



TEST REPORT

Test Report No. : UL-RPT-RP10950538JD11A

Manufacturer : Sigma Connectivity AB
Model No. : SSG-002
FCC ID : 2AFCP-002
Technology : WLAN
Test Standard(s) : FCC Parts 15.207, 15.209(a) & 15.407

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 1.0.

Date of Issue: 10 October 2016

Checked by:

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Steven White
Service Lead, Radio Laboratory
UL VS LTD



This laboratory is accredited by UKAS.
The tests reported herein have been
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1. Customer Information











Company Name:	Sigma Connectivity AB
Address:	Mobilevägen 10 223 62 Lund Sweden

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.407 and 47CFR15.403
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart E (Unlicensed National Information Infrastructure Devices) – Sections 15.403 and 15.407
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209
Site Registration:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	03 September 2015 to 07 October 2016

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	
Part 15.403(i)	Transmitter 26 dB Emission Bandwidth	
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.407(a)(1)(iv)	Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band)	
Part 15.407(a)(2)	Transmitter Maximum Conducted Output Power (5.25-5.35 GHz & 5.47-5.725 GHz bands)	
Part 15.407(a)(1)(iv)	Transmitter Maximum Power Spectral Density (5.15-5.25 GHz band)	
Part 15.407(a)(2)	Transmitter Maximum Power Spectral Density (5.25-5.35 GHz & 5.47-5.725 GHz bands)	
Part 15.407(b)/15.209(a)	Transmitter Out of Band Radiated Emissions	
Part 15.407(b)/15.209(a)	Transmitter Band Edge Radiated Emissions	
Part 15.407(g)	Transmitter Frequency Stability (Temperature & Voltage Variation)	Note 2
Part 15.407(h)(1)	Transmitter Power Control	Note 3
Key to Results  = Complied  = Did not comply		

Note(s):

1. The measurement was performed to assist in the calculation of the level of average output power, power spectral density and emissions as the EUT employs pulsed operation.
2. Frequency stability is better than 20 ppm which ensures that the signal remains in the allocated bands under all operational conditions stated in the user manual.
3. Transmit Power Control was not tested as the maximum EIRP is less than 500 mW (27 dBm).

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 789033 D02 General UNII Test Procedures New Rules v01r02 April 8, 2016
Title:	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices – Part 15, Subpart E

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specifications identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Sensgate
Model Name or Number:	SSG-002
Test Sample Serial Number:	01001B8D (<i>Conducted sample with RF port #1</i>)
Hardware Version:	Revision 2.0
Software Version:	Revision 219
FCC ID:	2AFCP-002

Brand Name:	Sensgate
Model Name or Number:	SSG-002
Test Sample Serial Number:	0100174A (<i>Conducted sample with RF port #2</i>)
Hardware Version:	Revision 2.0
Software Version:	Revision 219
FCC ID:	2AFCP-002

Brand Name:	Sensgate
Model Name or Number:	SSG-002
Test Sample Serial Number:	02001-0354 (<i>Radiated sample #1</i>)
Hardware Version:	Revision 2.0
Software Version:	Revision 219
FCC ID:	2AFCP-002

Brand Name:	Sensgate
Model Name or Number:	SSG-002
Test Sample Serial Number:	MC000170 (<i>Radiated sample #2</i>)
Hardware Version:	Revision 2.0
Software Version:	Revision 219
FCC ID:	2AFCP-002

3.2. Description of EUT

The equipment under test was a gateway in the SENS BY SIGMA system, collecting data from sensors and ensuring that all component parts are continuously under full control. The gateway communicates with the sensors via *Bluetooth* and is transmitting data to the Cloud via WiFi. SensGate is designed to be mounted in the ceiling or on the wall. It carries a battery for backup and is powered via the USB port.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	WLAN (IEEE 802.11a,n) / U-NII		
Type of Unit:	Transceiver		
Modulation:	BPSK, QPSK, 16QAM & 64QAM		
Data rates:	802.11a	6, 9, 12, 18, 24, 36 ,48 & 54 Mbps	
	802.11n HT20	MCS0 to MCS7 (1 spatial stream)	
	802.11n HT40	MCS0 to MCS7 (1 spatial stream)	
Power Supply Requirement(s):	Nominal	3.8 VDC via 120 VAC 60 Hz adaptor	
Antenna Gains:	5.15 to 5.35 GHz	0.0 dBi	
	5.47 to 5.725 GHz	0.1 dBi	
Channel Spacing:	20 MHz		
Transmit Frequency Band:	5150 MHz to 5250 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	36	5180
	Middle	40	5200
	Top	48	5240
Transmit Frequency Band:	5250 MHz to 5350 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	52	5260
	Middle	56	5280
	Top	64	5320
Transmit Frequency Band:	5470 MHz to 5725 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	100	5500
	Middle	116	5580
	Top	140	5700

Additional Information Related to Testing (continued)

Channel Spacing:	40 MHz		
Transmit Frequency Band:	5150 MHz to 5250 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	38	5190
	Top	46	5230
Transmit Frequency Band:	5250 MHz to 5350 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	54	5270
	Top	62	5310
Transmit Frequency Band:	5470 MHz to 5725 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	102	5510
	Middle	110	5550
	Top	134	5670

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	Test laptop
Brand Name:	Hewlett Packard
Model Name or Number:	Compaq 6910p
Serial Number:	HUB7451SGN

Description:	USB Cable
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Power Supply
Brand Name:	Phihong
Model Name or Number:	PSA05E-050Q
Serial Number:	Not marked or stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):

- Continuously transmitting with a modulated carrier at maximum power on the bottom, middle and top channels as required using the supported data rates/modulation types.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

- Controlled using a terminal application on the laptop PC along with instructions provided by the customer. The instructions were called *"How to set to WLAN continuous signal 01 Oct 2015.docx"* dated 13 January 2016.
- The terminal application was used to enable a continuous transmission mode and to select the test channels, data rates and modulation schemes as required.
- In order for all test cases to meet their respective limits, the power settings used are stated in Section 4.3 of this report.
- All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and widest bandwidth for all bands were:
 - Highest output power and power spectral density
 - 802.11a – QPSK / 12 Mbps
 - 802.11n HT20 – 16QAM / MCS4
 - 802.11n HT40 – BPSK / MCS0
 - Widest bandwidth
 - 802.11a – BPSK / 9 Mbps
 - 802.11n HT20 – BPSK / MCS0
 - 802.11n HT40 – BPSK / MCS0

Pre-scan results for all modes are archived on the UL VS LTD IT server and available for inspection if required.

- RF cables and attenuators connecting the test equipment to the EUT were calibrated before use and the calibration data incorporated into the conducted measurement results.
- Transmitter spurious emissions were performed with the EUT transmitting with a data rate of MCS4 (802.11n HT20). This was found to be the worst case modulation scheme with regards to emissions after preliminary investigations and, as this mode emits the highest power spectral density, it was deemed to be the worst case.
- Transmitter radiated emissions were performed with the EUT connected to its AC/DC Power Supply and USB cable. The Power Supply input was connected to a 120 VAC 60 Hz single phase supply.

4.3. Power Settings

The power settings below have been used for testing:

U-NII Band 1 (5150 to 5250 MHz)

Mode	Bottom channel 5180 MHz	Middle channel 5200 MHz	Top Channel 5240 MHz
802.11a	11 dBm	11 dBm	11 dBm
802.11n HT20	11 dBm	11 dBm	11 dBm
802.11n HT40	Bottom channel 5190 MHz	Top Channel 5230 MHz	
	11 dBm	11 dBm	

U-NII Band 2A (5250 to 5350 MHz)

Mode	Bottom channel 5260 MHz	Middle channel 5280 MHz	Top Channel 5320 MHz
802.11a	11 dBm	11 dBm	11 dBm
802.11n HT20	11 dBm	11 dBm	11 dBm
802.11n HT40	Bottom channel 5270 MHz	Top Channel 5310 MHz	
	11 dBm	11 dBm	

U-NII Band 2C (5470 to 5725 MHz)

Mode	Bottom channel 5500 MHz	Middle channel 5580 MHz	Top Channel 5700 MHz
802.11a	12 dBm	12 dBm	12 dBm
802.11n HT20	12 dBm	12 dBm	12 dBm
802.11n HT40	Bottom channel 5510 MHz	Middle channel 5550 MHz	Top Channel 5670 MHz
	12 dBm	12 dBm	12 dBm

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6 Measurement Uncertainty* for details.

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Matthew Galbraith	Test Date:	07 October 2016
Test Sample Serial Number:	MC000170		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2

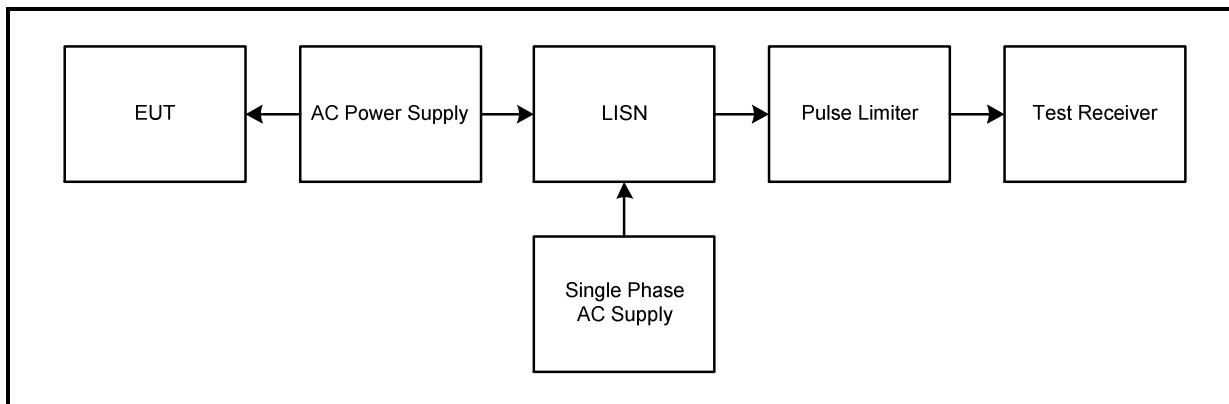
Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	43

Note(s):

1. The EUT was plugged into a USB cable which is connected to an AC charger. The AC charger was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
3. A pulse limiter was fitted between the LISN and the test receiver.

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.190500	Live	47.4	64.0	16.6	Complied
0.235500	Live	44.9	62.3	17.4	Complied
0.289500	Live	38.9	60.5	21.6	Complied
2.566500	Live	34.1	56.0	21.9	Complied
3.588000	Live	36.1	56.0	19.9	Complied
4.434000	Live	36.1	56.0	19.9	Complied

Results: Live / Average

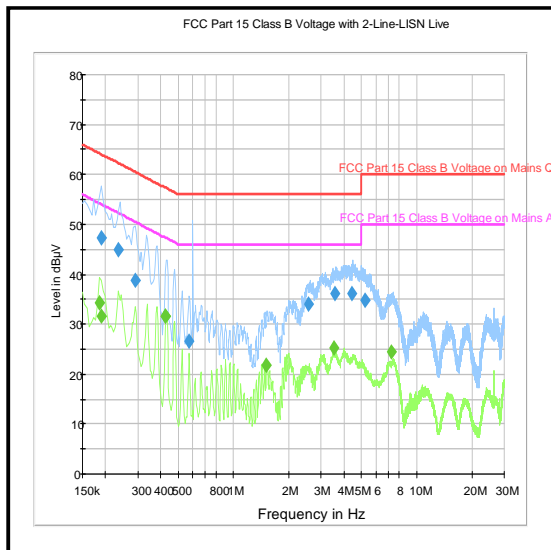
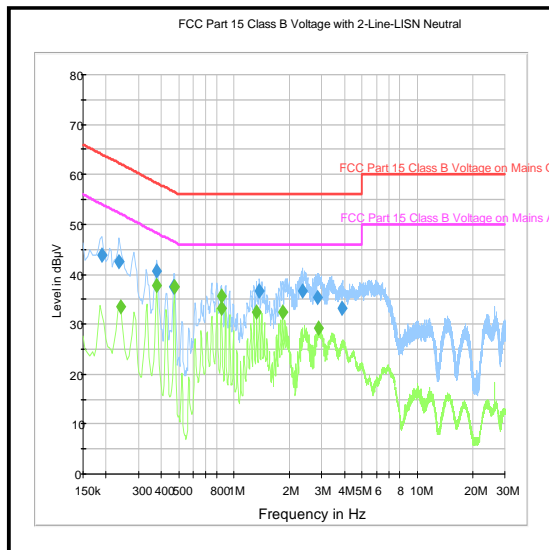
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.186000	Live	34.3	54.2	19.9	Complied
0.190500	Live	31.7	54.0	22.3	Complied
0.424500	Live	31.6	47.4	15.8	Complied
0.424500	Live	31.6	47.4	15.8	Complied
1.513500	Live	21.8	46.0	24.2	Complied
3.507000	Live	25.2	46.0	20.8	Complied

Results: Neutral / Quasi Peak

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.190500	Neutral	43.7	64.0	20.3	Complied
0.235500	Neutral	42.6	62.3	19.7	Complied
0.379500	Neutral	40.6	58.3	17.7	Complied
0.469500	Neutral	37.3	56.5	19.2	Complied
1.374000	Neutral	36.6	56.0	19.4	Complied
2.368500	Neutral	36.7	56.0	19.3	Complied

Results: Neutral / Average

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.379500	Neutral	37.6	48.3	10.7	Complied
0.474000	Neutral	37.4	46.4	9.0	Complied
0.852000	Neutral	35.6	46.0	10.4	Complied
0.852000	Neutral	33.3	46.0	12.7	Complied
1.324500	Neutral	32.5	46.0	13.5	Complied
1.846500	Neutral	32.5	46.0	13.5	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Live****Neutral**

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2015	Thermohygrometer	Testo	608-H1	45046424	10 Jun 2017	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	09 Aug 2017	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	08 Mar 2017	12
M1379	Test Receiver	Rohde & Schwarz	ESIB7	100330	15 Dec 2016	12

5.2.2. Transmitter 26 dB Emission Bandwidth**Test Summary:**

Test Engineer:	Sandeep Bharat	Test Date:	05 October 2016
Test Sample Serial Number:	01001B8D		

FCC Reference:	Part 15.403(i)
Test Method Used:	KDB 789033 D02 Section II.C.1.

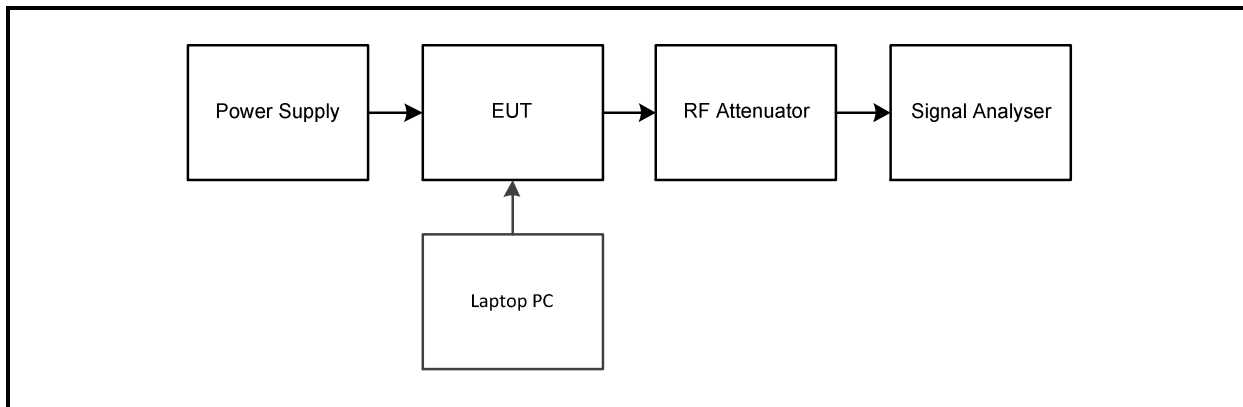
Environmental Conditions:

Temperatures (°C):	25
Relative Humidity (%):	31

Note(s):

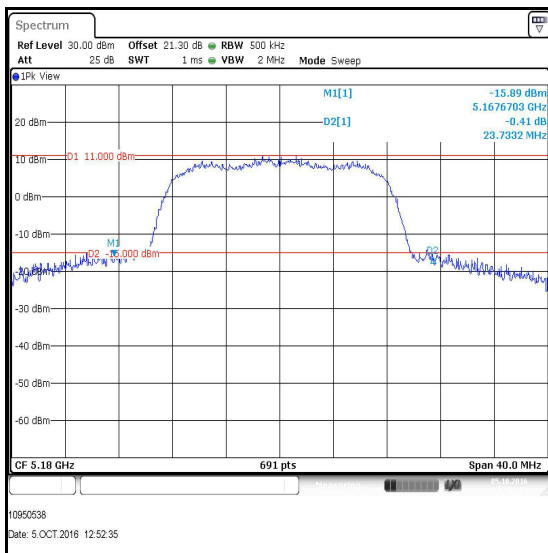
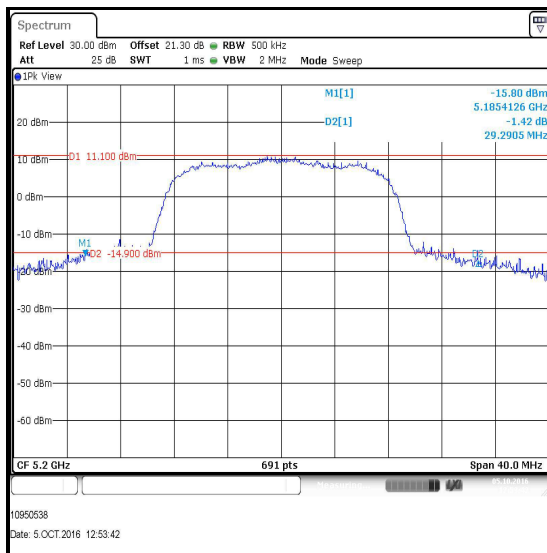
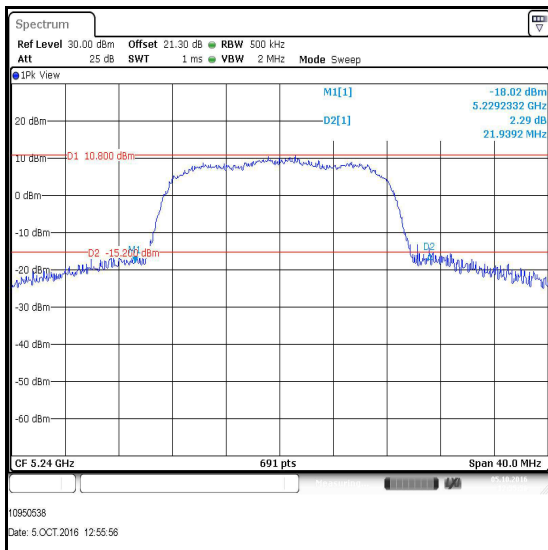
1. All configurations supported by the EUT were investigated on the one channel in accordance with KDB 789033 Section II.C.1. Emission Bandwidth (EBW) test procedure. The data rates that produced the widest bandwidth and therefore deemed worst case were:
 - o 802.11a – BPSK / 9 Mbps
 - o 802.11n HT20 – BPSK / MCS0
 - o 802.11n HT40 – BPSK / MCS0
2. Final measurements were performed in each supported operating band using the above configurations on the bottom, middle and top channels.
3. The signal analyser resolution bandwidth was set at approximately 1% (1-5%) of the emission bandwidth and video bandwidth to at least 3 times the resolution bandwidth. A peak detector was used, sweep time set to auto and trace mode was Max Hold. The span was set to twice the nominal channel bandwidth of the signal. The emission bandwidth was measured at 26 dB down from the peak of the signal.
4. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.
5. Plots for all data rates are archived on the UL VS LTD IT server and available for inspection upon request.
6. For the power measurements in this report, the highest power output level was recorded when the EUT was configured as:
 - o 802.11a – QPSK / 12 Mbps
 - o 802.11n HT20 – 16QAM / MCS4

Emission bandwidth plots for these configurations have been included as 'Reference plots' at the end of this section and the results used for calculations in Section 5.2.4.

Transmitter 26 dB Emission Bandwidth (continued)**Test setup:**

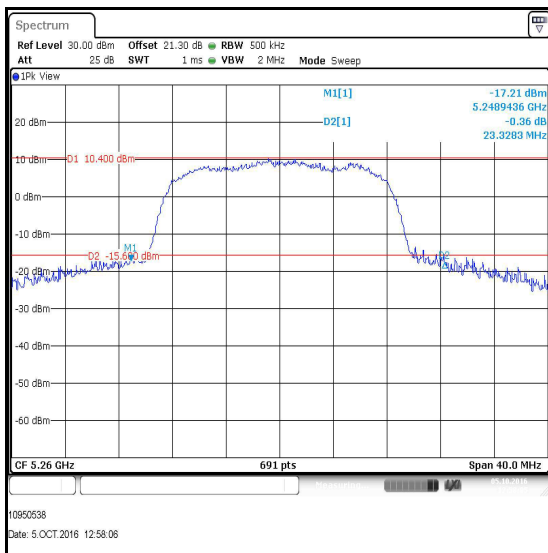
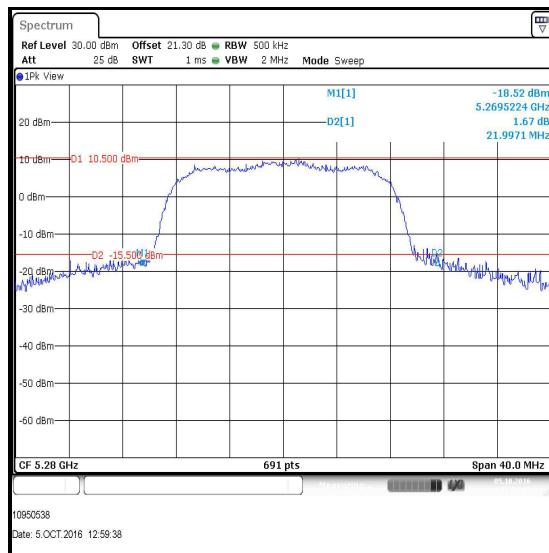
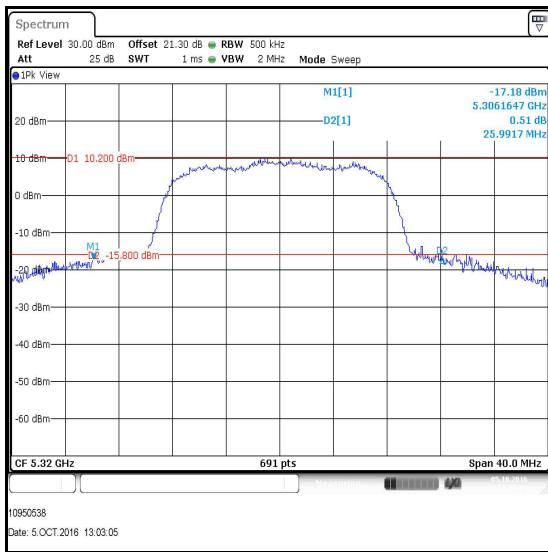
Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11a / 20 MHz / BPSK / 9 Mbps / 5.15-5.25 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
36	5180	23.733
40	5200	29.290
48	5240	21.939

**Channel 36****Channel 40****Channel 48**

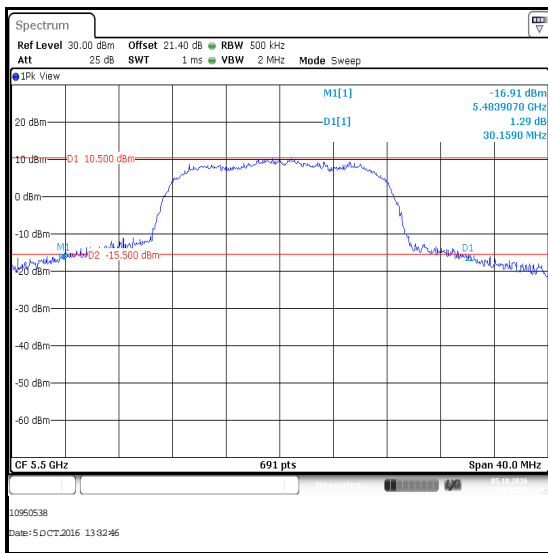
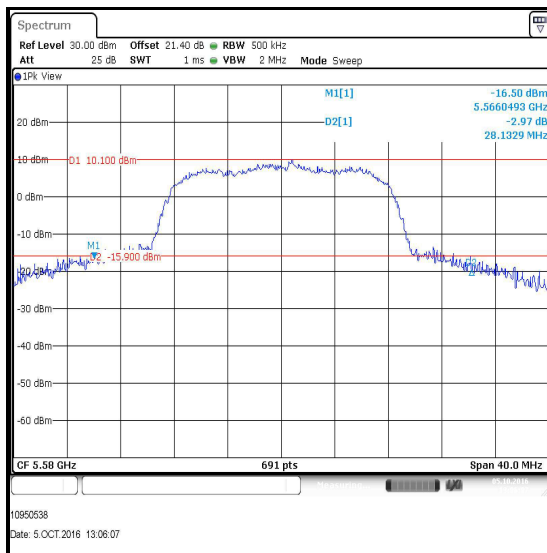
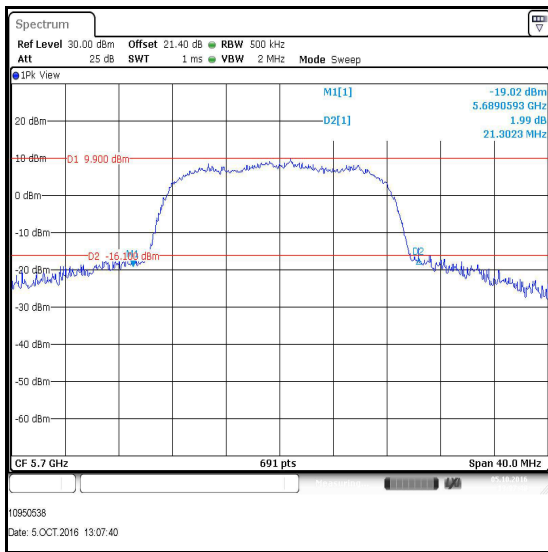
Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11a / 20 MHz / BPSK / 9 Mbps / 5.25-5.35 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
52	5260	23.328
56	5280	21.997
64	5320	25.992

**Channel 52****Channel 56****Channel 64**

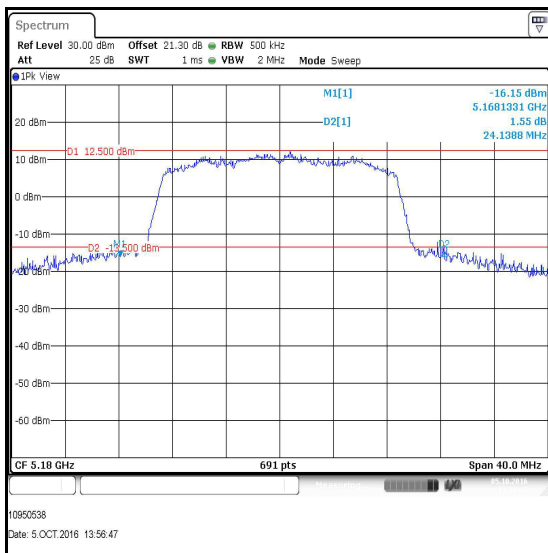
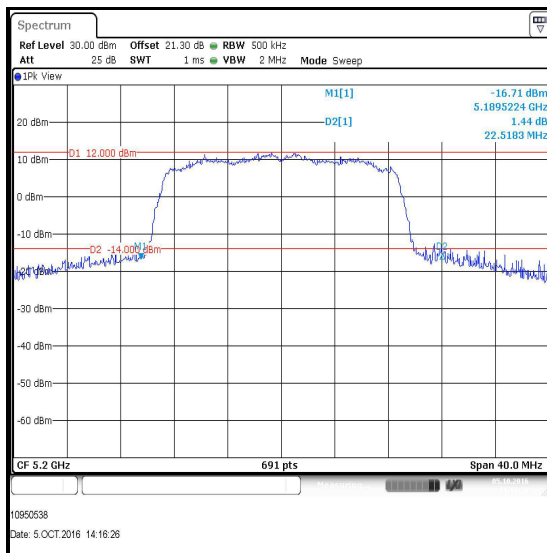
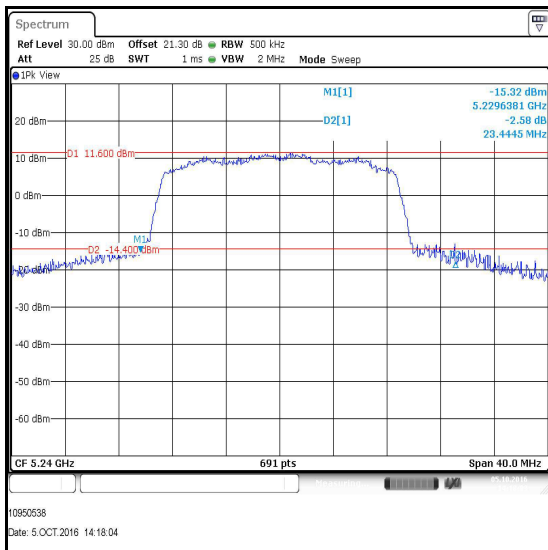
Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11a / 20 MHz / BPSK / 9 Mbps / 5.47-5.725 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
100	5500	30.159
116	5580	28.133
140	5700	21.302

**Channel 100****Channel 116****Channel 140**

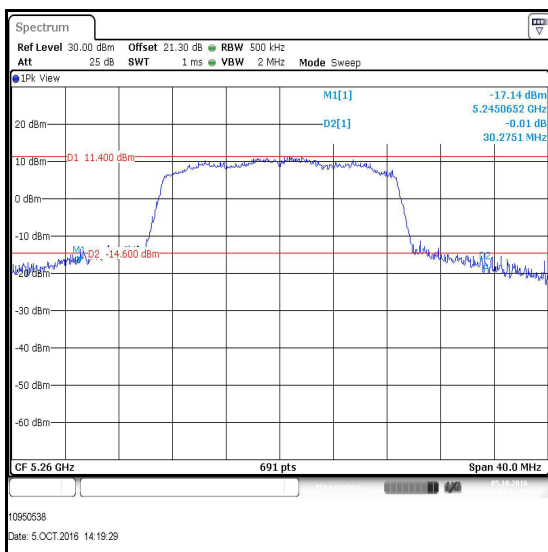
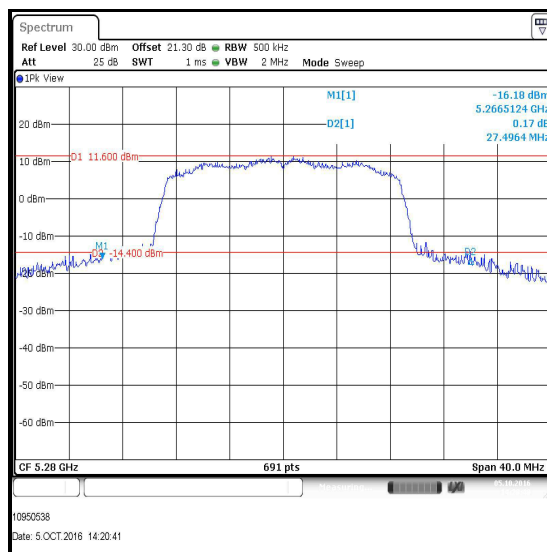
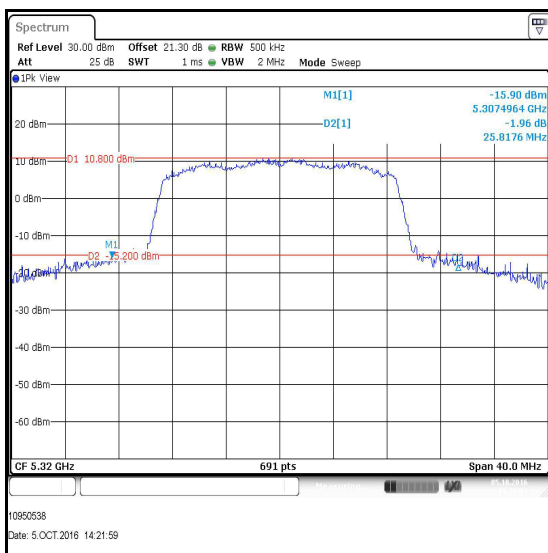
Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / 5.15-5.25 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
36	5180	24.139
40	5200	22.518
48	5240	23.444

**Channel 36****Channel 40****Channel 48**

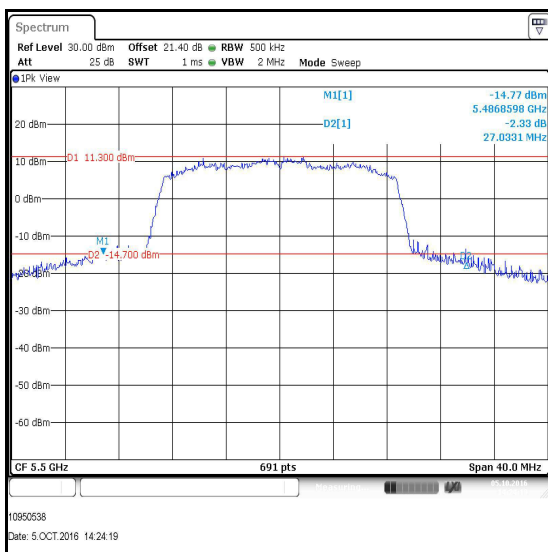
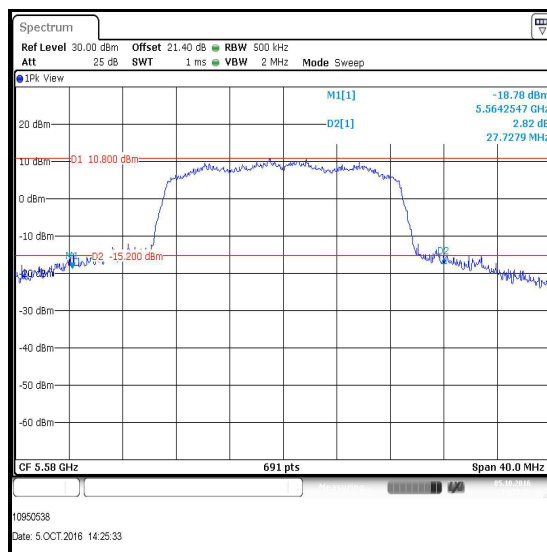
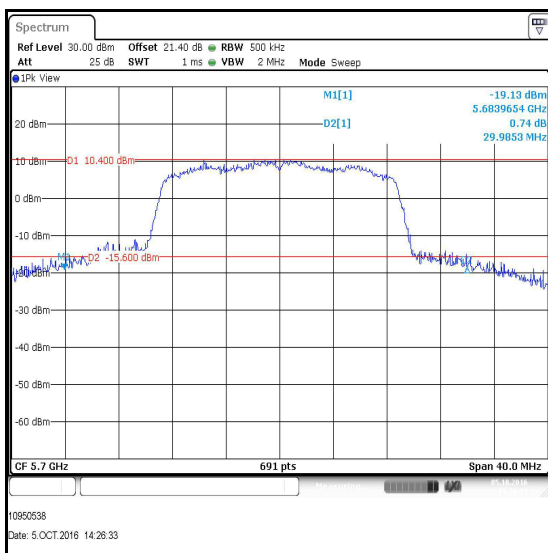
Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / 5.25-5.35 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
52	5260	30.275
56	5280	27.496
64	5320	25.818

**Channel 52****Channel 56****Channel 64**

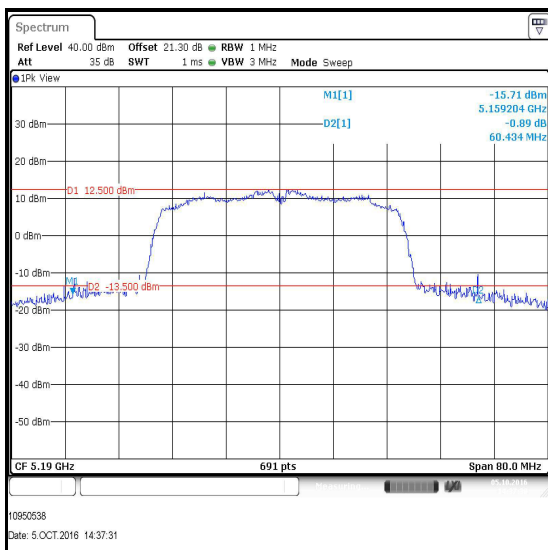
Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / 5.47-5.725 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
100	5500	27.033
116	5580	27.728
140	5700	29.985

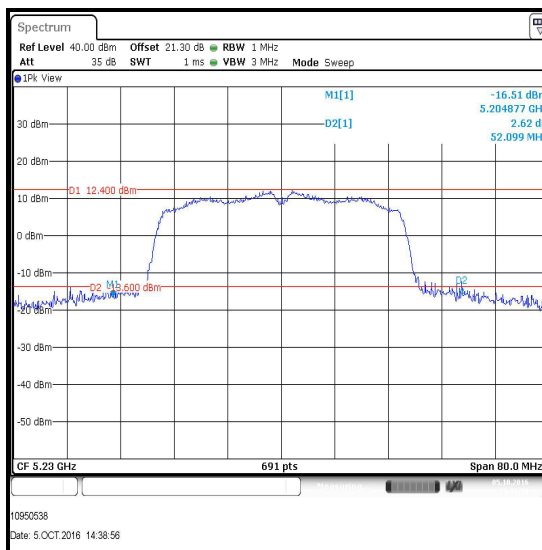
**Channel 100****Channel 116****Channel 140**

Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11n / 40 MHz / BPSK / MCS0 / 5.15-5.25 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
38	5190	60.434
46	5230	52.099



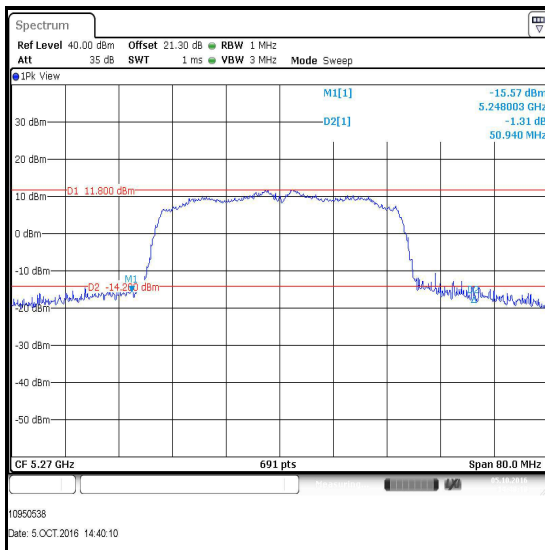
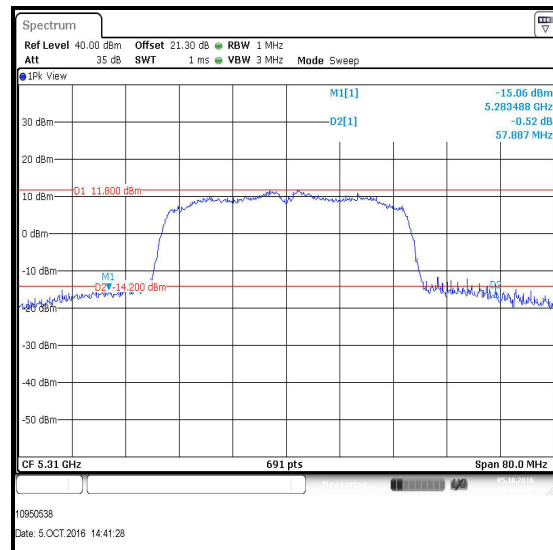
Channel 38



Channel 46

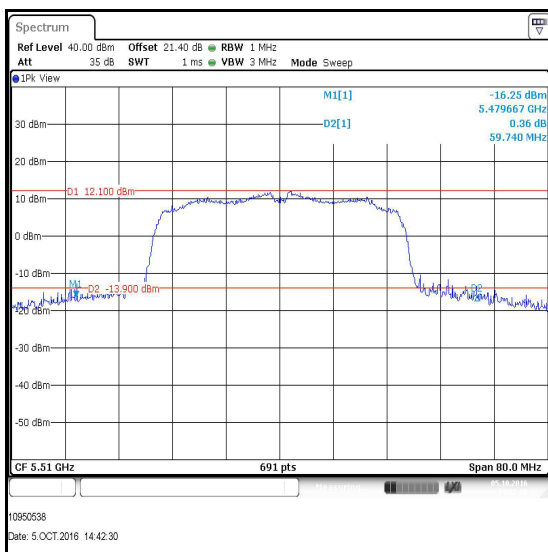
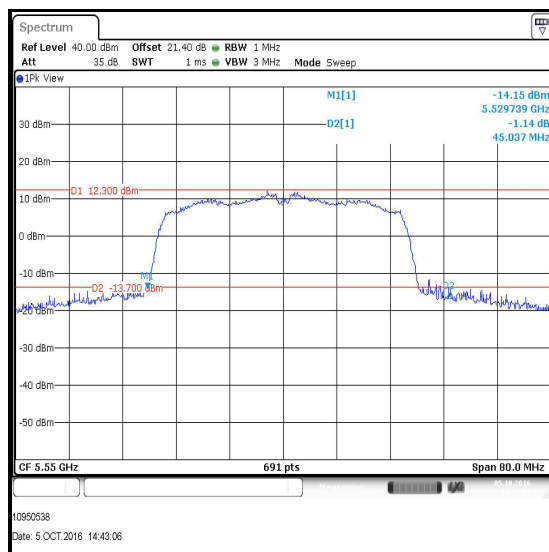
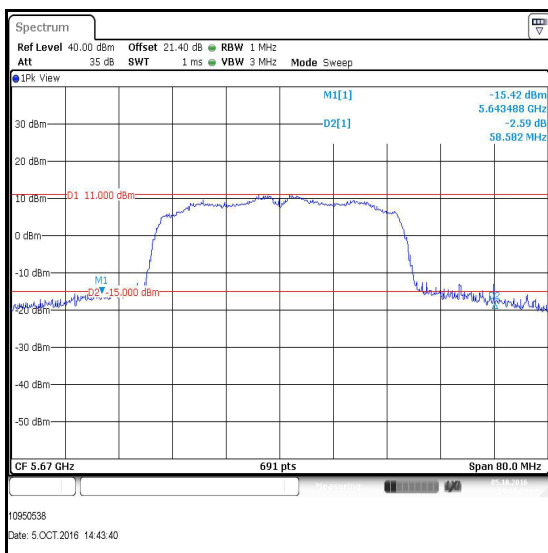
Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11n / 40 MHz / BPSK / MCS0 / 5.25-5.35 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
54	5270	50.940
62	5310	57.887

**Channel 54****Channel 62**

Transmitter 26 dB Emission Bandwidth (continued)**Results: 802.11n / 40 MHz / BPSK / MCS0 / 5.47-5.725 GHz band**

Channel	Frequency (MHz)	26dB Emission Bandwidth (MHz)
102	5510	59.740
110	5550	45.037
134	5670	58.582

**Channel 102****Channel 110****Channel 134**