

# FCC/ISED UNII REPORT

## Class II Permissive change

**Applicant Name:**  
LG Electronics Inc.

**Address:**  
222 LG-ro Jinwi-myeon, Pyeongtaek-si,  
Gyeonggi-do 451-713, Korea

**Date of Issue:**  
November 11, 2016

**Test Site/Location:**  
HCT CO., LTD., 74,Seoicheon-ro 578beon-gil,Majang-  
myeo,Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA  
**Report No.:** HCT-R-1611-F008  
**HCT FRN:** 0005866421  
**ISED Recognition No.:** 5944A-6

<b>FCC ID</b>	<b>: BEJLC7F</b>
<b>ISED</b>	<b>: 2703H-LC7F</b>
<b>APPLICANT</b>	<b>: LG Electronics Inc.</b>

**Model(s):** LC7F  
**EUT Type:** Faceplate RADIO ASM-RECEIVER  
**Modulation type** OFDM  
**FCC Classification:** Unlicensed National Information Infrastructure(UNII)  
**FCC Rule Part(s):** Part 15.407  
**ISED Rule Part(s):** RSS-247 Issue 1 (May 2015), RSS-GEN Issue 4(November 2014)

Band	Mode	Frequency Range (MHz)	Power (dBm)	Power (W)
UNII3	802.11a	5745 – 5825	11.50	0.0141
	802.11n_HT20	5745 – 5825	11.47	0.0140

**Engineering Statement:**

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)



**Report prepared by**  
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**Test Engineer of RF Team**



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## Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-R-1611-F008	November 11, 2016	- First Approval Report

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## 1. GENERAL INFORMATION

**Applicant:** LG Electronics Inc.

**Address:** 222 LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do 451-713, Korea

**FCC ID:** BEJLC7F

**ISED:** 2703H-LC7F

**EUT Type:** Faceplate RADIO ASM-RECEIVER

**Model (s):** LC7F

**Date(s) of Tests:** October 05, 2016 ~ November 10, 2016

**Place of Tests:** HCT Co., Ltd.  
74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea  
(ISED Registration Number : 5944A-6)

## 2. EUT DESCRIPTION

<b>Model</b>	LC7F	
<b>EUT Type</b>	Faceplate RADIO ASM-RECEIVER	
<b>Power Supply</b>	DC 12 V	
<b>Frequency Range</b>	TX_20 MHz BW:	5745 MHz - 5825 MHz (UNII 3)
	RX_20 MHz BW:	5745 MHz - 5825 MHz (UNII 3)
<b>Modulation Type</b>	OFDM(802.11a, 802.11n)	
<b>Antenna Specification</b>	Manufacturer: AMOTECH Antenna type: Chip ANTENNA Peak Gain : 5.5 dBi (5745~5825 UNII3 BAND)	

### **3. TEST METHODOLOGY**

The measurement procedure described in FCC KDB 789033 D02 General UNII Test Procedures New Rules v01r03 dated August 22, 2016 entitled "Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part15, Subpart E" and ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices' were used in the measurement.

#### **3.1 EUT CONFIGURATION**

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

#### **3.2 EUT EXERCISE**

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.407 under the FCC Rules Part 15 Subpart E.

#### **3.3 GENERAL TEST PROCEDURES**

##### **Conducted Emissions**

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10 (Version :2013), conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

##### **Radiated Emissions**

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5 m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3.75 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

##### **Conducted Antenna Terminal**

See Section from 8.1 to 8.4.(KDB 789033 D02 v01r03)

#### **3.4 DESCRIPTION OF TEST MODES**

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

Channel low, mid and high with highest data rate (worst case) is chosen for full testing.

## 4. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipments, which is traceable to recognized national standards

Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).

## 5. FACILITIES AND ACCREDITATIONS

### 5.1 FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated July 07, 2015 (Registration Number: 90661) / October 19, 2015 (ISED Registration Number: 5944A-6)

### 5.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

## 6. ANTENNA REQUIREMENTS

### According to FCC 47 CFR §15.203, §15.407

"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 this E.U.T are permanently attached.

\* The E.U.T Complies with the requirement of §15.203, §15.407, RSS-GEN 7.1.2

## 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4:2014.

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  $U_{\text{CISPR}}$  measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty ( $\pm$ dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	6.07

## 8. SUMMARY OF TEST RESULTS

### 8.1 FCC Part

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
26dB Bandwidth	§15.407 (for Power Measurement)	N/A	CONDUCTED	PASS
6 dB Bandwidth	§15.407(e)	>500 kHz (5725-5850 MHz)		PASS
Maximum Conducted Output Power	§15.407(a)(1)	< 250 mW (5150-5250 MHz) < 250 mW or 11+10 log log <sub>10</sub> (BW) dBm (5250-5350 MHz) < 250 mW or 11+10 log log <sub>10</sub> (BW) dBm (5470-5725 MHz) <1 W (5725-5850 MHz)		PASS
Peak Power Spectral Density	§15.407(a)(1),(5)	<11 dBm/ MHz (5150-5250 MHz) <11 dBm/ MHz (5250-5350 MHz) <11 dBm/ MHz (5470-5725 MHz) <30 dBm/500 kHz(5725-5850 MHz)		PASS
Frequency Stability	§15.407(g)	N/A		PASS
AC Conducted Emissions 150 kHz-30 MHz	15.207	<FCC 15.207 limits		PASS
Undesirable Emissions	§15.407(b)	<-27 dBm/MHz EIRP (UNII1, 2A, 2C) <-17 dBm/MHz EIRP within 5715-5725 MHz and 5850-5860 MHz (UNII3) <-27 dBm/MHz EIRP outside 5715-5860 MHz (UNII 3)	RADIATED	PASS
General Field Strength Limits(Restricted Bands and Radiated Emission Limits)	15.205, 15.407(b)(5), (6)	Emissions in restricted bands must meet the radiated limits detailed in 15.209		PASS

\* Note : The test report is only tested for ch.149.

The other test results, please refer to the original report.

(FCC ID : BEJLC7F / Report No. : HCT-R-1501-F005)

## 8.2 ISED Part

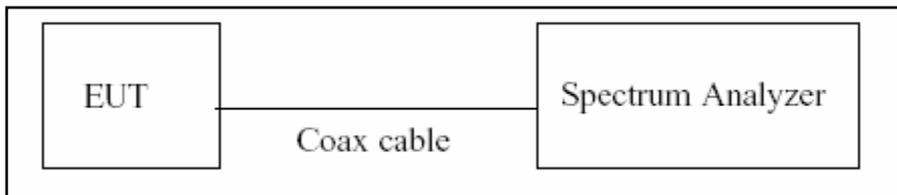
Test Description	ISED Part Section(s)	Test Limit	Test Condition	Test Result
99% Bandwidth(ISED)	RSS-GEN, 6.6	N/A	CONDUCTED	PASS
6 dB Bandwidth	RSS-247, 6.2.4.1)	> 500 kHz (5725-5850 MHz)		PASS
Maximum Conducted Output Power,	RSS-247, 6.2	< 250 mW or 11+10 log <sub>10</sub> (BW) dBm (5250-5350 MHz) < 250 mW or 11+10 log <sub>10</sub> (BW) dBm (5470-5600, 5650-5725 MHz) Whichever power is less		PASS
	RSS-247, 6.2.4 1)	<1 W (5725-5850 MHz)		
Maximum e.i.r.p	RSS-247, 6.2	< 200 mW or 10+10 log <sub>10</sub> (BW) dBm (5150-5250 MHz) < 1 W or 17+10 log <sub>10</sub> (BW) dBm (5250-5350 MHz) < 1 W or 17+10 log <sub>10</sub> (BW) dBm (5470-5725 MHz) Whichever power is less		
Power Spectral Density	RSS-247 6.2	<10 dBm/ MHz(e.i.r.p.) (5150-5250 MHz) <11 dBm/MHz(Conducted) (5250-5350 MHz, 5470-5600 MHz, 5650-5725 MHz)		PASS
	RSS-247, 6.2.4 1)	<30 dBm/500 kHz(Conducted) (5725-5850 MHz)		
AC Conducted Emissions 150 kHz-30 MHz	RSS-GEN, 8.8	RSS-GEN section 8.8 table 3		NA
Undesirable Emissions	RSS-247, 6.2.1 2)	OBW does not fall within 5250-5350 MHz (5150-5350 MHz)		PASS
	RSS-247, 6.2	<-27 dBm/ MHz EIRP (5150-5350 MHz, 5470-5725 MHz)		PASS
	RSS-247, 6.2.4 2)	<-17 dBm/MHz EIRP within 5715-5725 MHz and 5850-5860 MHz, <-27 dBm/MHz EIRP outside 5715-5860 MHz (5725-5850 MHz)		
General Field Strength Limits(Restricted Bands and Radiated Emission Limits)	RSS-GEN, 8.9	RSS-GEN section 8.9 table 4, 5 section 8.10 table 6	RADIATED	PASS
	RSS-GEN, 8.10			
Receiver Spurious Emissions	RSS-GEN, 5 RSS-GEN, 7.1.2	RSS-GEN section 7.1.2 table 2	PASS	

## 9. TEST RESULT

### 9.1 DUTY CYCLE

The zero-span mode on a spectrum analyzer or EMI receiver ,if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set  $RBW \geq EBW$  if possible; otherwise, set RBW to the largest available value. Set  $VBW \geq RBW$ . Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are  $> 50/T$ , where  $T$  is defined in section B)1)a), and the number of sweep points across duration  $T$  exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if  $T \leq 16.7$  microseconds.)

#### ■ TEST CONFIGURATION



#### ■ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. We tested according to the zero-span measurement method, (B.2 in KDB 789033 D02 v01r03)

The largest available value of RBW is 8 MHz and VBW is 50 MHz. The zero-span method of measuring duty cycle shall not be used if  $T \leq 6.25$  microseconds. ( $50/6.25 = 8$ )

The zero-span method was used because all measured  $T$  data are  $> 6.25$  microseconds and both RBW and VBW are  $> 50/T$ .

1. RBW = 8 MHz (the largest available value)
2. VBW = 8 MHz ( $\geq$  RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep  $> 100$
6. Trace mode = Clear write
7. Measure  $T_{total}$  and  $T_{on}$
8. Calculate Duty Cycle =  $T_{on} / T_{total}$  and Duty Cycle Factor =  $10 \cdot \log(1/\text{Duty Cycle})$

■ **Duty Cycle Factor**

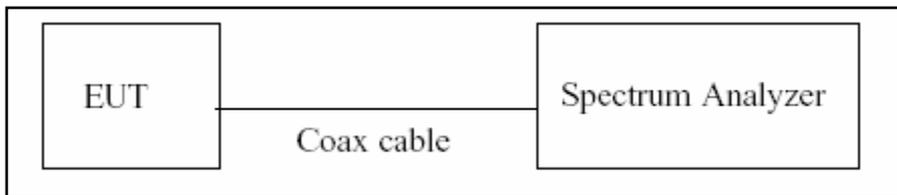
Mode	Data Rate (Mbps)	T <sub>on</sub> (ms)	T <sub>total</sub> (ms)	Duty Cycle	Duty Cycle Factor (dB)
802.11a	6	2.064	2.162	0.95467160	0.201
	9	1.386	1.484	0.93396226	0.297
	12	1.047	1.145	0.91441048	0.389
	18	0.708	0.806	0.87841191	0.563
	24	0.534	0.632	0.84493671	0.732
	36	0.369	0.467	0.79014989	1.023
	48	0.276	0.377	0.73209549	1.354
	54	0.248	0.348	0.71264368	1.471
Mode	MCS INDEX	T <sub>on</sub> (ms)	T <sub>total</sub> (ms)	Duty Cycle	Duty Cycle Factor (dB)
802.11n_HT20	0	1.920	2.020	0.95049505	0.221
	1	0.980	1.080	0.90740741	0.422
	2	0.665	0.765	0.86928105	0.608
	3	0.510	0.610	0.83606557	0.778
	4	0.355	0.455	0.78021978	1.078
	5	0.272	0.374	0.72727273	1.383
	6	0.248	0.348	0.71264368	1.471
	7	0.228	0.329	0.69300912	1.593

## 9.2 EMISSION BANDWIDTH AND MINIMUM EMISSION BANDWIDTH MEASUREMENT

The bandwidth at 26 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating at its maximum power control level, as defined in KDB 789033 D02 v01r03, at the appropriate frequencies. The spectrum analyzer's bandwidth measurement function is configured to measure the 26 dB bandwidth.

The 26 dB bandwidth is used to determine the conducted power limits.

### ■ TEST CONFIGURATION



### ■ TEST PROCEDURE (26dB Bandwidth)

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to ( C.1 in KDB 789033 D02 v01r03)

1. RBW = approximately 1 % of the emission bandwidth
2. VBW > RBW
3. Detector = Peak
4. Trace mode = max hold
5. Measure the maximum width of the emission that is 26 dB down from the maximum of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1 %.

Note : We tested 26 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 26 dB.

■ **TEST PROCEDURE (for the band 5.725-5.85 GHz, 6 dB Bandwidth)**

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to( C.2 in KDB 789033 D02 v01r03)

1. RBW = 100 kHz
2. VBW  $\geq$  3\*RBW
3. Detector = Peak
4. Trace mode = max hold
5. Allow the trace to stabilize
6. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points(upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Note : We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

■ TEST RESULTS for 802.11a, 802.11n\_HT20

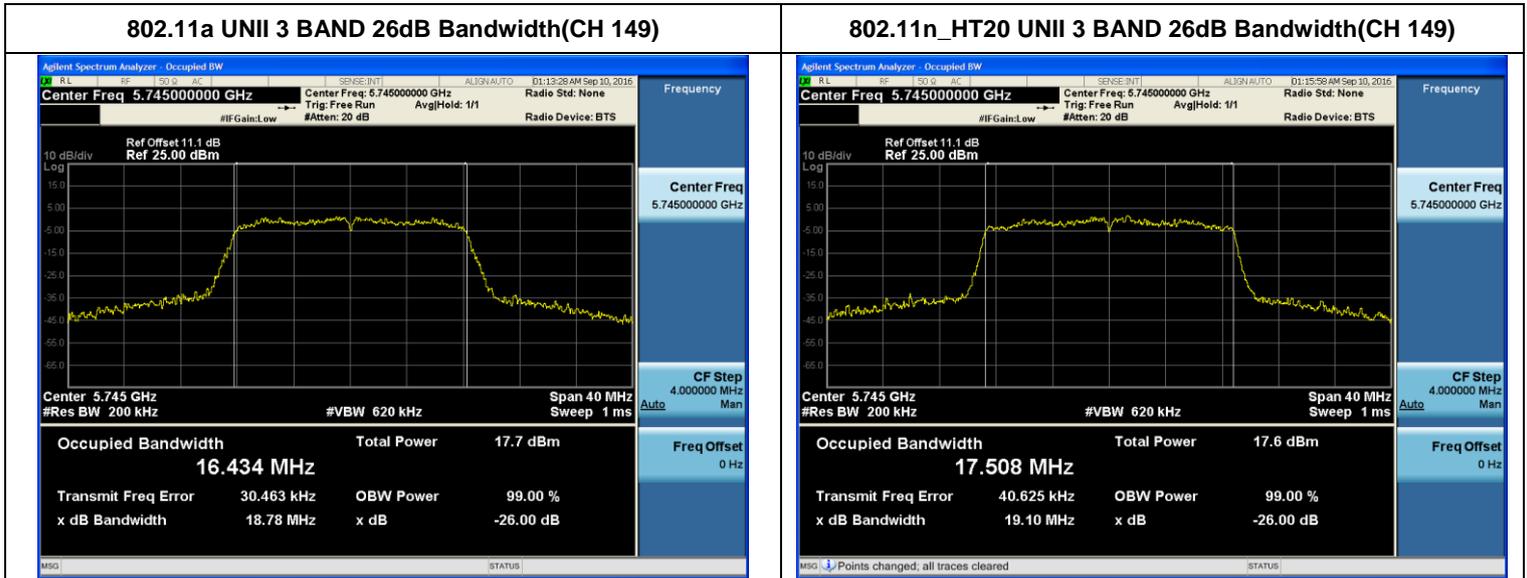
Conducted 26 dB Bandwidth Measurements for 802.11a

802.11a Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5745	149	18.78	N/A	Pass

Conducted 26 dB Bandwidth Measurements for 802.11n\_HT20

802.11n_HT20 Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5745	149	19.10	N/A	Pass

■ TEST RESULTS for 802.11a, 802.11n\_HT20



■ **TEST RESULTS for 802.11a, 802.11n\_HT20**

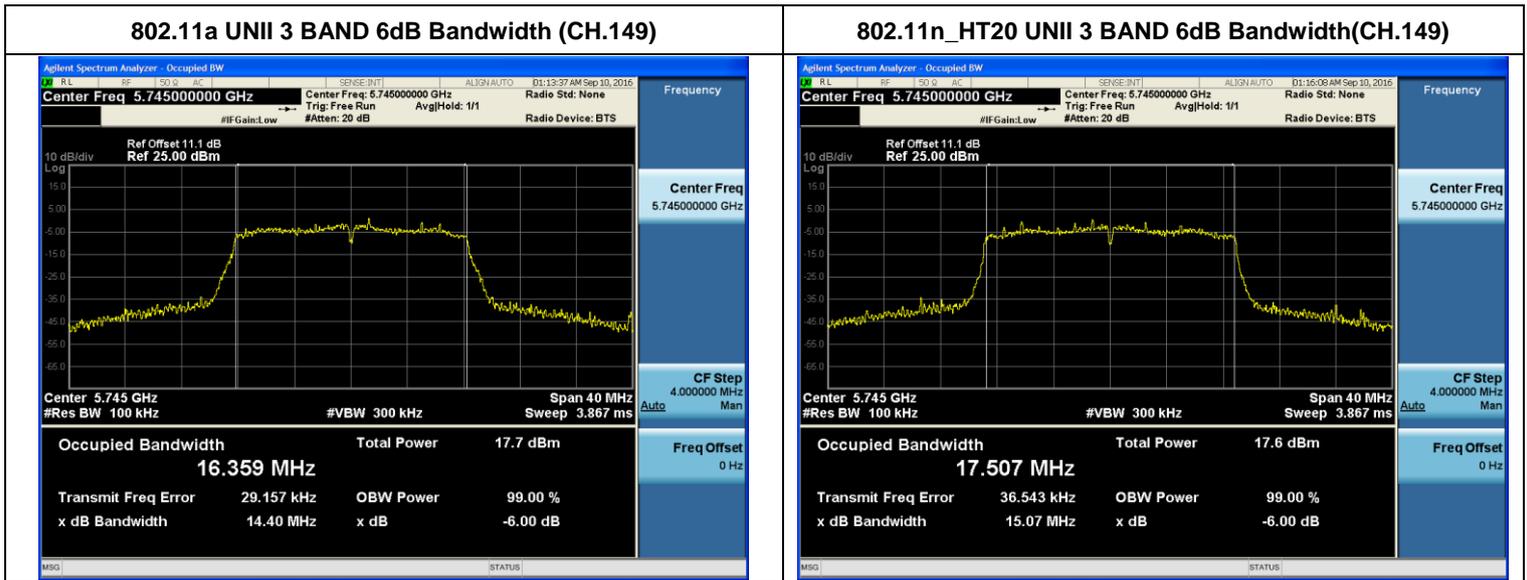
Conducted 6 dB Bandwidth Measurements for 802.11a

802.11a Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5745	149	14.40	0.5	Pass

Conducted 6 dB Bandwidth Measurements for 802.11n\_HT20

802.11n_HT20 Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5745	149	15.07	0.5	Pass

■ **TEST Plot for 802.11a, 802.11n\_HT20**



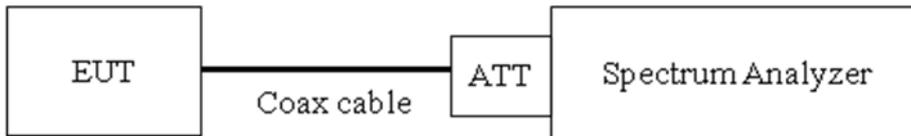
### 9.3 99% BANDWIDTH MEASUREMENT

#### limit

None; for ISED reporting purposes only

The 99 % bandwidth is used to determine the conducted power limits(for ISED).

#### ■ TEST CONFIGURATION



#### ■ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to as close to 1% of the selected span. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

RBW = 1% of the total span

VBW  $\geq$  3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

**TEST RESULTS**

Conducted 99% Bandwidth Measurements for 802.11a

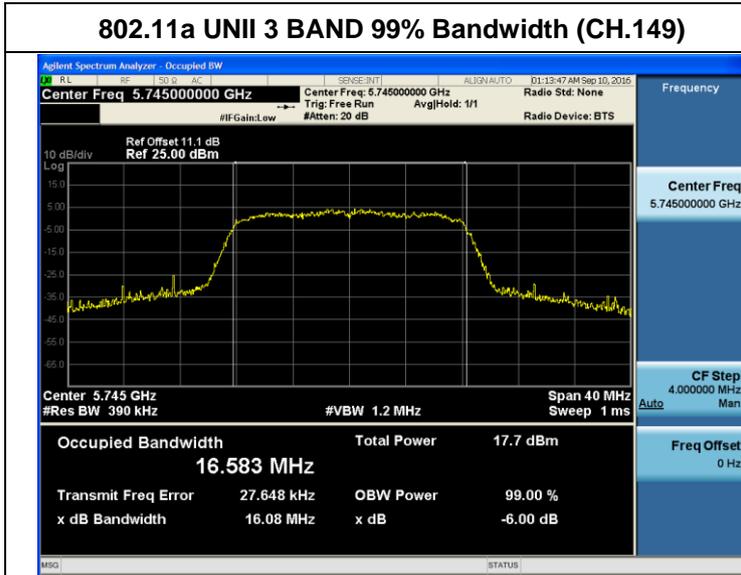
802.11a Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
5745	149	16.583

Conducted 99% Bandwidth Measurements for 802.11n\_HT20

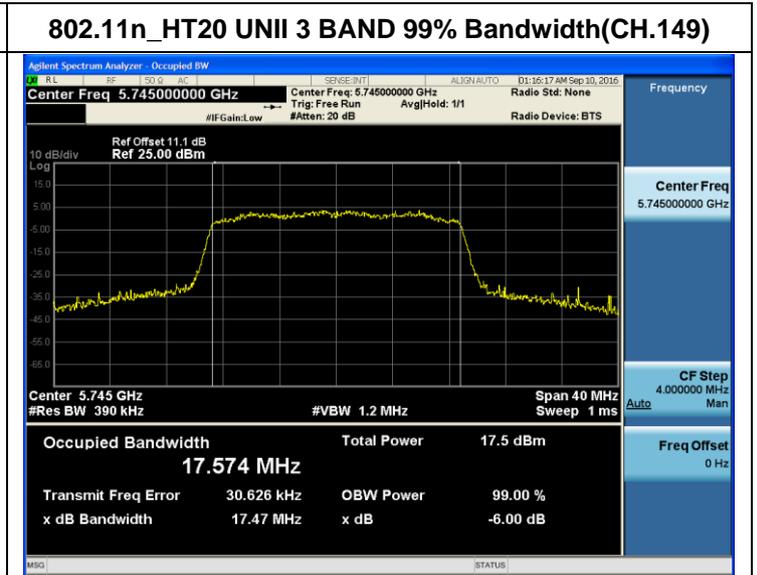
802.11n_HT20 Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
5745	149	17.574

**TEST Plot for 802.11a, 802.11n\_HT20**

802.11a UNII 3 BAND 99% Bandwidth (CH.149)



802.11n\_HT20 UNII 3 BAND 99% Bandwidth(CH.149)



## 9.4 OUTPUT POWER MEASUREMENT

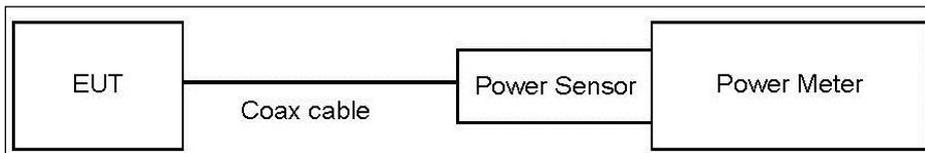
### Test Requirements and limit, §15.407(a)(1) / RSS-247(Issue 1) Section 6.2

A transmitter antenna terminal of EUT is connected to the input of a Power meter or Spectrum Analyzer .Measurement is made while the EUT is operating in transmission mode at the appropriate frequencies.

#### ■ Limit

Band	Mode	Limit (dBm)
UNII 3	802.11a, n	30.00

#### ■ TEST CONFIGURATION(20 MHz BW)



#### ■ TEST PROCEDURE(20 MHz BW)

- Average Power (Procedure E.3.a in KDB 789033 D02 v01r03).
  1. Measure the duty cycle.
  2. Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
  3. Add  $10 \log(1/x)$ , where  $x$  is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Note :

1. Actual value of loss for the attenuator and cable combination is below table.

Band	Loss(dB)
UNII 3	11.1

(Actual value of loss for the attenuator and cable combination)

■ **Sample Calculation (Conducted)**

Output Power = Reading Value + ATT loss + Cable loss(1 ea) + Duty Cycle Factor

Note: 1. Spectrum reading values are not plot data. The power results in plot is already including the actual values of loss for the attenuator and cable combination.

2. Spectrum offset = Attenuator loss + Cable loss

3. Actual value of loss for the attenuator and cable combination is below table.

Band	Loss(dB)
UNII 3	11.1

(Actual value of loss for the attenuator and cable combination)

■ **TEST RESULTS**

**UNII 3 BAND**

**Conducted Output Power Measurements (802.11a Mode)**

802.11a Mode		Rate (Mbps)	Measured Power (dBm)	Duty Cycle Factor (dB)	Measured Power(dBm) + Duty Cycle Factor(dB)	Limit (dBm)
Frequency [MHz]	Channel No.					
5745	149	6	11.28	0.20	11.48	30
		9	11.19	0.30	11.49	30
		12	11.10	0.39	11.49	30
		18	10.92	0.56	11.48	30
		24	10.77	0.73	11.50	30
		36	10.44	1.02	11.46	30
		48	10.09	1.35	11.44	30
		54	9.89	1.47	11.36	30

**UNII 3 BAND**

**Conducted Output Power Measurements (802.11n\_HT20 Mode: 5745~5825)**

802.11n_HT20 Mode		MCS Index	Measured Power (dBm)	Duty Cycle Factor (dB)	Measured Power(dBm) + Duty Cycle Factor(dB)	Limit (dBm)
Frequency [MHz]	Channel No.					
5745	149	0	11.25	0.22	11.47	30
		1	10.84	0.42	11.26	30
		2	10.69	0.61	11.30	30
		3	10.50	0.78	11.28	30
		4	10.23	1.08	11.31	30
		5	9.95	1.38	11.33	30
		6	9.85	1.47	11.32	30
		7	9.75	1.59	11.34	30

## 9.5 POWER SPECTRAL DENSITY

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies. The maximum permissible peak power spectral density is 30 dBm/500 kHz for UNII 3.

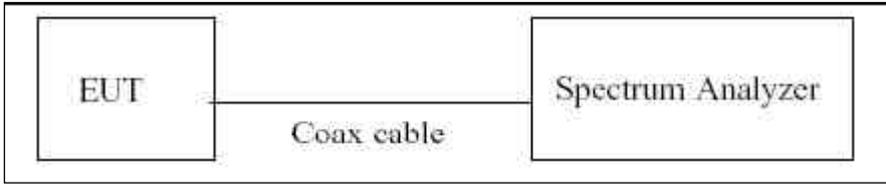
### ■ Limit

#### Power Spectral Density

Band	Mode	Limit
UNII 3	802.11 a, n	30 dBm/500 kHz

Note : According to KDB644545 D03 v01, emission for straddle channels in each band shall comply with the PSD limits applicable to that band under the appropriate rule section.

■ **TEST CONFIGURATION**



■ **TEST PROCEDURE**

We tested according to Method in KDB 789033 D02 v01r03

The spectrum analyzer is set to :

1. Set span to encompass the entire emission bandwidth(EBW) of the signal.
2. RBW = 1 MHz (510 kHz for UNII 3)
3. VBW ≥ 3 MHz
4. Number of points in sweep ≥ 2\*span/RBW.
5. Sweep time = auto.
6. Detector = RMS(i.e., power averaging), if available. Otherwise, use sample detector mode.
7. Do not use sweep triggering. Allow the sweep to “free run”.
8. Trace average at least 100 traces in power averaging(RMS) mode
9. Use the peak search function on the spectrum analyzer to find the peak of the spectrum.
10. If Method SA-2 was used, add  $10 \log(1/x)$ , where x is the duty cycle, to the peak of the spectrum.

■ **Sample Calculation**

PSD = Reading Value + ATT loss + Cable loss(1 ea) + Duty Cycle Factor

Output Power = 5 dBm + 10 dB + 0.8 dB + 0.21 dB = 16.01 dBm

Note :

1. Spectrum reading values are not plot data. The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 5.2 GHz, 5.3 GHz and 5.6 GHz range that was rounded off to the closest tenth dB. Actual value of loss for the attenuator and cable combination is below table.

Band	Loss(dB)
UNII 3	11.1

(Actual value of loss for the attenuator and cable combination)

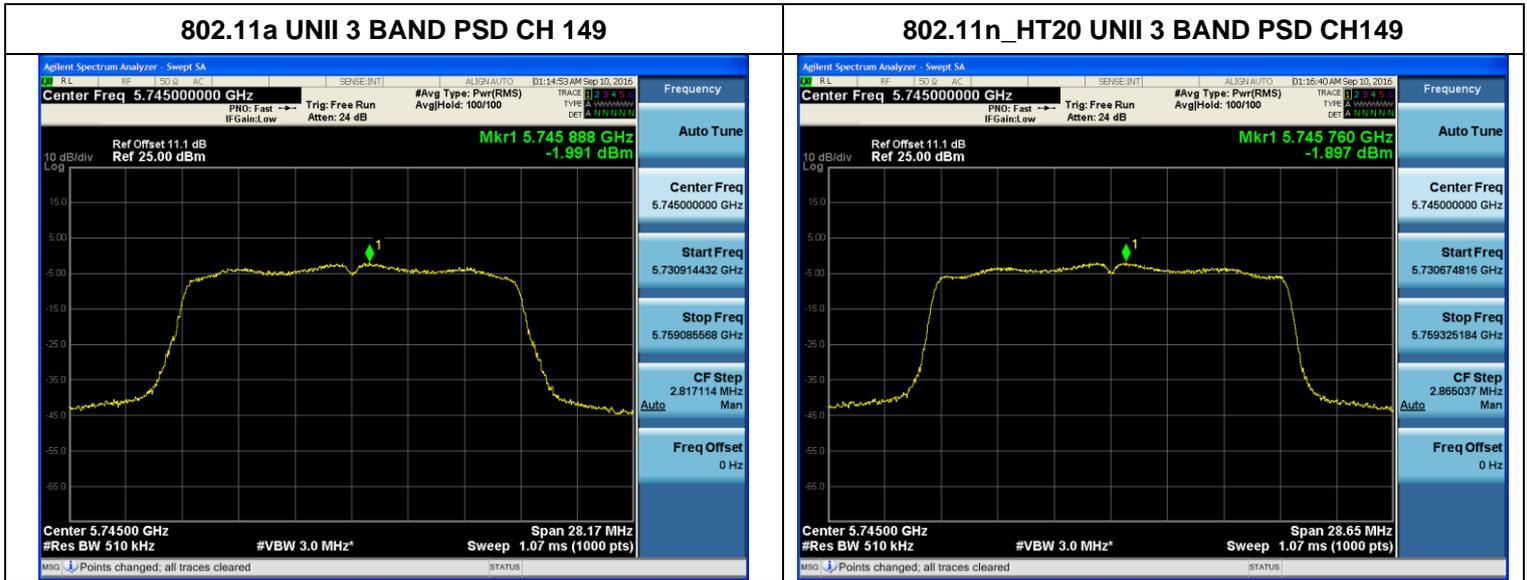
■ TEST RESULTS

■ 802.11a, 802.11n\_HT20

Conducted Power Density Measurements

Frequency (MHz)	Channel No.	Mode	Test Result				
			Measured Power Density (dBm)	Duty Cycle Factor (dB)	Measured Power Density(dBm) + Duty Cycle Factor	Limit (dBm)	Pass/Fail
5745	149	802.11a	-1.991	0.732	-1.259	30	Pass
5745	149	802.11n_HT20	-1.897	0.221	-1.676	30	Pass

■ TEST Plot for 802.11a



## 9.6 FREQUENCY STABILITY

The EUT was placed inside an environmental chamber as the temperature in the chamber was varied between -30 °C and 50 °C. The temperature was incremented by 10 °C intervals and the unit was allowed to stabilize at each temperature before each measurement. The center frequency of the transmitting channel was evaluated at each temperature and the frequency deviation from the channel's center frequency was recorded.

### 20 MHz BW

OPERATING BAND:	<u>UNII Band 3</u>
OPERATING FREQUENCY:	<u>5,745,000,000 Hz</u>
CHANNEL:	<u>149</u>
REFERENCE VOLTAGE:	<u>12.0 VDC</u>

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (kHz)	Frequency Error (kHz)
100%	12.00	+20(Ref)	5745030.80	30.80
100%		-30	5745022.40	22.40
100%		-20	5745024.50	24.5
100%		-10	5745025.90	25.9
100%		0	5745028.12	28.12
100%		+10	5745030.15	30.15
100%		+30	5745035.62	35.62
100%		+40	5745037.84	37.84
100%		+50	5745039.25	39.25
115%	13.80	+20	5745033.26	33.26
Batt. Endpoint	10.20	+20	5745037.49	37.49

### Note:

Based on the results of the frequency stability test shown above the frequency deviation results measured are very small. As such it is determined that the channels at the band edge would remain in-band when the maximum measured frequency error noted during the frequency stability tests is applied. Therefore the device is determined to remain operating in band over the temperature and voltage range as tested.

## 9.7 RADIATED MEASUREMENT

### 9.7.1 RADIATED SPURIOUS EMISSIONS.

Test Requirements and limit, §15.205, §15.209, §15.407 / RSS-GEN(Issue 4) Section 8.9.

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

#### ■ §15.407, KDB 789033 D02

All harmonics that do not lie in a restricted band are subject to a peak limit of -27 dBm/MHz. At a distance of 3 meters the field strength limit in dBµV/m can be determined by adding a “conversion” factor of 95.2 dB to the EIRP limit of -27 dBm/MHz to obtain the limit for out of band spurious emissions of 68.2 dBµV/m.

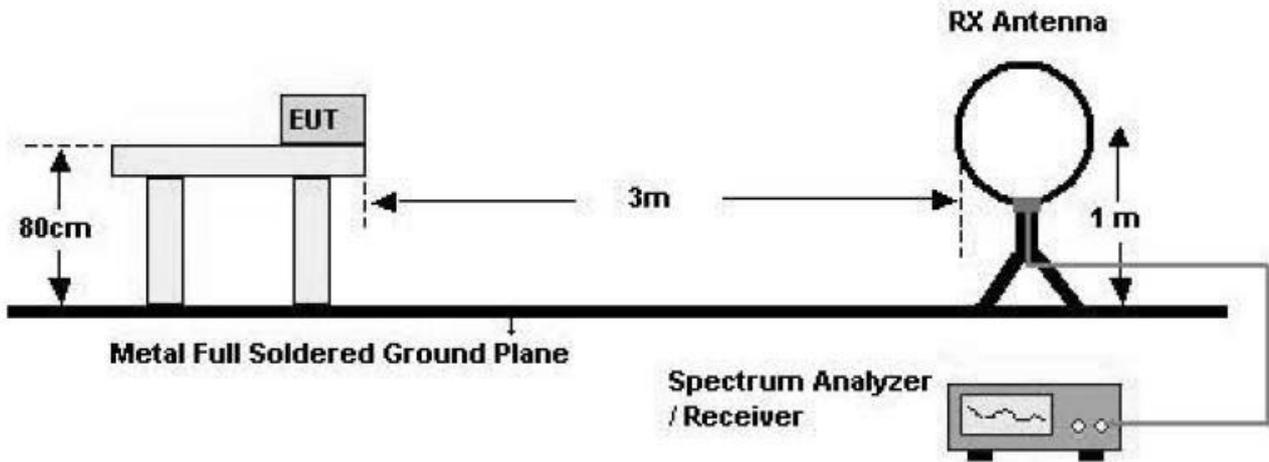
#### §15.407 (b)(4)(i)

(4) For transmitters operating in the 5.725-5.85 GHz band:

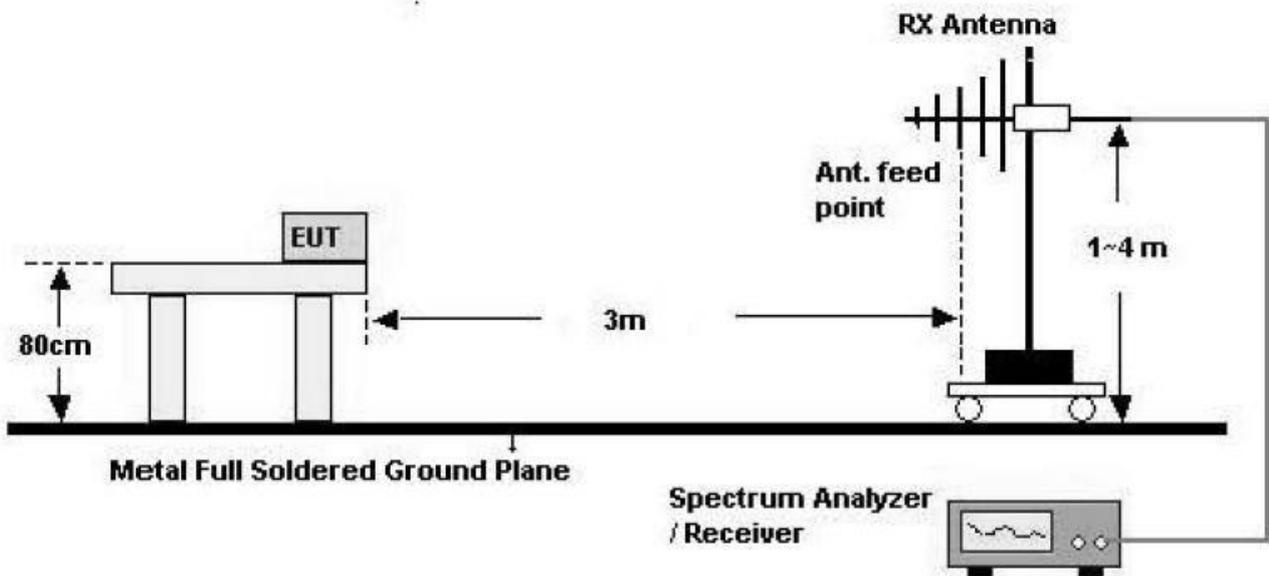
(i) All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

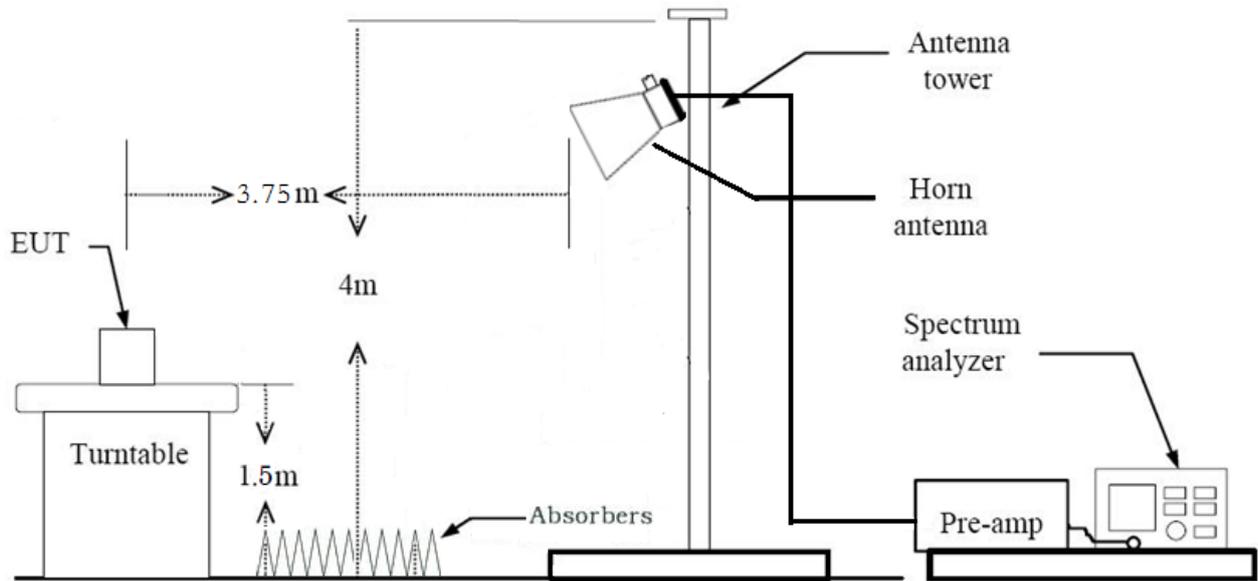
**Test Configuration**

**Below 30 MHz**



**30 MHz - 1 GHz**



**Above 1 GHz****TEST PROCEDURE USED**

ANSI C63.10:2013

Method G)5) in KDB 789033 D02 v01r03 (Peak)

Method G)6)d) in KDB 789033 D02 v01r03 (Average)

**. Spectrum setting:**

- Peak.

1. RBW = 1 MHz

2. VBW  $\geq$  3 MHz

3. Detector = Peak

4. Sweep Time = auto

5. Trace mode = max hold

6. Allow sweeps to continue until the trace stabilizes.

7. Note that if the transmission is not continuous, the time required for the trace to stabilize will increase by a factor of approximately  $1/x$ , where  $x$  is the duty cycle.

- Average (Method VB :Averaging using reduced video bandwidth)

1. RBW = 1 MHz

2. VBW

2.1. If the EUT is configured to transmit with duty cycle  $\geq$  98 percent, set VBW  $\leq$  RBW/100(i.e., 10 kHz) but not less than 10 Hz.

2.2. If the EUT duty cycle is < 98 percent, set  $VBW \geq 1/T$ , where T is the minimum transmission duration.

3. The analyzer is set to linear detector mode.

4. Detector = Peak.

5. Sweep time = auto.

6. Trace mode = max hold.

7. Allow max hold to run for at least 50 traces if the transmitted signal is continuous or has at least 98 percent duty cycle. For lower duty cycles, increase the minimum number of traces by a factor of  $1/x$ , where x is the duty cycle.

**Note :**

1. We used the Method VB for 802.11a, n\_HT20 mode to perform the average filed strength measurements.

2. The actual setting value of VBW for 802.11a, n\_HT20 mode.

3. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor (reference distance : 3 m).

4. Distance extrapolation factor =  $20 \log (\text{test distance} / \text{specific distance})$  (dB)

Mode	Worst Data rate (Mbps)	T <sub>on</sub> (ms)	T <sub>total</sub> (ms)	Duty Cycle (%)	VBW(1/T) (Hz)	The actual setting value of VBW (Hz)
<b>a</b>	<b>6</b>	<b>2.064</b>	<b>2.162</b>	<b>95.55</b>	<b>0.201</b>	<b>1000</b>
<b>n_HT20</b>	<b>MCS 0</b>	<b>1.920</b>	<b>2.020</b>	<b>95.05</b>	<b>0.221</b>	<b>1000</b>

**TEST RESULTS**

**9 kHz – 30MHz**

**Operation Mode:** Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

**Notes:**

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor =  $40 \log (\text{specific distance} / \text{test distance})$  (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

## TEST RESULTS

### Below 1 GHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

### Notes:

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

**Above 1 GHz**

Band :	UNII 3
Operation Mode:	802.11a
Transfer Rate:	6 Mbps
Operating Frequency	5745 MHz
Channel No.	149 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
11490	54.51	-2.50	V	52.01	73.98	21.97	PK
11490	40.62	-2.50	V	38.12	53.98	15.86	AV
17235	53.17	3.09	V	56.26	68.20	11.94	PK
11490	53.75	-2.50	H	51.25	73.98	22.73	PK
11490	40.30	-2.50	H	37.80	53.98	16.18	AV
17235	52.43	3.09	H	55.52	68.20	12.68	PK

**Notes:**

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
5. We have done all data rate in 802.11a. Worst case is 6 Mbps in 802.11a.
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
7. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)

Band :	UNII 3
Operation Mode:	802.11 n_HT20
Transfer MCS Index:	0
Operating Frequency	5745 MHz
Channel No.	149 Ch

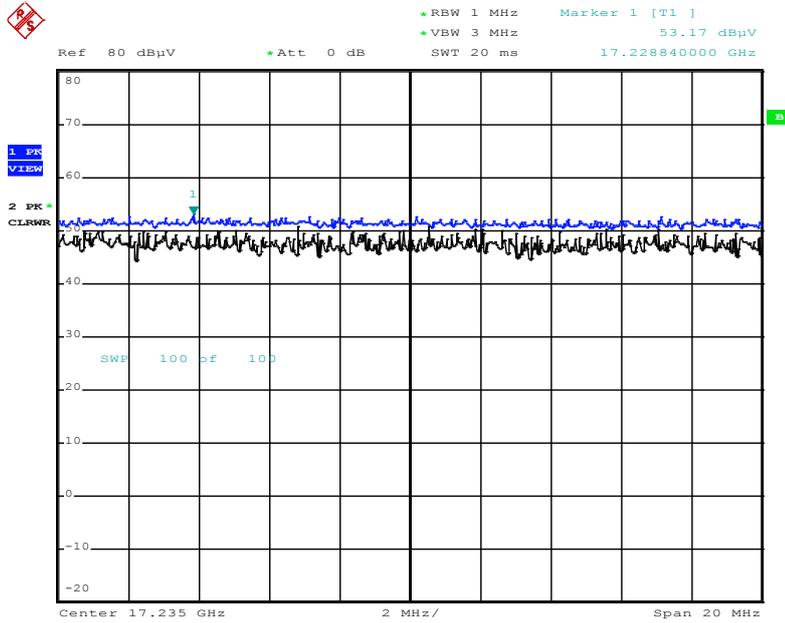
Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
11490	54.80	-2.50	V	52.30	73.98	21.68	PK
11490	40.47	-2.50	V	37.97	53.98	16.01	AV
17235	53.23	3.09	V	56.32	68.20	11.88	PK
11490	54.58	-2.50	H	52.08	73.98	21.90	PK
11490	40.23	-2.50	H	37.73	53.98	16.25	AV
17235	52.75	3.09	H	55.84	68.20	12.36	PK

**Notes:**

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
5. We have done all data rate in 802.11n\_HT20. Worst case is MCS0 in 802.11n\_HT20.
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
7. Distance extrapolation factor =  $20 \log (\text{test distance} / \text{specific distance})$  (dB)

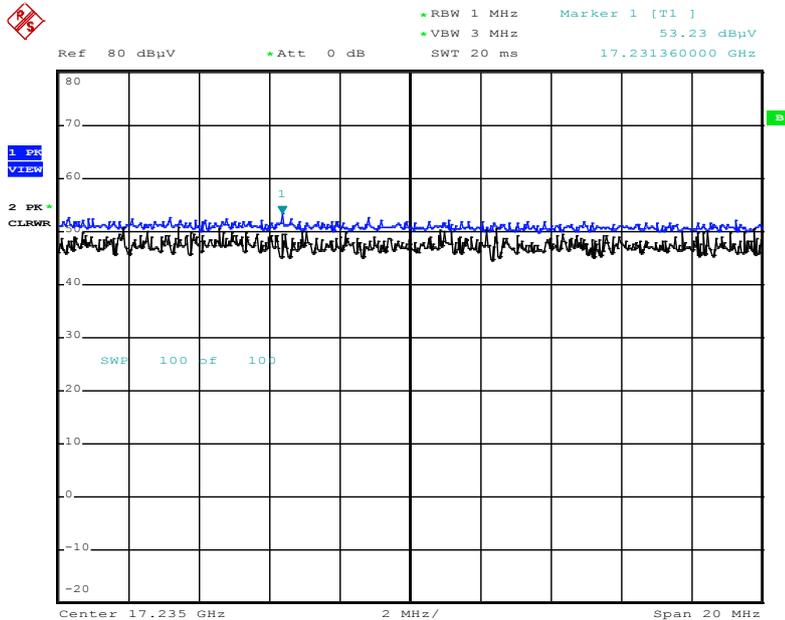
■ **RESULT PLOTS**

**Radiated Spurious Emissions plot –Peak Reading (802.11a, Ch.149 3rd Harmonic, x-V)**



Date: 9.SEP.2016 11:05:27

**Radiated Spurious Emissions plot – Peak Reading(802.11n\_HT20, Ch.149 3rd Harmonic, x-V)**



Date: 9.SEP.2016 11:06:30

**Note : Only the worst case plots for Radiated Spurious Emissions.**

### 9.7.2 RADIATED RESTRICTED BAND EDGE MEASUREMENTS

#### Test Requirements and limit, §15.247(d) §15.205, §15.209 / RSS-GEN(Issue 4) Section 8.10

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c)).

Band : UNII 3  
 Operation Mode: 802.11 a  
 Transfer Rate: 6 Mbps  
 Operating Frequency 5745 MHz  
 Channel No. 149 Ch

Frequency [MHz]	Reading DBuV	AN.+CL+AMP+ATT. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
5725	66.08	5.95	H	72.03	78.20	6.17	PK
5725	69.53	5.95	V	75.48	78.20	2.72	PK
5715	54.94	5.69	H	60.63	68.20	7.57	PK
5715	57.07	5.69	V	62.76	68.20	5.44	PK

Band : UNII 3  
 Operation Mode: 802.11 n\_HT20  
 Transfer MCS Index: 0  
 Operating Frequency 5745 MHz  
 Channel No. 149 Ch

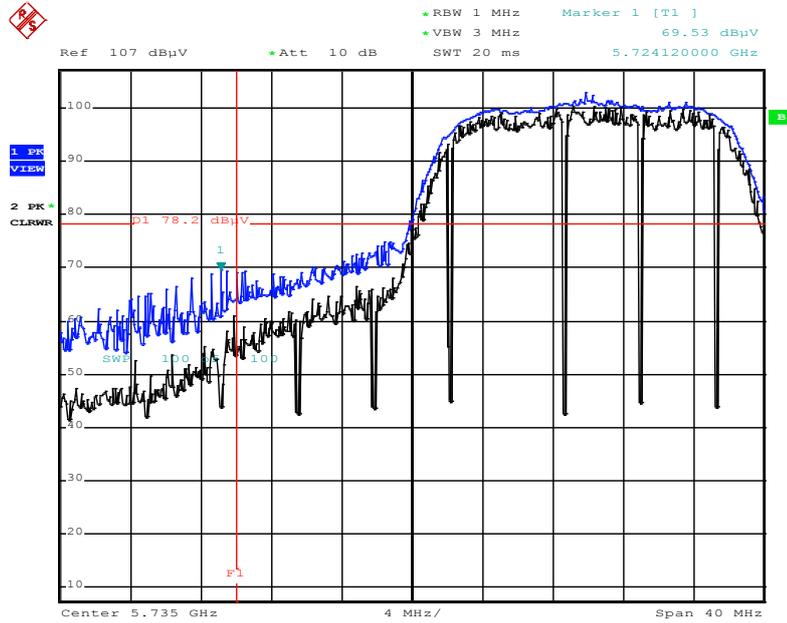
Frequency [MHz]	Reading DBuV	AN.+CL+AMP+ATT. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
5725	63.62	5.95	H	69.57	78.20	8.63	PK
5725	66.74	5.95	V	72.69	78.20	5.51	PK
5715	55.42	5.69	H	61.11	68.20	7.09	PK
5715	56.99	5.69	V	62.68	68.20	5.52	PK

**Notes:**

1. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + ATT
2. We have done all data rate in 802.11a/n/ mode test. . Worst case of EUT is lowest data rate in 802.11a/n\_HT20
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. “\*” is radiated band edge test frequency.(not restricted band emissions)

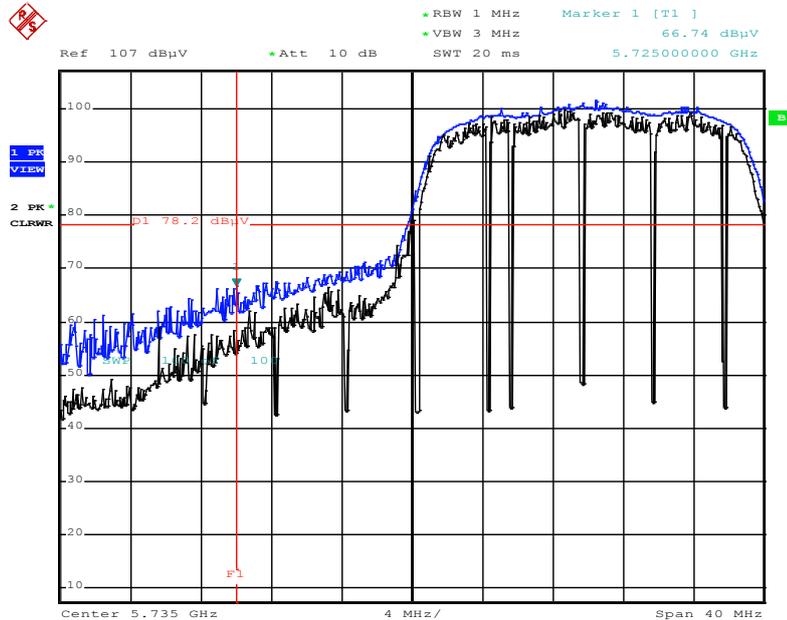
■ **RESULT PLOTS**

**Radiated Restricted Band Edges plot – Peak Reading (802.11a, Ch.149, x-V)**



Date: 8.SEP.2016 17:48:17

**Radiated Restricted Band Edges plot – Peak Reading (802.11n\_HT20, Ch.149, x-V)**



Date: 8.SEP.2016 17:46:02

### 9.7.3 RECEIVER SPURIOUS EMISSIONS

**IC Rule(s)** RSS-GEN  
**Test Requirements:** Blow the table  
**Operating conditions:** Under normal test conditions  
**Method of testing:** Radiated

**S/A. Settings:** F < 1 GHz: RBW: 120 kHz, VBW: 300 kHz (Quasi Peak)  
 F > 1 GHz: RBW: 1 MHz, VBW: 1 MHz (Peak)  
**Mode of operation:** Receive

Frequency (MHz)	Field Strength (microvolts/m at 3 meters)
30 – 88	100
88 - 216	150
216 – 960	200
Above 960	500

**Operation Mode: Receive:**

30 MHz ~ 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dB $\mu$ V	dB /m	dB	(H/V)	dB $\mu$ V/m	dB $\mu$ V/m	dB
No Critical peaks found							

Above 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dB $\mu$ V	dB /m	dB	(H/V)	dB $\mu$ V/m	dB $\mu$ V/m	dB
No Critical peaks found							

## 9.8 POWERLINE CONDUCTED EMISSIONS

### Test Requirements and limit, §15.207 / RSS-GEN(Issue 4) 8.8.

For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

Frequency Range (MHz)	Limits (dB $\mu$ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

### Test Configuration

See test photographs attached in Appendix 1 for the actual connections between EUT and support equipment.

### TEST PROCEDURE

1. The EUT is placed on a wooden table 80 cm above the reference groundplane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

### Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

Note : We don't perform powerline conducted emission test. Because this EUT is used with vehicle.

## 10. LIST OF TEST EQUIPMENT

### 10.1 LIST OF TEST EQUIPMENT(Conducted Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Rohde & Schwarz	ENV216 / LISN	12/28/2015	Annual	100073
Rohde & Schwarz	ESCI / Test Receiver	12/28/2015	Annual	100584
Agilent	N9020A / Signal Analyzer	06/24/2016	Annual	MY51110085
Agilent	N9030A / Signal Analyzer	11/24/2015	Annual	MY49431210
Agilent	N1911A / Power Meter	03/11/2016	Annual	MY45100523
Agilent	N1921A / Power Sensor	03/11/2016	Annual	MY52260025
Agilent	87300B / Directional Coupler	11/30/2015	Annual	3116A03621
Hewlett Packard	11667B / Power Splitter	06/14/2016	Annual	05001
Hewlett Packard	E3632A / DC Power Supply	03/09/2016	Annual	KR75303962
Agilent	8493C / Attenuator(10 dB)	07/15/2016	Annual	07560

## 10.2 LIST OF TEST EQUIPMENT(Radiated Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Innco system	MA4000-EP / Antenna Position Tower	N/A	N/A	N/A
Innco system	CT0800 / Turn Table	N/A	N/A	N/A
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
ETS	2090 / Controller(Turn table)	N/A	N/A	1646
Rohde & Schwarz	Loop Antenna	02/23/2016	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	04/15/2015	Biennial	255
Schwarzbeck	BBHA 9120D / Horn Antenna	12/11/2015	Biennial	9120D-1191
Schwarzbeck	BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz)	09/03/2015	Biennial	BBHA9170541
Rohde & Schwarz	FSP / Spectrum Analyzer	09/29/2016	Annual	836650/016
Rohde & Schwarz	FSV40-N / Spectrum Analyzer	09/23/2016	Annual	101068-SZ
Wainwright Instruments	WHKX10-2700-3000-18000-40SS / High Pass Filter	08/11/2016	Annual	4
Wainwright Instruments	WHKX8-6090-7000-18000-40SS / High Pass Filter	07/15/2016	Annual	5
Wainwright Instruments	WRCJV2400/2483.5-2370/2520-60/12SS / Band Reject Filter	07/06/2016	Annual	2
Wainwright Instruments	WRCJV5100/5850-40/50-8EEK / Band Reject Filter	01/26/2016	Annual	2
H.P.	8491A / Attenuator(10 dB)	08/11/2016	Annual	18593
CERNEX	CBLU1183540 / Power Amplifier	02/01/2016	Annual	24614
CERNEX	CBL06185030 / Power Amplifier	02/01/2016	Annual	24615
CERNEX	CBL18265035 / Power Amplifier	07/11/2016	Annual	22966
CERNEX	CBL26405040 / Power Amplifier	07/11/2016	Annual	25956