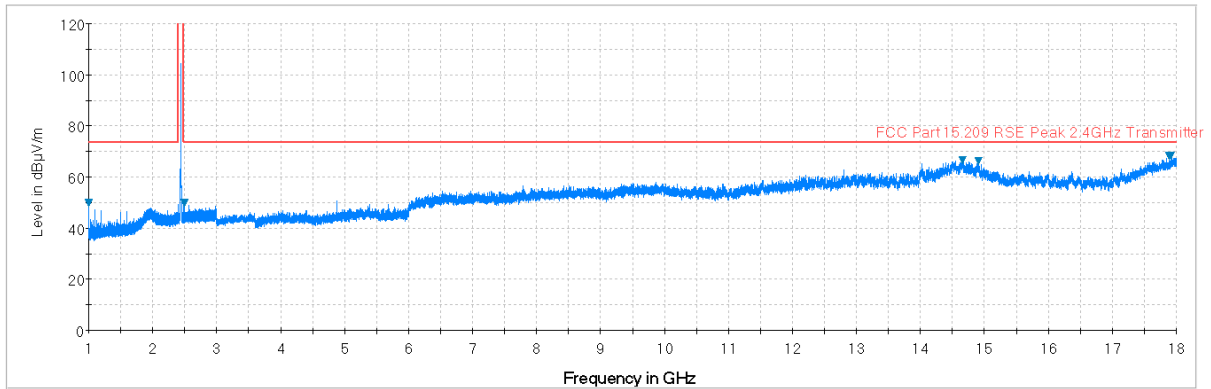
§15.205 §15.209 §15.247 (d)



Plot 7-21. Radiated Spurious Plot above 1GHz (Zigbee – Ch. 11, Ant. Pol. H)

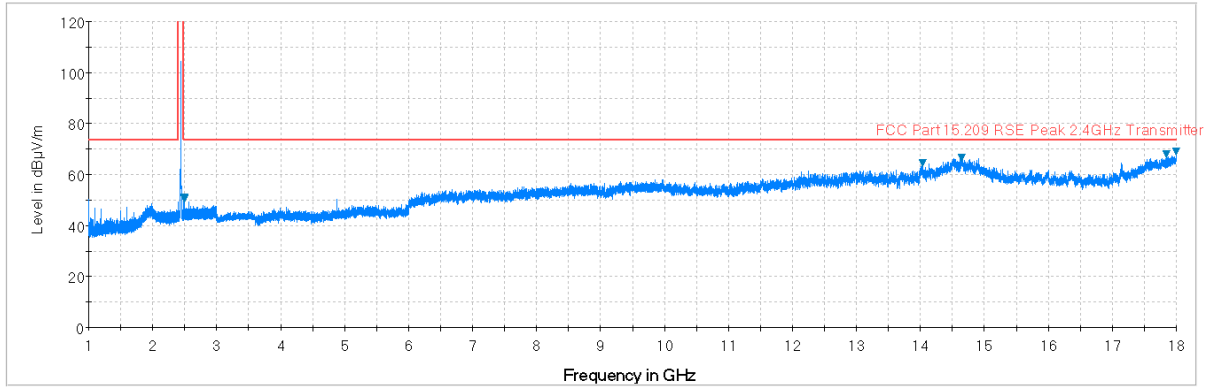


Plot 7-22. Radiated Spurious Plot above 1GHz (Zigbee – Ch. 11, Ant. Pol. V)

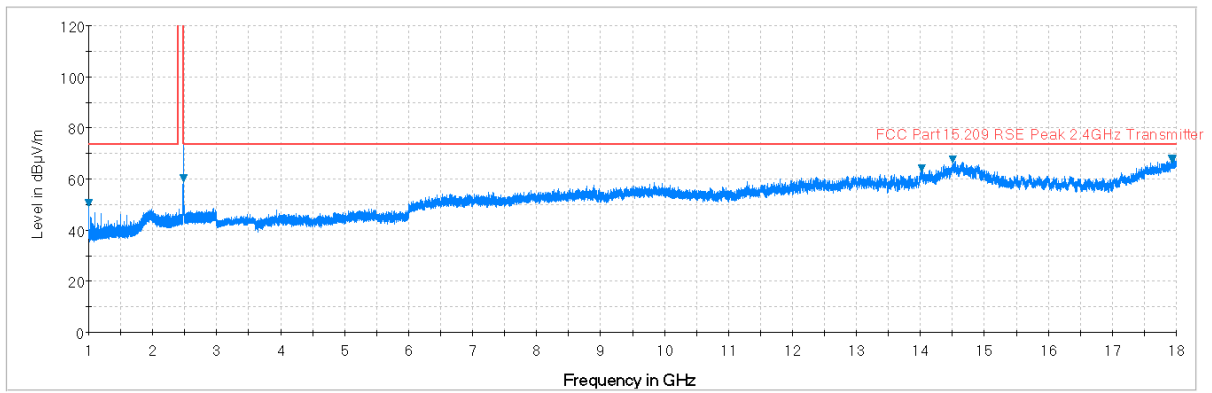


Plot 7-23. Radiated Spurious Plot above 1GHz (Zigbee – Ch. 18, Ant. Pol. H)

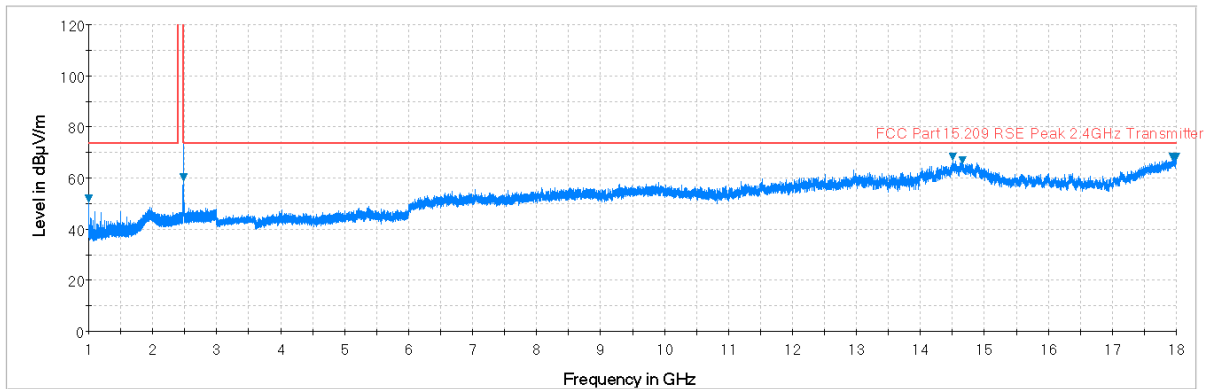
FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Plot 7-24. Radiated Spurious Plot above 1GHz (Zigbee – Ch. 18, Ant. Pol. V)



Plot 7-25. Radiated Spurious Plot above 1GHz (Zigbee – Ch. 26, Ant. Pol. H)

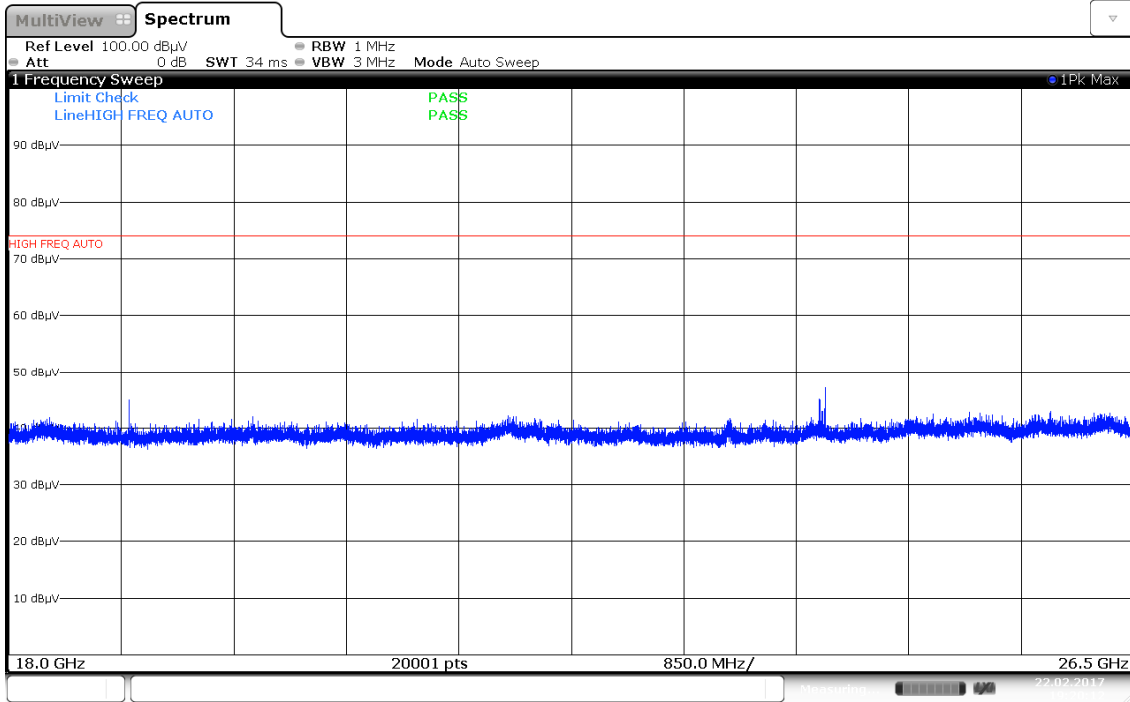


Plot 7-26. Radiated Spurious Plot above 1GHz (Zigbee – Ch. 26, Ant. Pol. V)

FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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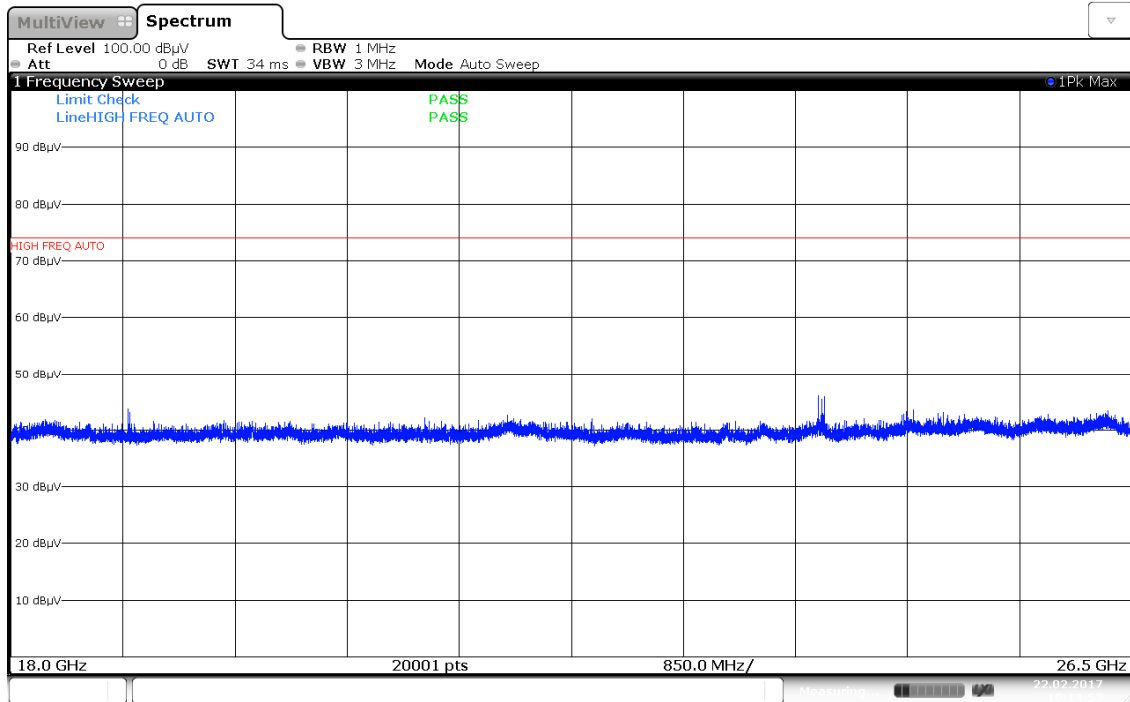
Radiated Spurious Emissions Measurements (Above 18GHz)

§15.209



19:20:13 22.02.2017

Plot 7-27. Radiated Spurious Plot above 18GHz (Pol. H)



19:14:53 22.02.2017

Plot 7-28. Radiated Spurious Plot above 18GHz (Pol. V)

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Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247 (d)

Mode: Zigbee
 Measurement Distance: 3 Meters
 Operating Frequency: 2405MHz
 Channel: 11



Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4810.00	Avg	H	124	0	-61.90	0.54	45.64	53.98	-8.34
4810.00	Peak	H	124	0	-53.07	0.54	54.47	73.98	-19.51
12025.00	Avg	H	-	-	-72.49	16.38	50.89	53.98	-3.09
12025.00	Peak	H	-	-	-58.50	16.38	64.88	73.98	-9.10

Table 7-7. Radiated Measurements

Mode: Zigbee
 Measurement Distance: 3 Meters
 Operating Frequency: 2440MHz
 Channel: 18

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4880.00	Avg	H	192	272	-61.63	1.32	46.69	53.98	-7.29
4880.00	Peak	H	192	272	-53.21	1.32	55.11	73.98	-18.87
7320.00	Avg	H	-	-	-69.79	9.89	47.10	53.98	-6.88
7320.00	Peak	H	-	-	-57.37	9.89	59.52	73.98	-14.46
12200.00	Avg	H	-	-	-72.65	15.96	50.31	53.98	-3.67
12200.00	Peak	H	-	-	-58.51	15.96	64.45	73.98	-9.53

Table 7-8. Radiated Measurements

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Radiated Spurious Emission Measurements

§15.205 §15.209 §15.247 (d)

Mode: Zigbee
 Measurement Distance: 3 Meters
 Operating Frequency: 2480MHz
 Channel: 26

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Avg	H	161	267	-67.71	0.66	39.95	53.98	-14.03
4960.00	Peak	H	161	267	-56.77	0.66	50.89	73.98	-23.09
7440.00	Avg	H	-	-	-69.92	10.29	47.37	53.98	-6.61
7440.00	Peak	H	-	-	-58.68	10.29	58.61	73.98	-15.37
12400.00	Avg	H	-	-	-72.16	16.05	50.89	53.98	-3.09
12400.00	Peak	H	-	-	-58.73	16.05	64.32	73.98	-9.66

Table 7-9. Radiated Measurements

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7.8 Radiated Restricted Band Edge Measurements

§15.205 §15.209 §15.247 (d)

The radiated restricted band edge measurements are measured with an EMI test receiver connected to the receive antenna while the EUT is transmitting. Two different amplitude offsets were used depending on whether peak or average measurements were measured. The average measurements use a duty cycle correction factor (DCCF).

The amplitude offset shown in the following plots for average measurements was calculated using the formula:

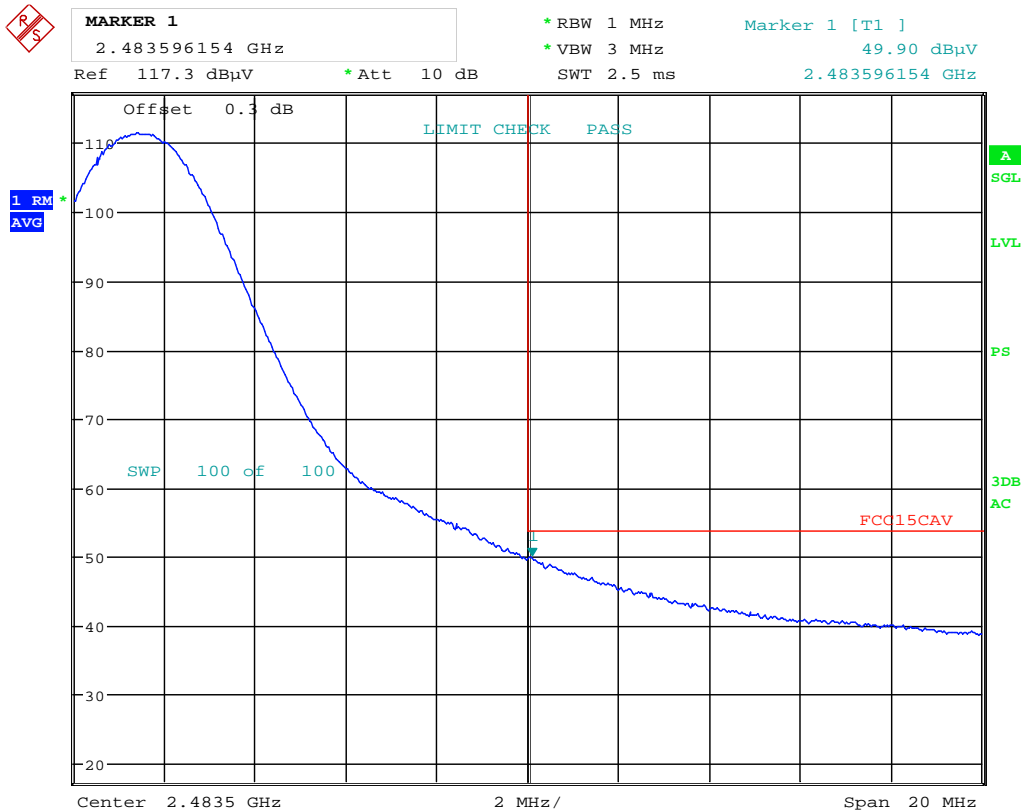
$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + \text{Attenuator}) - \text{Pre-amplifier Gain} + \text{DCCF}$$

Mode: ZigBee

Measurement Distance: 3 Meters

Operating Frequency: 2475MHz

Channel: 25



Date: 21.FEB.2017 10:02:41

Plot 7-29. Radiated Restricted Upper Band Edge Measurement (Average)

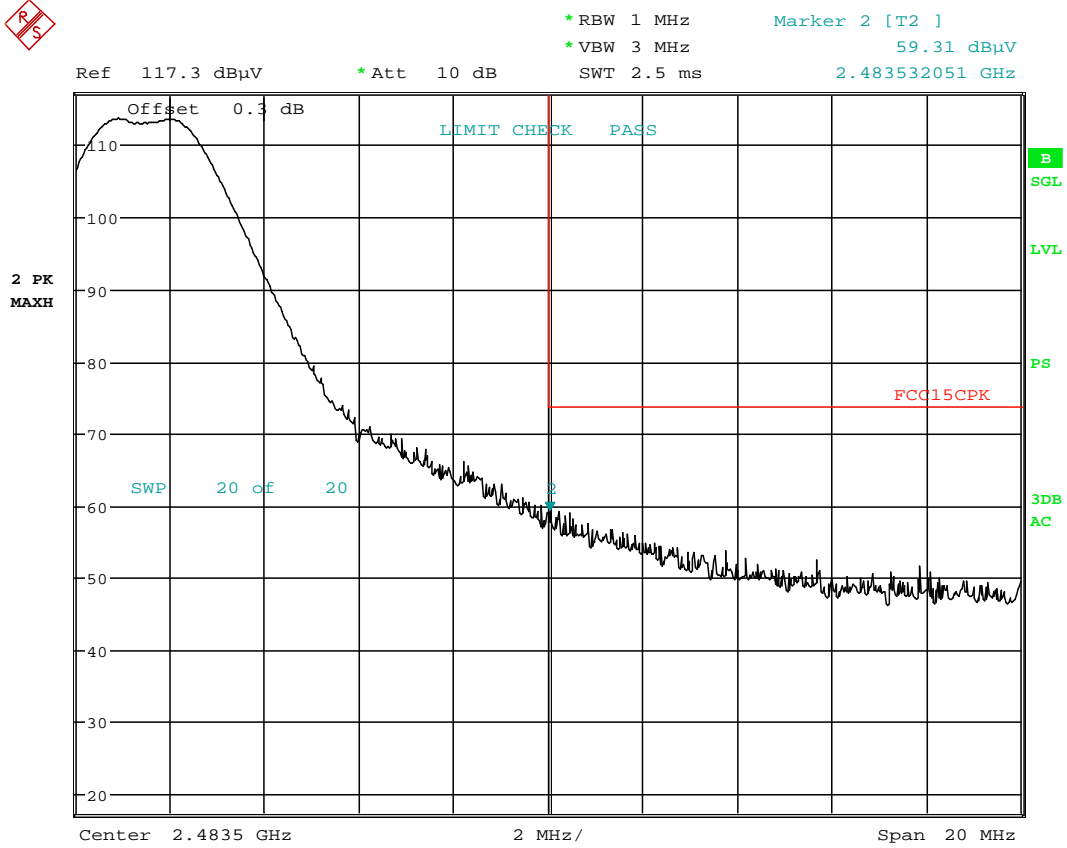
FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Radiated Restricted Band Edge Measurements

§15.205 §15.209 §15.247 (d)

The amplitude offset shown in the following plots for peak measurements was calculated using the formula:

$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + \text{Attenuator}) - \text{Pre-amplifier Gain}$$



Date: 21.FEB.2017 10:03:22

Plot 7-30. Radiated Restricted Upper Band Edge Measurement (Peak)

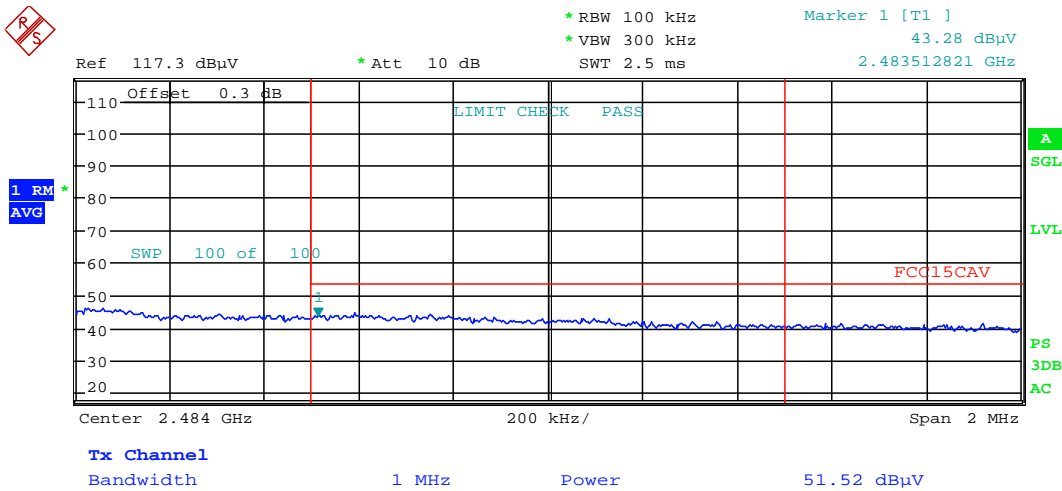
FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Radiated Restricted Band Edge Measurements §15.205 §15.209 §15.247 (d)

The amplitude offset shown in the following plots for peak measurements was calculated using the formula:

$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + \text{Attenuator}) - \text{Preamplifier Gain}$$

Mode: ZigBee
 Measurement Distance: 3 Meters
 Operating Frequency: 2480MHz
 Channel: 26



Date: 21.FEB.2017 10:20:05

Plot 7-31. Radiated Restricted Upper Band Edge Measurement (Average)

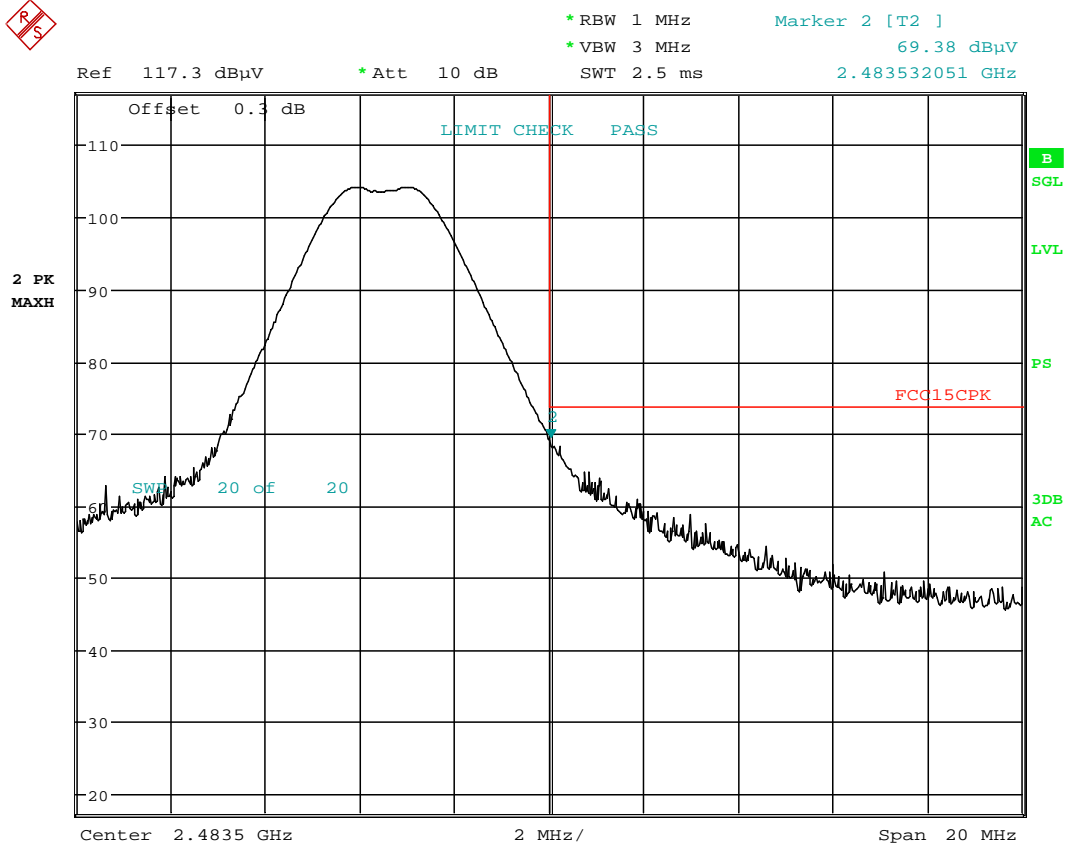
FCC ID: A3LETWV521		FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)		Approved by: Quality Manager
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Radiated Restricted Band Edge Measurements

§15.205 §15.209 §15.247 (d)

The amplitude offset shown in the following plots for peak measurements was calculated using the formula:

$$\text{Offset (dB)} = (\text{Antenna Factor} + \text{Cable Loss} + \text{Attenuator}) - \text{Pre-amplifier Gain}$$



Date: 21.FEB.2017 10:19:17

Plot 7-32. Radiated Restricted Upper Band Edge Measurement (Peak)

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7.9 Radiated Spurious Emissions Measurements – Below 1GHz

§15.209

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-10 per Section 15.209.

Frequency	Field Strength [$\mu\text{V/m}$]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 7-10. Radiated Limits



Test Procedures Used

ANSI C63.10-2013

Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

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Test Setup

The EUT and measurement equipment were set up as shown in the diagrams below.

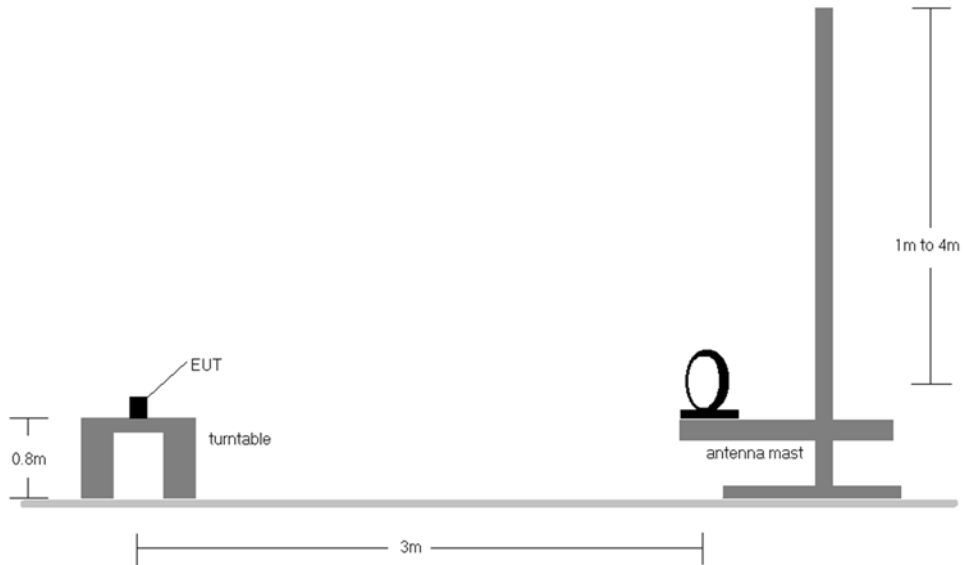


Figure 7-7. Radiated Test Setup < 30Mhz

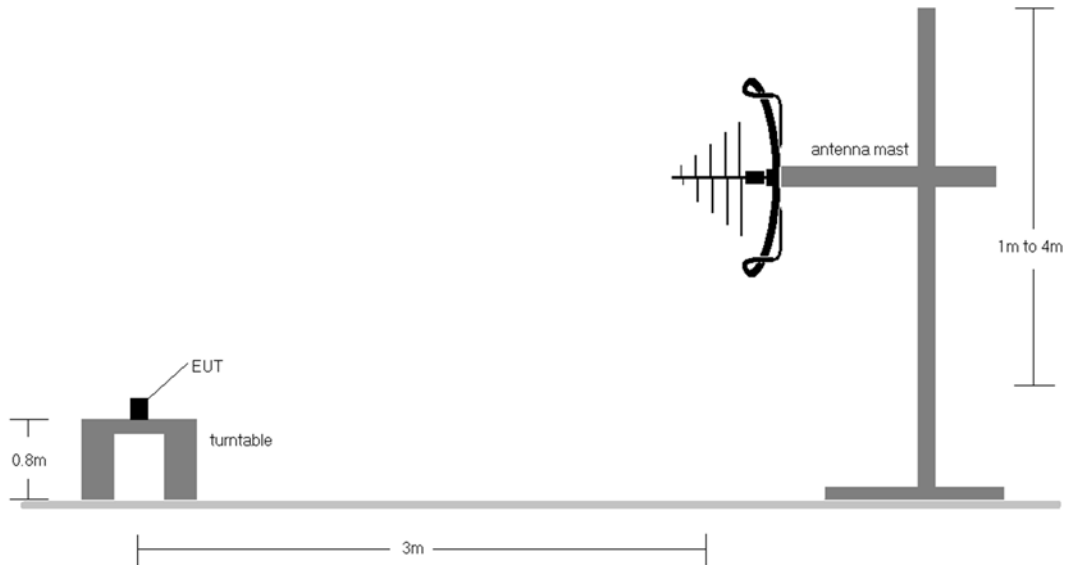






Figure 7-8. Radiated Test Setup < 1GHz

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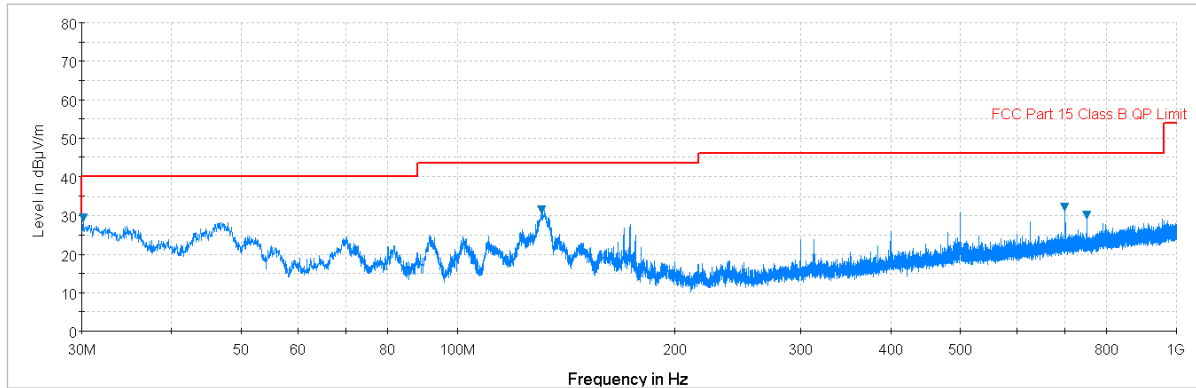
Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-10.
2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes.
3. This unit was tested while powered by an DC power source.
4. The spectrum is investigated using a peak detector and final measurements are recorded using CISPR quasi peak detector. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
5. Emissions were measured at a 3 meter test distance.
6. Emissions are investigated while operating on the center channel of the mode, band, and modulation that produced the worst case results during the transmitter spurious emissions testing.
7. No spurious emissions were detected within 20dB of the limit below 30MHz.
8. The results recorded using the broadband antenna is known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
9. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. There were no emissions detected in the 30MHz – 1GHz frequency range, as shown in the subsequent plots.

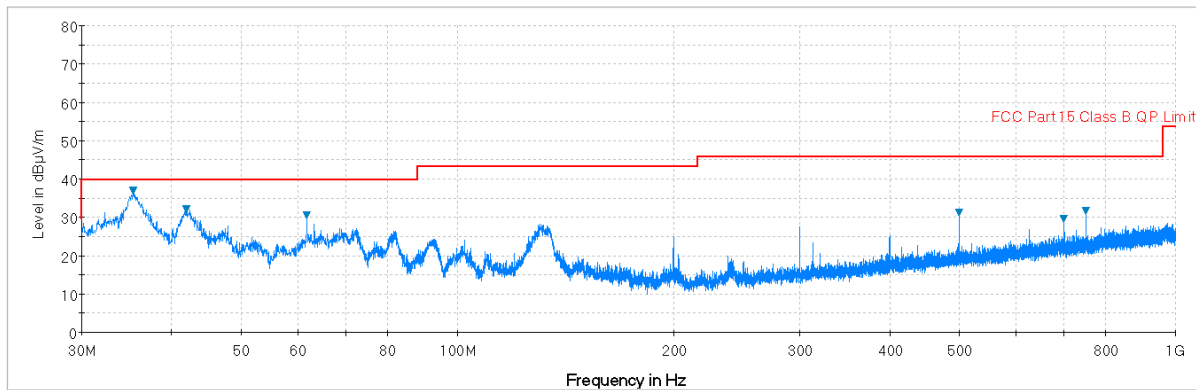
FCC ID: A3LETWV521	 FCC Pt. 15.247 ZIGBEE TEST REPORT (CERTIFICATION)			Approved by: Quality Manager
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Radiated Spurious Emissions Measurements (Below 1GHz)



§15.209



Plot 7-33. Radiated Spurious Plot below 1GHz (Pol. H)



Plot 7-34. Radiated Spurious Plot below 1GHz (Pol. V)

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7.10 Line Conducted Measurement Data

§15.207

Test Overview and Limit

All AC line conducted spurious emissions are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

All conducted emissions must not exceed the limits shown in the table below, per Section 15.207.

Frequency of emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

Table 7-11. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2013, Section 6.2



Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = RMS
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

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Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

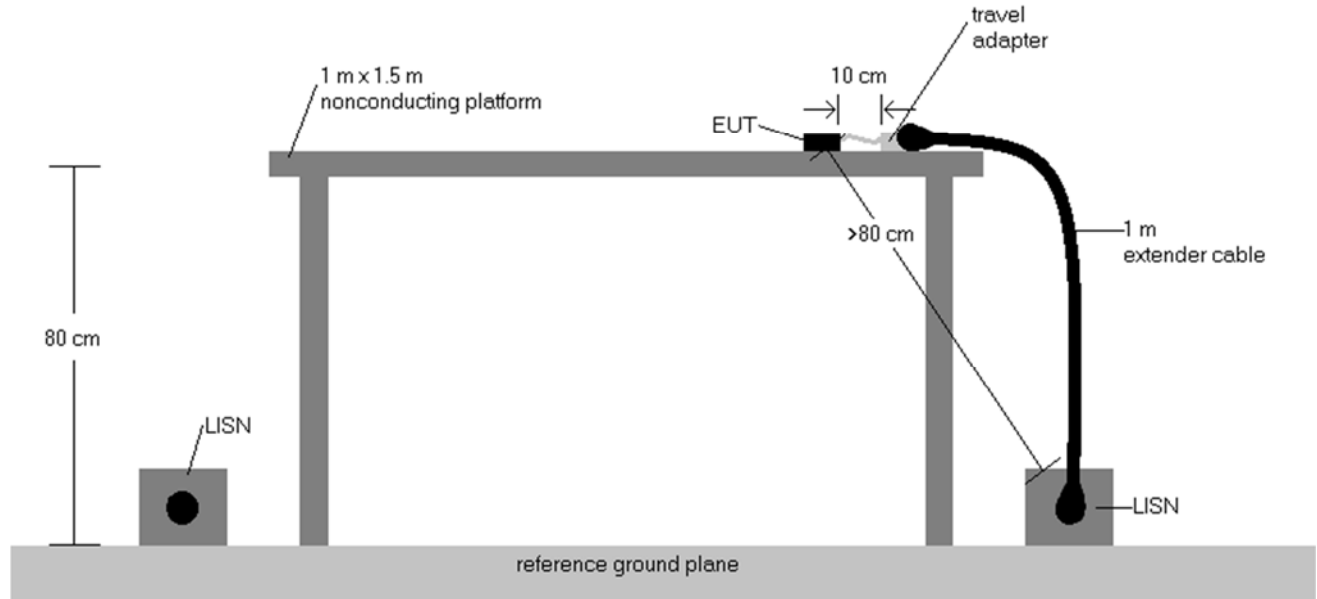




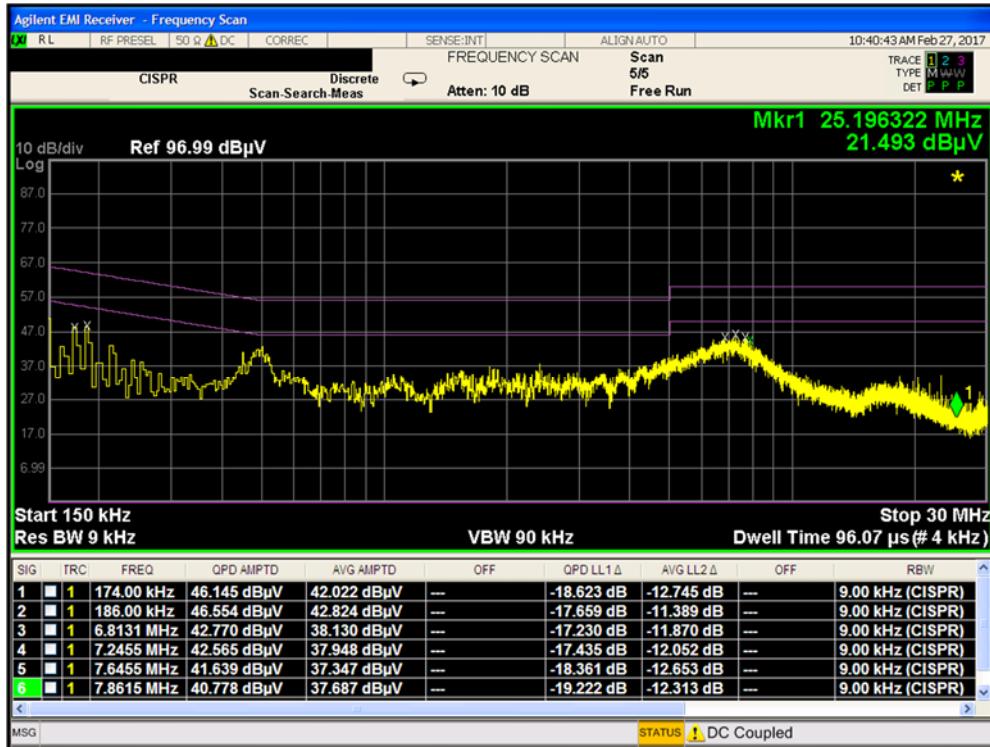
Figure 7-9. Test Instrument & Measurement Setup

Test Notes

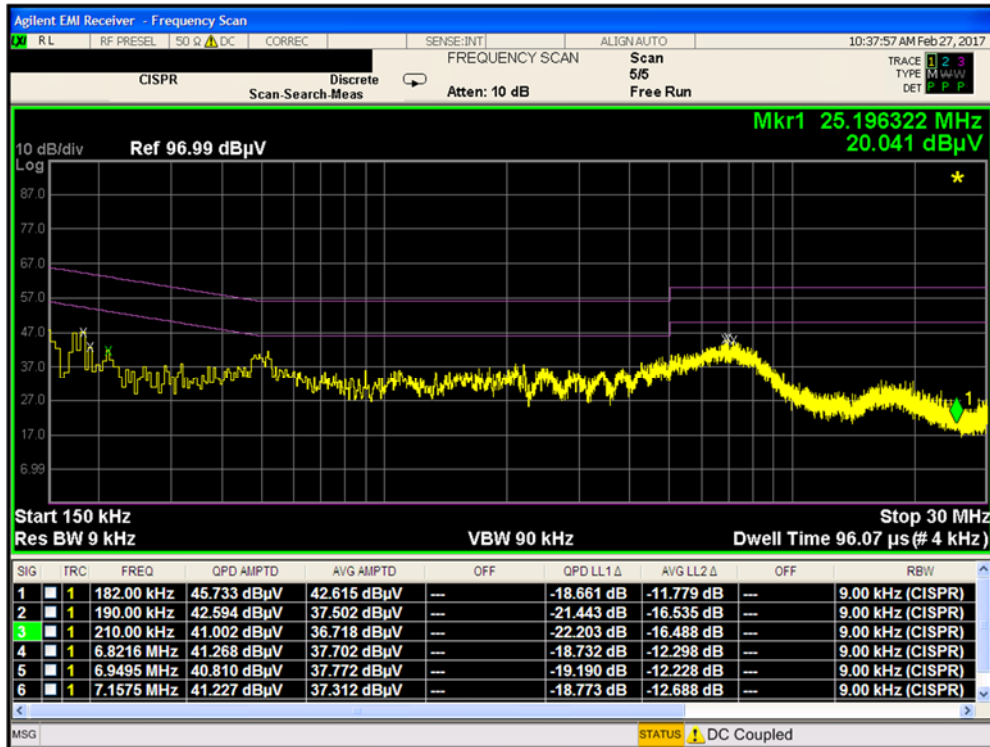
1. All modes of operation were investigated and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
2. The limit for an intentional radiator from 150kHz to 30MHz are specified in 15.207.
3. $\text{Corr. (dB)} = \text{Cable loss (dB)} + \text{LISN insertion factor (dB)}$
4. $\text{QP/AV Level (dB}\mu\text{V)} = \text{QP/AV Analyzer/Receiver Level (dB}\mu\text{V)} + \text{Corr. (dB)}$
5. $\text{Margin (dB)} = \text{QP/AV Limit (dB}\mu\text{V)} - \text{QP/AV Level (dB}\mu\text{V)}$
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.

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Line Conducted Measurement Data
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Plot 7-35. Line-Conducted Test Plot (L1)





Plot 7-36. Line-Conducted Test Plot (N)

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8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Samsung Indoor Access Point FCC ID: A3LETWV521** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.

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