



CERTIFICATION TEST REPORT

Report Number. : 12524644-E4V1

Applicant : GOOGLE LLC
1600 AMPHITHEATRE PARKWAY
MOUNTAIN VIEW, CA 94043, U.S.A.

Model : H1A

EUT Description : INTERACTIVE VIDEO STREAMING DEVICE

Test Standard(s) : LP0002:2018

Date Of Issue:
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REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	10/16/2018	Initial Issue	---

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: GOOGLE LLC
1600 AMPHITHEATRE PARKWAY
MOUNTAIN VIEW, CA 94043, U.S.A.

EUT DESCRIPTION: INTERACTIVE VIDEO STREAMING DEVICE

MODEL: H1A

SERIAL NUMBER: G1424638 (CONDUCTED)
G1421457 (RADIATED)

DATE TESTED: July 19, 2018 – August 14, 2018; October 11, 2018

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
LP0002:2018	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with LP0002:2018, FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 14-30, FCC KDB 905462 D02 v02/D03 v01r02/D06 v02, FCC KDB 789033 D02 v02r01, FCC KDB 644545 D03 v01, ANSI C63.10-2013, FCC 06-96, FCC KDB 905462 D02 and D03.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street	47658 Kato Rd
☒ Chamber A (ISED:2324B-1)	☐ Chamber D (ISED:22541-1)	☒ Chamber K (ISED:2324A-1)
☒ Chamber B (ISED:2324B-2)	☐ Chamber E (ISED:22541-2)	☒ Chamber L (ISED:2324A-3)
☐ Chamber C (ISED:2324B-3)	☐ Chamber F (ISED:22541-3)	
	☐ Chamber G (ISED:22541-4)	
	☐ Chamber H (ISED:22541-5)	

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$$\begin{aligned}\text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamplifier Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m}\end{aligned}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.65 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	3.15 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.32 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.45 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.24 dB

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The EUT is an Interactive Video Streaming Device

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

5.2 GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.2 GHz band, 1TX			
5180-5240	802.11a	17.32	53.95
5180-5240	802.11n HT20	17.02	50.35
5190-5230	802.11n HT40	15.66	36.81
5210	802.11ac VHT80	9.02	7.98

5.3 GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.3 GHz band, 1TX			
5260 - 5320	802.11a	17.31	53.83
5260 - 5320	802.11n HT20	17.01	50.23
5270 - 5310	802.11n HT40	15.16	32.81
5290	802.11ac VHT80	11.64	14.59

5.6 GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.6 GHz band, 1TX			
5500-5720	802.11a	17.06	50.82
5500-5720	802.11n HT20	16.87	48.64
5510-5710	802.11n HT40	15.78	37.84
5530-5690	802.11ac VHT80	16.33	42.95

5.8 GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.8 GHz band, 1TX			
5745-5825	802.11a	17.10	51.29
5745-5825	802.11n HT20	17.02	50.35
5755-5795	802.11n HT40	15.59	36.22
5775	802.11ac VHT80	15.96	39.45

STRADDLE CHANNELS

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
1Tx (Channels overlapping UNII-2C and UNII-3)			
5720 (Whole Fundamental)	802.11a	17.02	50.35
5720 (Whole Fundamental)	802.11n HT20	16.78	47.64
5710 (Whole Fundamental)	802.11n HT40	15.62	36.48
5690 (Whole Fundamental)	802.11ac VHT80	16.33	42.95

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a PIFA antenna, with a maximum gain of 5 dBi.

5.4. SOFTWARE AND FIRMWARE

The EUT firmware and utility software during testing was version 127694.

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

EUT can only be set up in desktop orientation; therefore, all radiated testing was performed with the EUT in desktop orientation.

Simultaneous transmission for BT/BLE radios and 5GHz WLAN radio was investigated, no additional noticeable emissions were found.

802.11ac VHT20 and VHT40 modes are different from 802.11nHT20 and HT40 only in control messages and have the same power settings. 802.11ac-VHT20 is covered by 802.11n-HT20, and 802.11ac-VHT40 is covered by 802.11n-HT40

Worst-case data rates as provided by the client were:

802.11a mode: 6 Mbps
 802.11n HT20mode: MCS0
 802.11n HT40mode: MCS0
 802.11ac VHT80 mode: MCS0

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

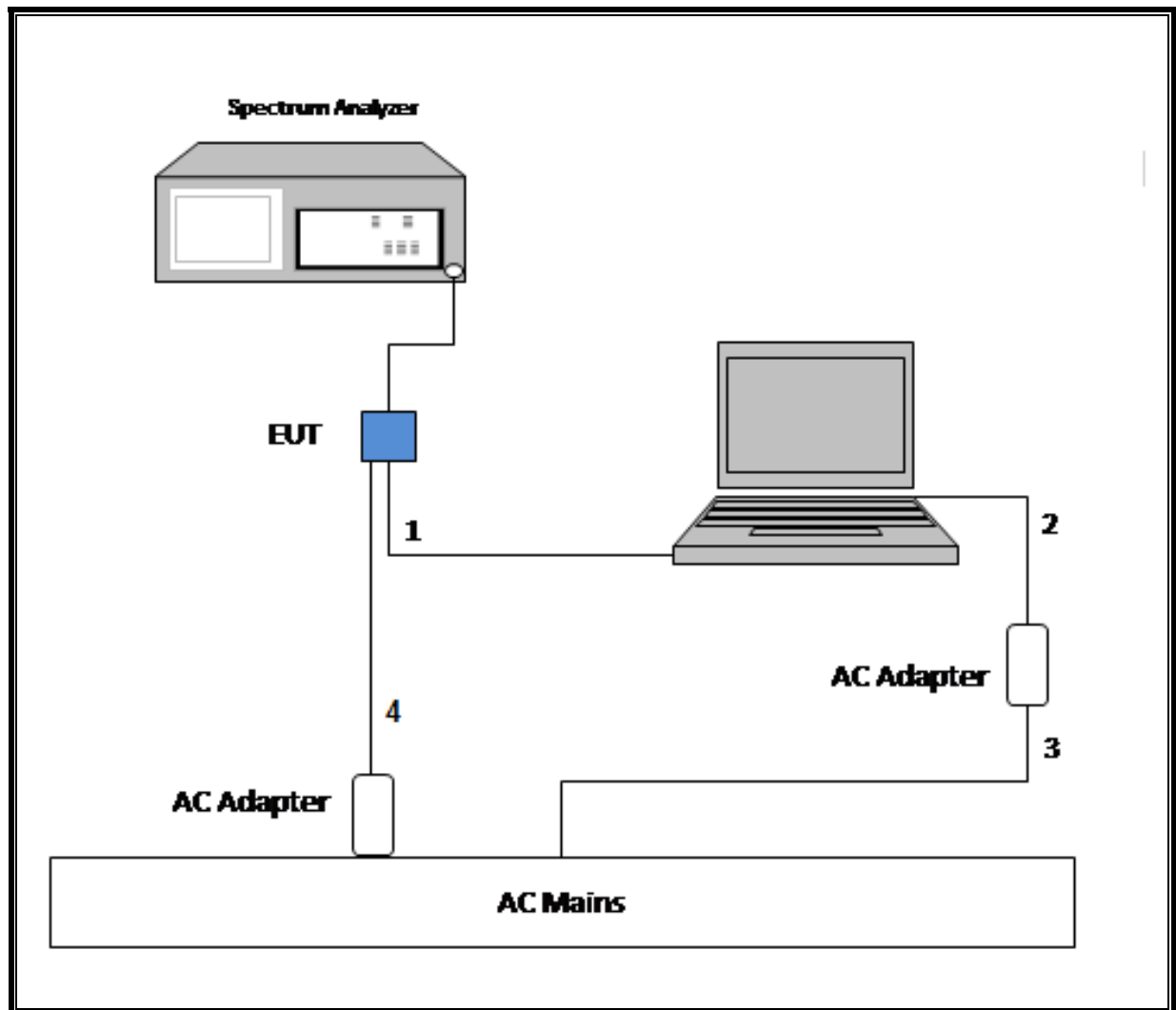
Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop AC/DC adapter	Lenovo	ADLX65NCT2A	11S36200293ZZ10049556E	NA
Laptop	Lenovo	X220	R9-P89W3	NA
AC adapter	Google	NA	W015R007q	NA

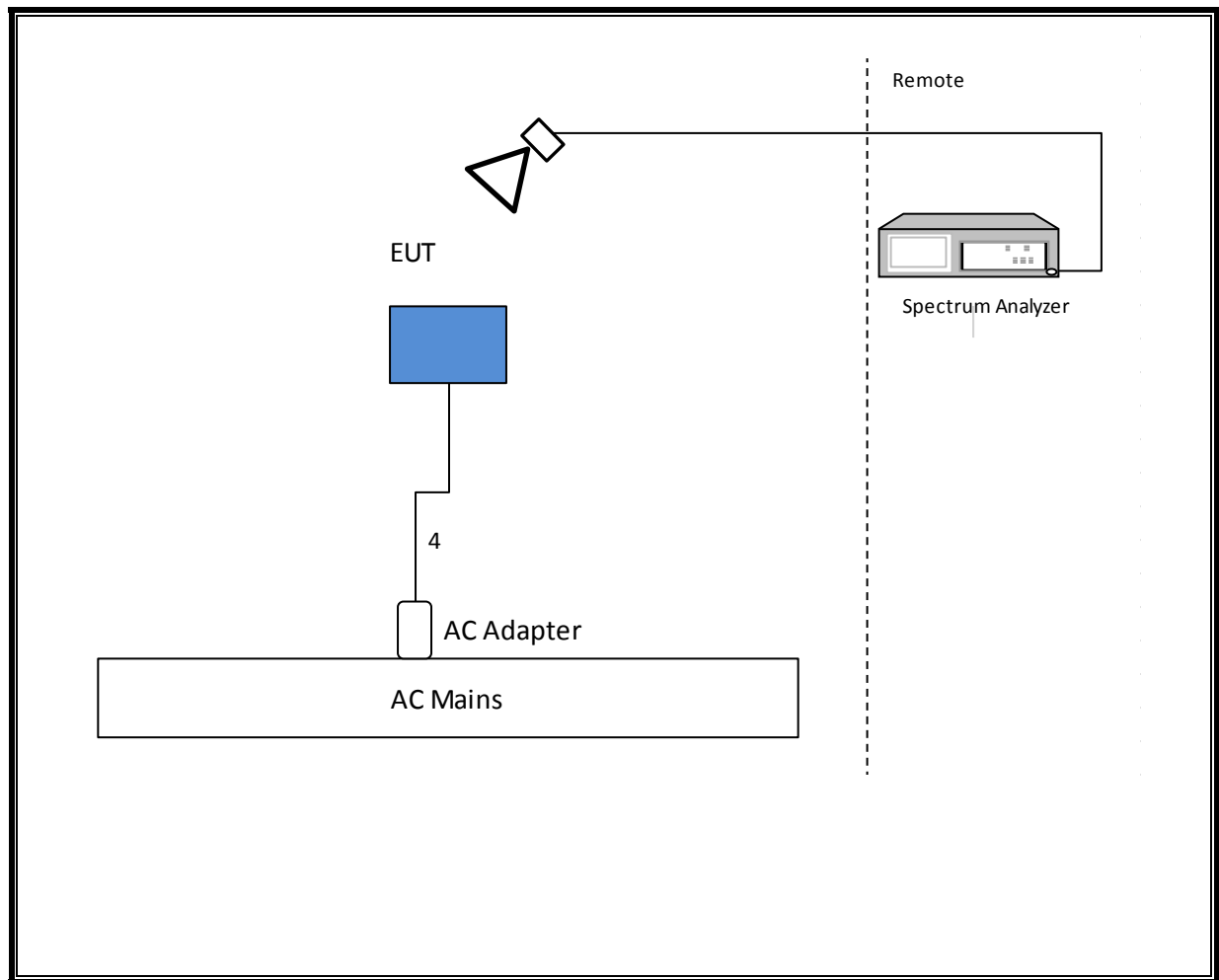
I/O CABLES

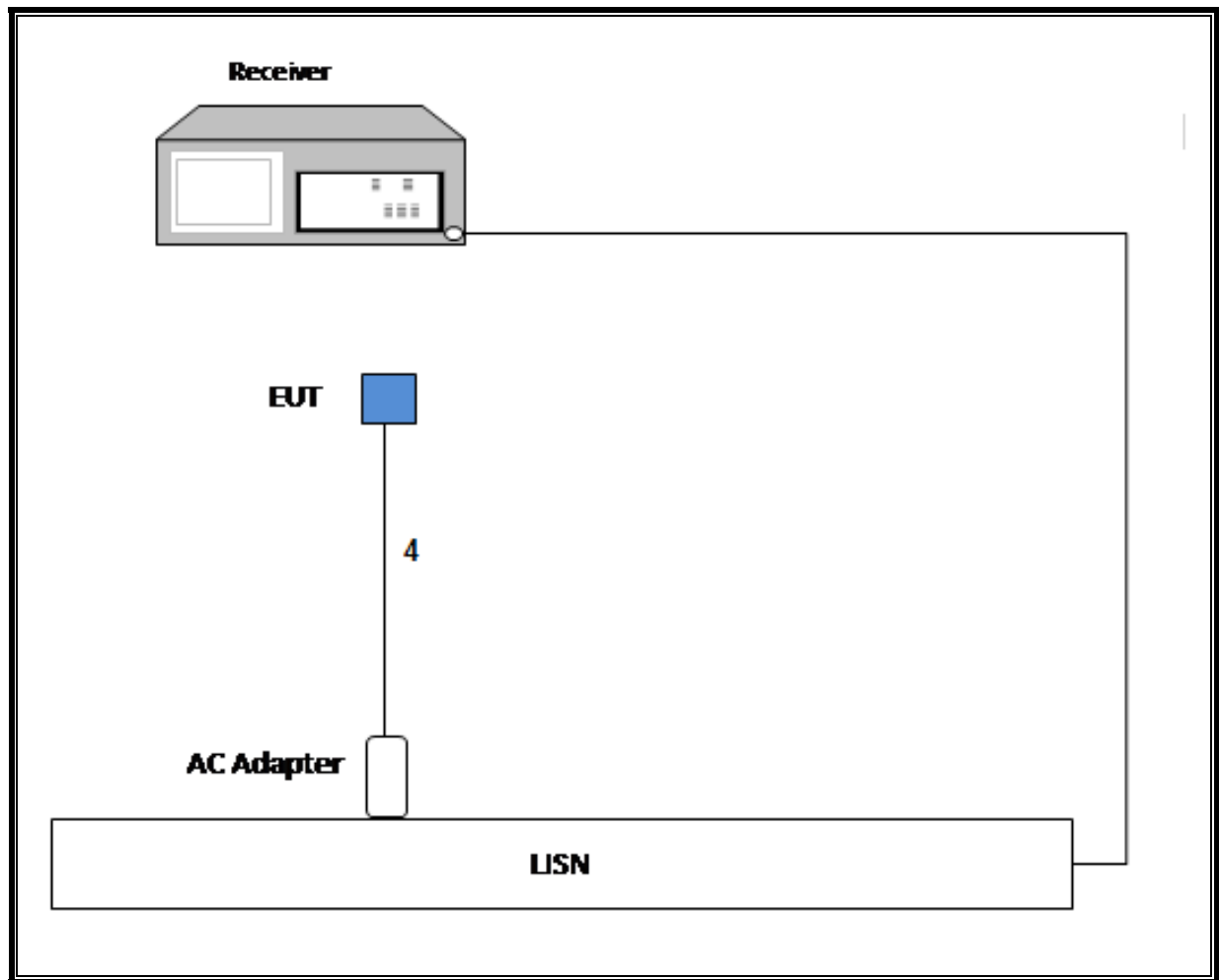
I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	USB	1	micro USB	Shielded	1	
2	DC	1	DC connector	Unshielded	1.75	
3	AC	1	2-Prong	Unshielded	1	
4	DC	1	DC connector	Unshielded	1.75	

TEST SETUP

The EUT was connected to a host Laptop via USB cable. Test software exercised the EUT.

SETUP DIAGRAM FOR ANTENNA PORT CONDUCTED TESTS

SETUP DIAGRAM FOR RADIATED TESTS

SETUP DIAGRAM FOR AC LINE CONDUCTED TESTS

6. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 789033 D02 v02r01, Section B.

6 dB Emission BW: KDB 789033 D02 v02r01, Section C.2

26 dB Emission BW: KDB 789033 D02 v02r01, Section C.1

99% Occupied BW: KDB 789033 D02 v02r01, Section D.

Conducted Output Power: KDB 789033 D02 v02r01, Section E.3.b (Method PM-G) and KDB 789033 D02 v02r01, Section E.2.b (Method SA-1)

Power Spectral Density: KDB 789033 D02 v02r01, Section F

Unwanted emissions in restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, and G.5.

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

7. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST EQUIPMENT LIST				
Description	Manufacturer	Model	Asset	Cal Due
Amplifier	Hewlet Packard	8447D	T64	02/14/2019
Amplifier, 1 - 18GHz	MITEQ	AFS42-00101800-25-S-42	T1568	06/21/2019
Amplifier, 1 - 18GHz	Ampical	AMP1G18-35	T1569	06/03/2019
Amplifier, 1 - 18GHz	MITEQ	AFS42-00101800-25-S-42	T931	09/20/2018
RF Preamplifier, 1 - 26GHz	Agilent	8449B	T404	03/09/2019
Pre-Amp, 26-40GHz	MITEQ	NSTTA2640-35-HG	T1864	03/09/2019
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences Corp.	JB3	T407	05/10/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	EMC4294	04/30/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T344	04/30/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T863	06/21/2019
Antenna Horn, 18 to 26GHz	ARA	MWH-1826/B	T488	10/04/2018
Antenna Horn, 26.5 to 40GHz	ARA	MWH-2640	T90	08/25/2018
Power Meter, P-series single channel	Keysight	N1912A	T1271	07/26/2019
Power Sensor	Keysight	N1921A	T1225	04/10/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1466	04/16/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1454	01/08/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1113	12/21/2018
EMI Test Receiver	Rohde & Schwarz	ESW44	PRE0179522	05/11/2019
EMI Test Receiver	Rohde & Schwarz	ESW44	PRE0179367	04/28/2019
AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESC17	T1124	11/07/2018
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2	EMC4385	01/31/2019
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2018
UL AUTOMATION SOFTWARE				
Radiated Software	UL	UL EMC	Ver 9.5, Dec 01, 2016	
Antenna Port Software	UL	UL EMC	Ver 7.9, Jan 24, 2018	
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015	

NOTES:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

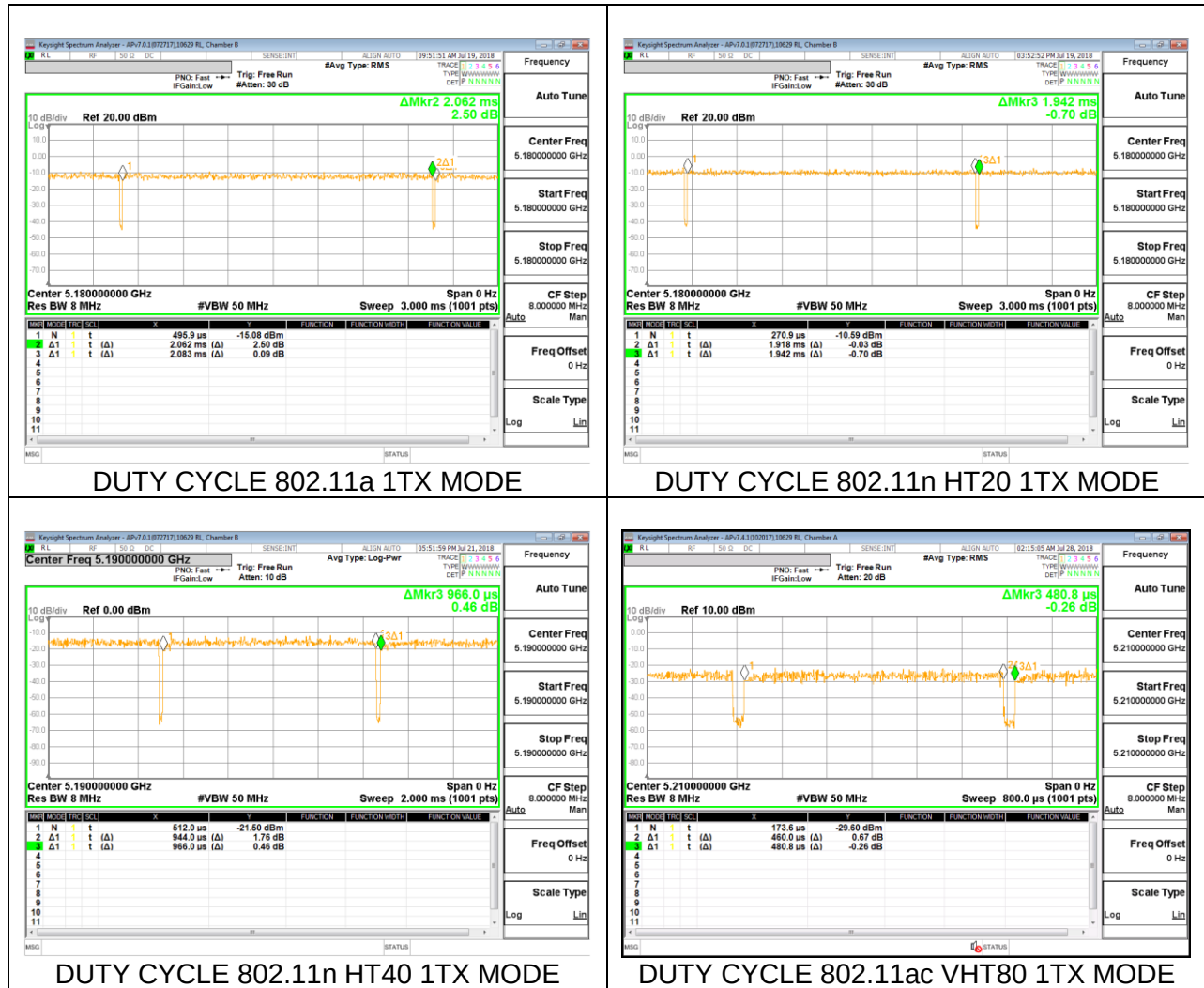
PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
802.11a 1TX	2.062	2.083	0.990	98.99%	0.00	0.010
802.11n HT20 1TX	1.918	1.942	0.988	98.76%	0.00	0.010
802.11n HT40 1TX	0.944	0.966	0.977	97.72%	0.10	1.059
802.11ac VHT80 1TX	0.460	0.481	0.956	95.63%	0.19	2.174

DUTY CYCLE PLOTS



8.2. 26 dB BANDWIDTH

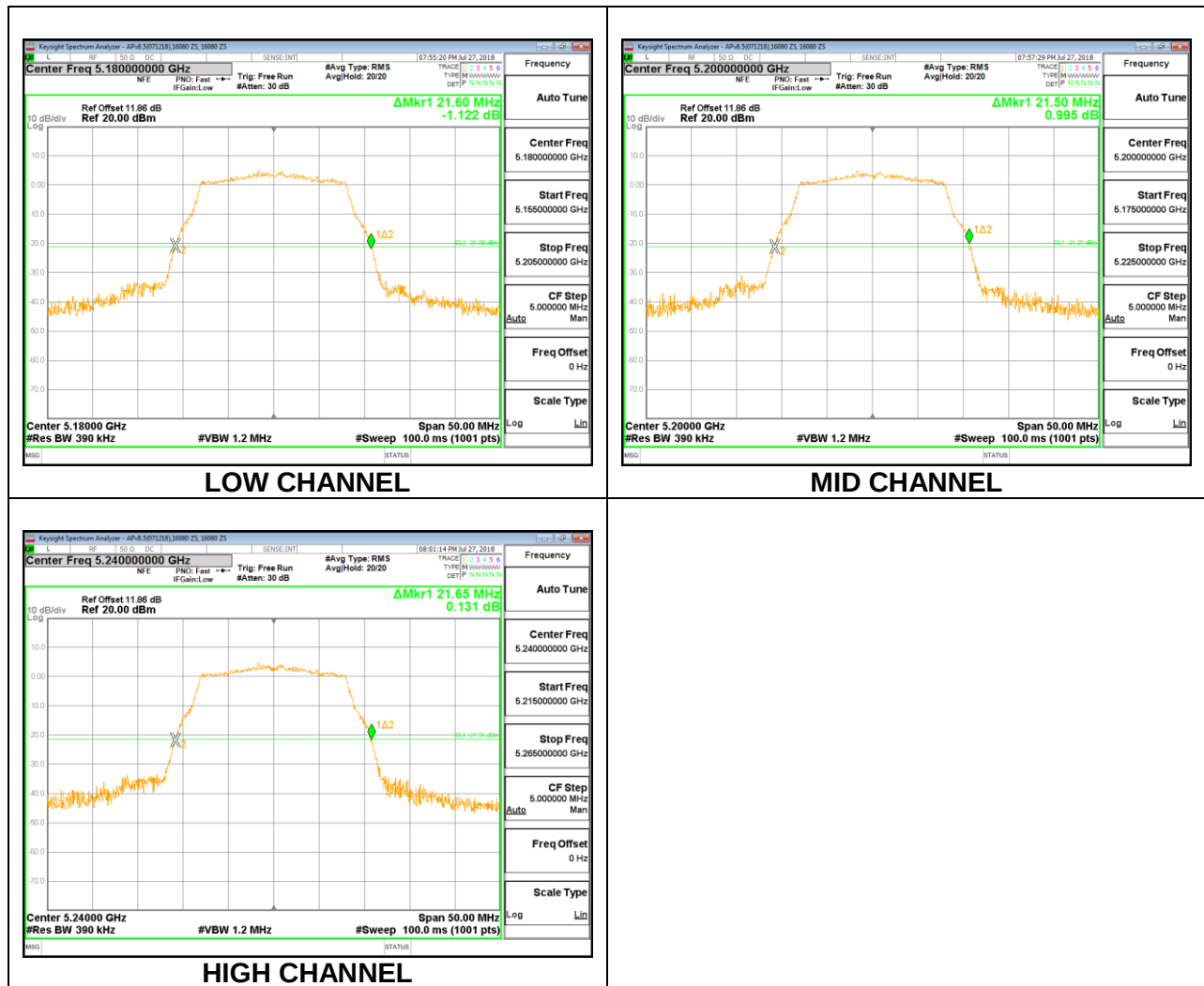
LIMITS

NCC LP0002: 4.7.2.3

RESULTS

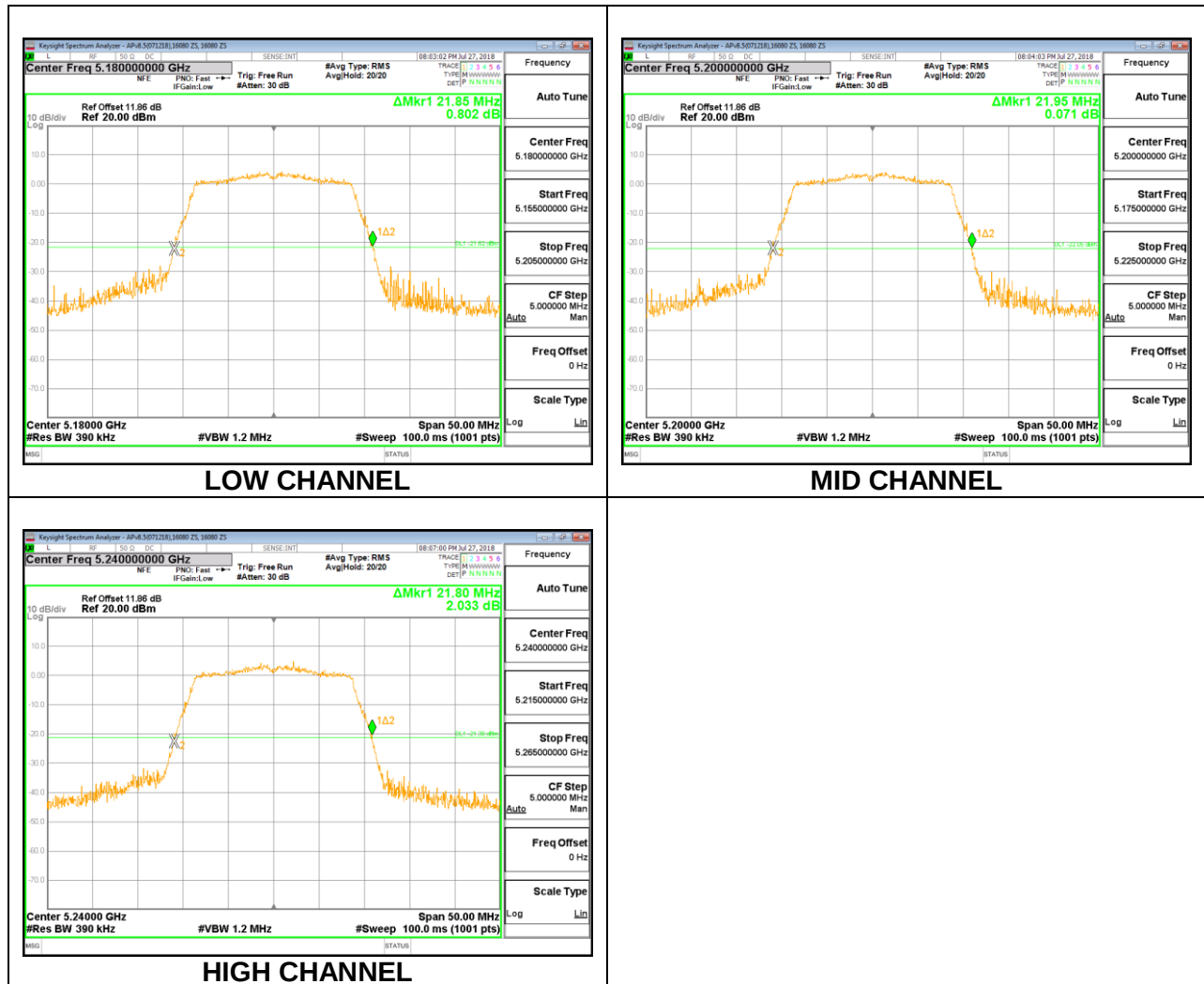
8.2.1. 802.11a MODE IN THE 5.2 GHz BAND

Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Low	5180	21.60
Mid	5200	21.50
High	5240	21.65



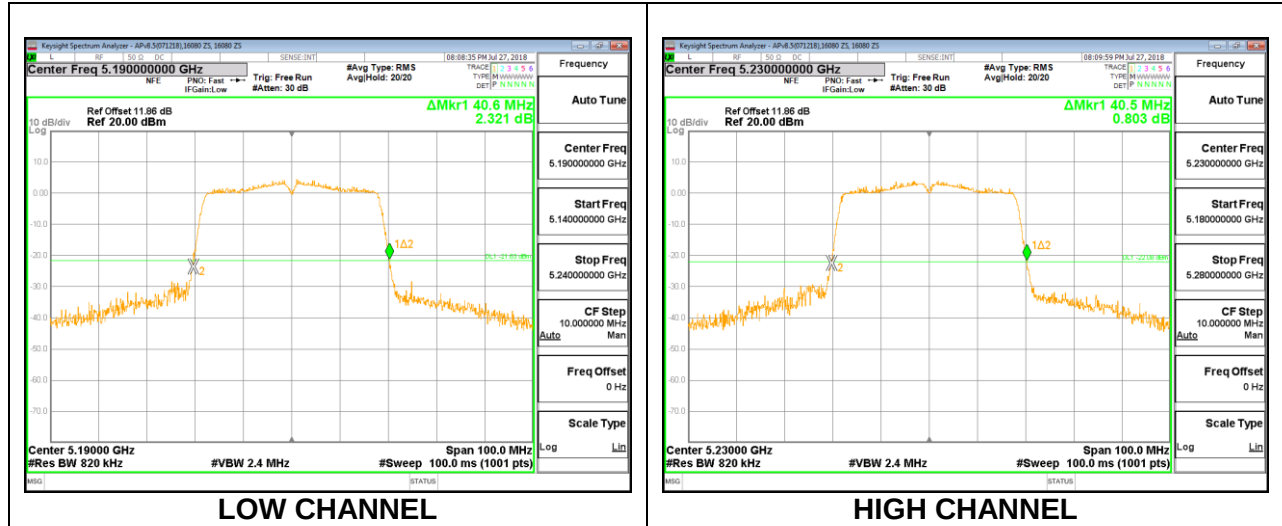
8.2.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	21.85
Mid	5200	21.95
High	5240	21.80



8.2.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND

Channel	Frequency	26dB Bandwidth
	(MHz)	(MHz)
Low	5190	40.60
High	5230	40.50

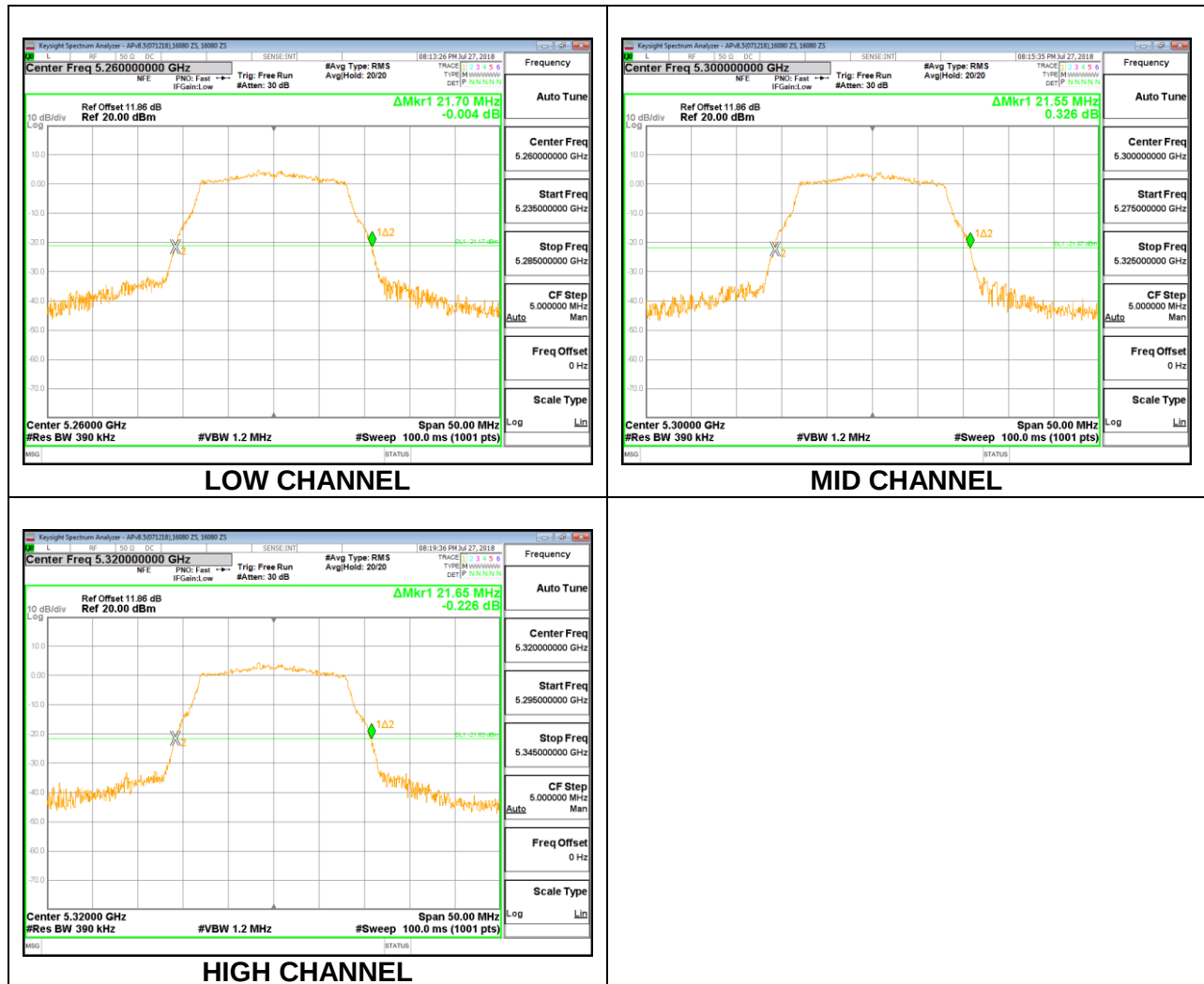


Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Mid	5210	82.60



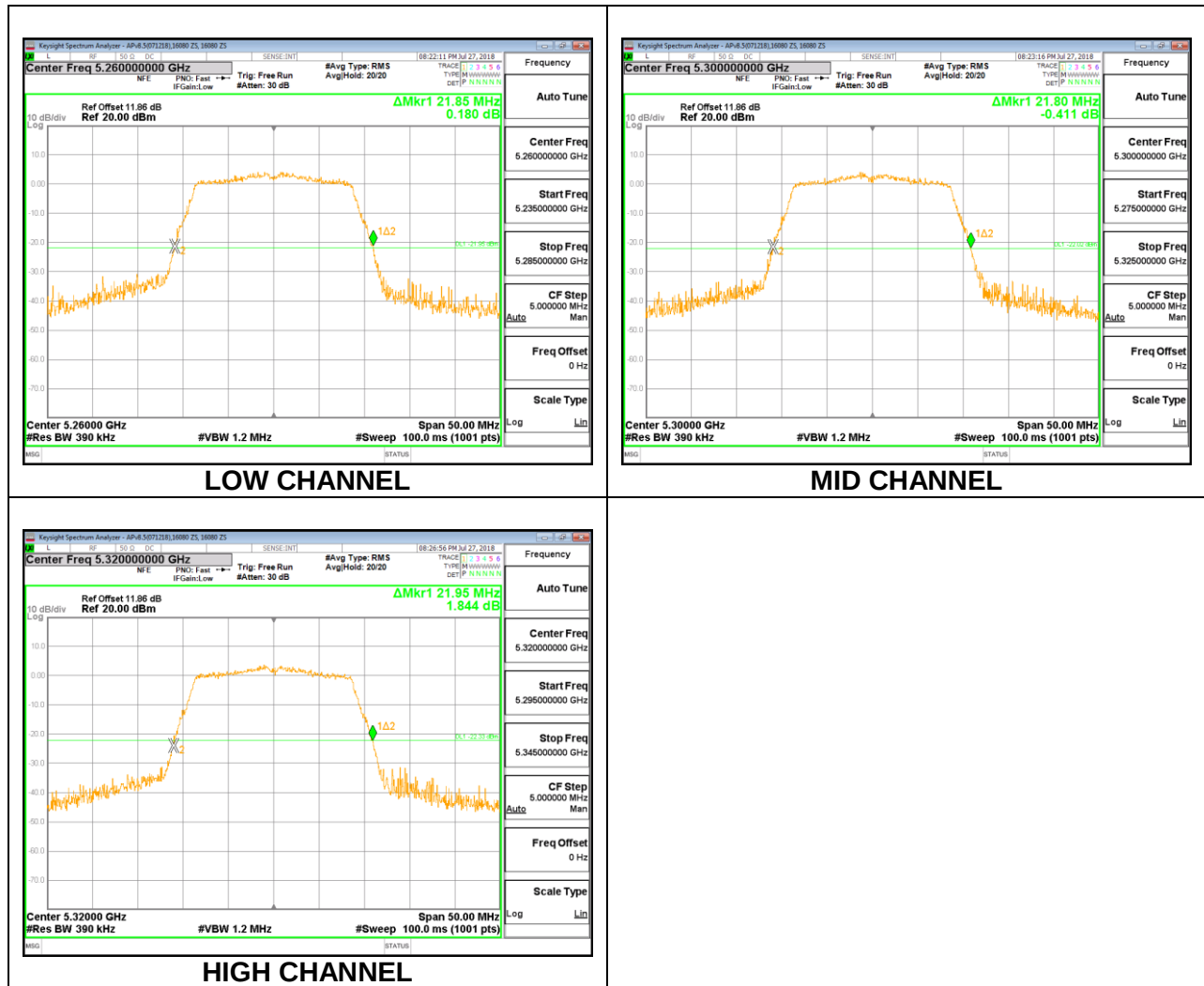
8.2.5. 802.11a MODE IN THE 5.3 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5260	21.70
Mid	5300	21.55
High	5320	21.65



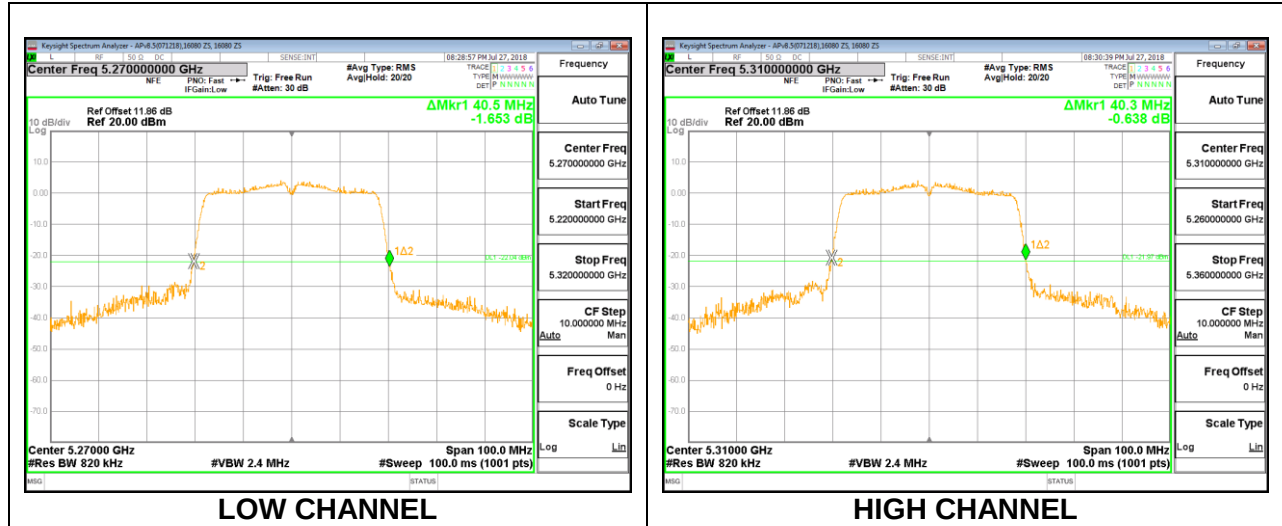
8.2.6. 802.11n HT20 MODE IN THE 5.3 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5260	21.85
Mid	5300	21.80
High	5320	21.95



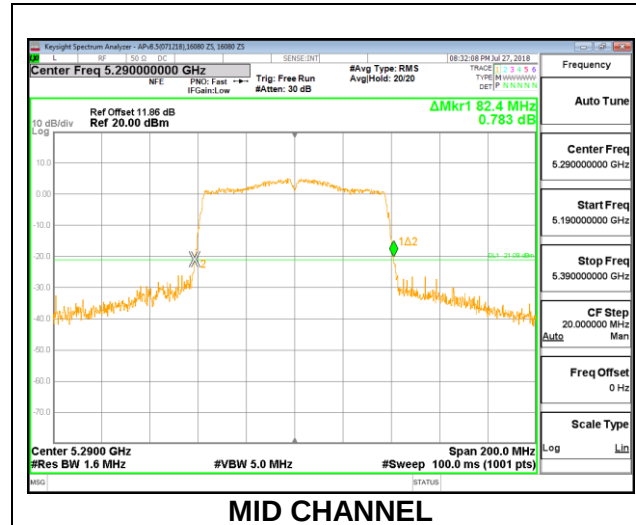
8.2.7. 802.11n HT40 MODE IN THE 5.3 GHz BAND

Channel	Frequency	26dB Bandwidth
	(MHz)	(MHz)
Low	5270	40.50
High	5310	40.30



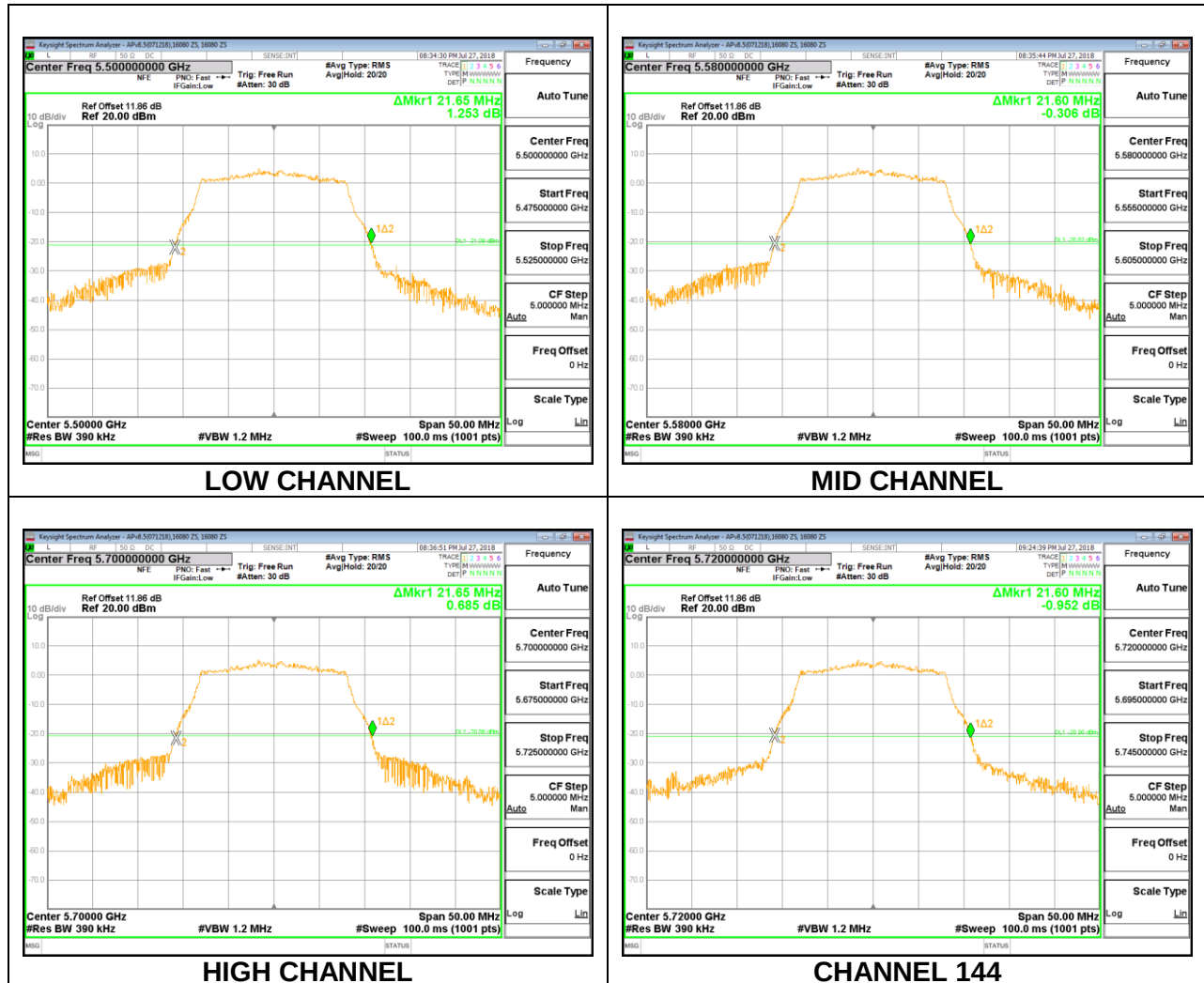
8.2.8. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND

Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Mid	5290	82.40



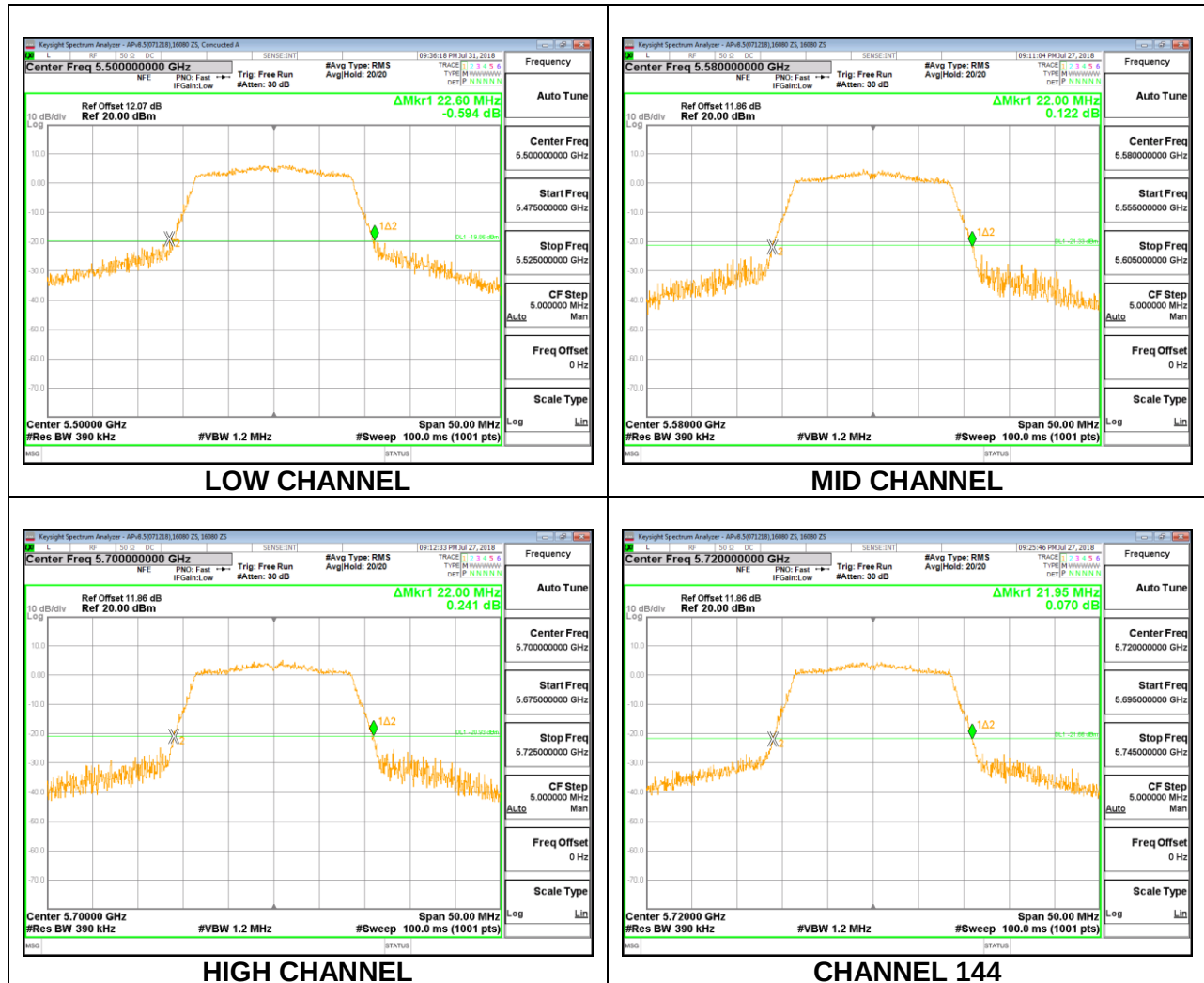
8.2.9. 802.11a MODE IN THE 5.6 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5500	21.65
Mid	5580	21.60
High	5700	21.65
144	5720	21.60



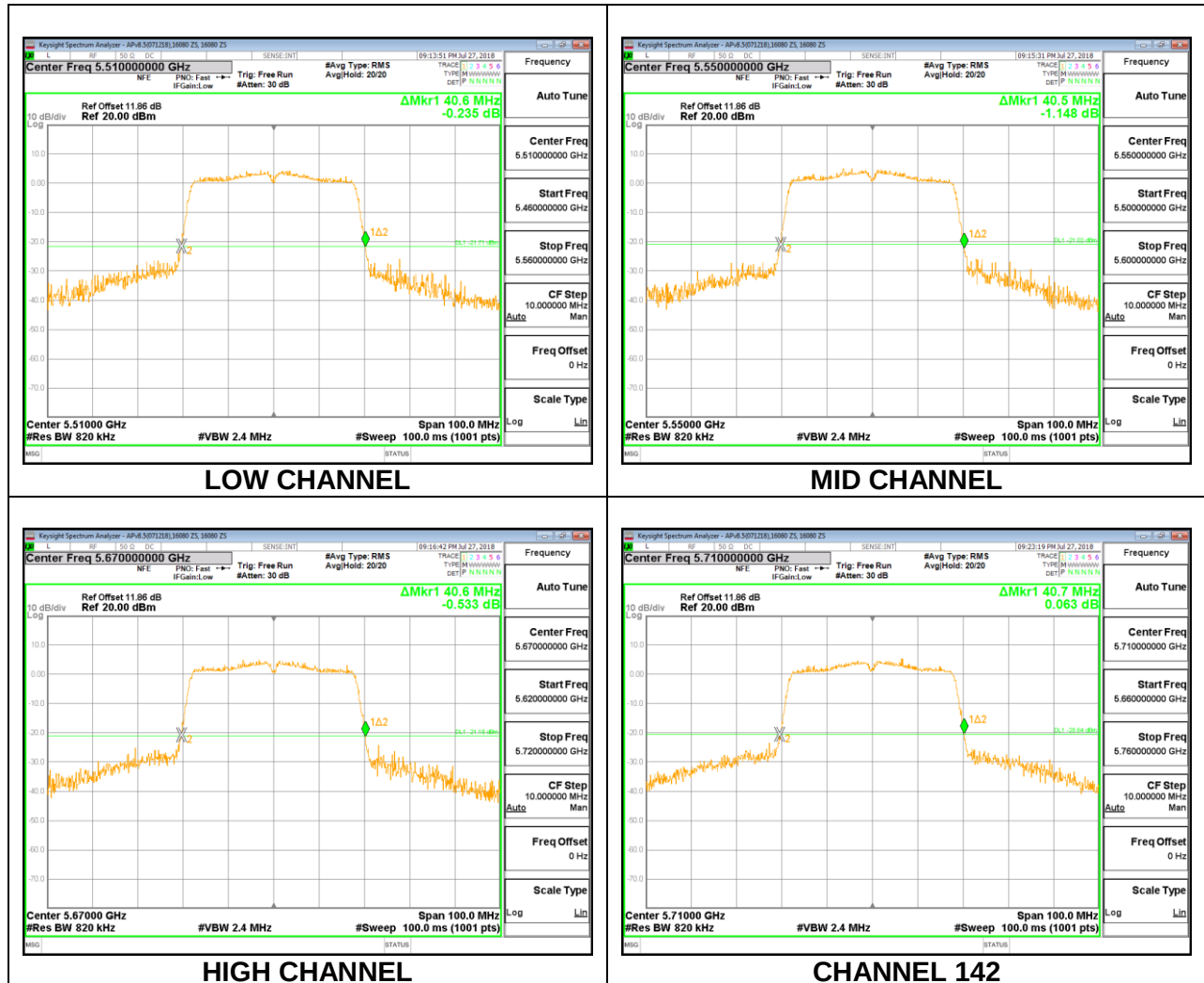
8.2.10. 802.11n HT20 MODE IN THE 5.6 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5500	22.60
Mid	5580	22.00
High	5700	22.00
144	5720	21.95



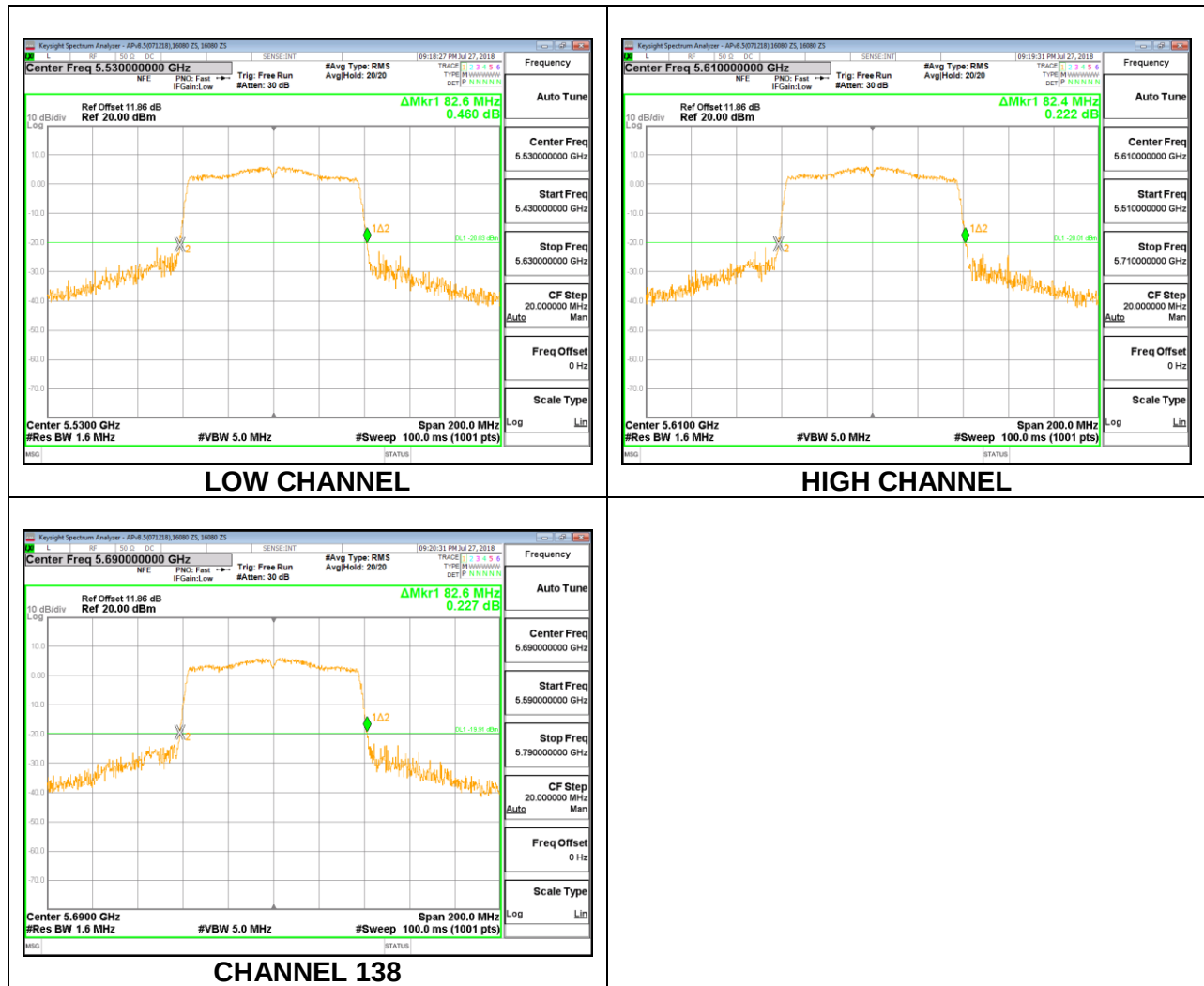
8.2.11. 802.11n HT40 MODE IN THE 5.6 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5510	40.60
Mid	5550	40.50
High	5670	40.60
142	5710	40.70



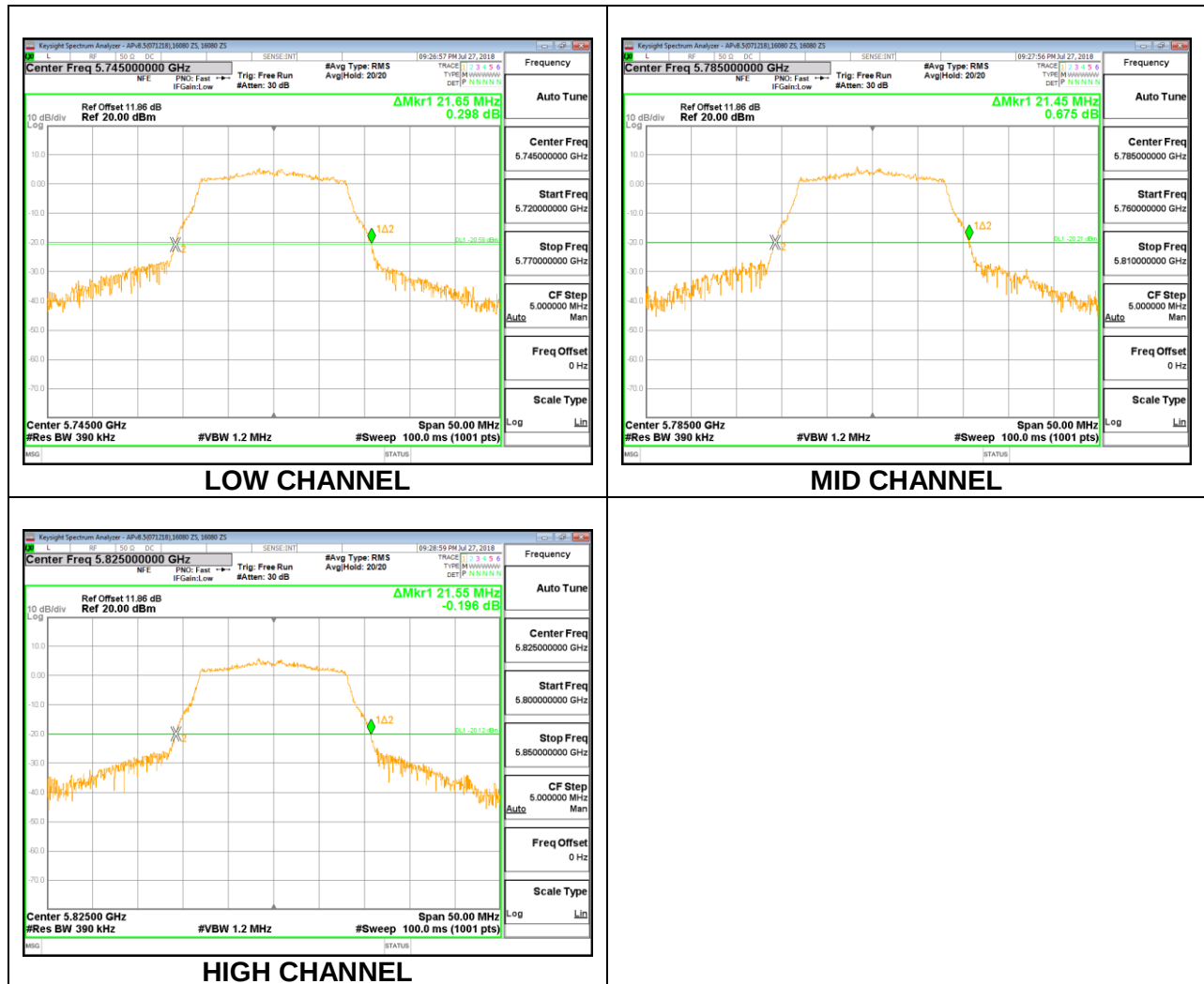
8.2.12. 802.11ac VHT80 MODE IN THE 5.6 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5530	82.60
High	5610	82.40
138	5690	82.60



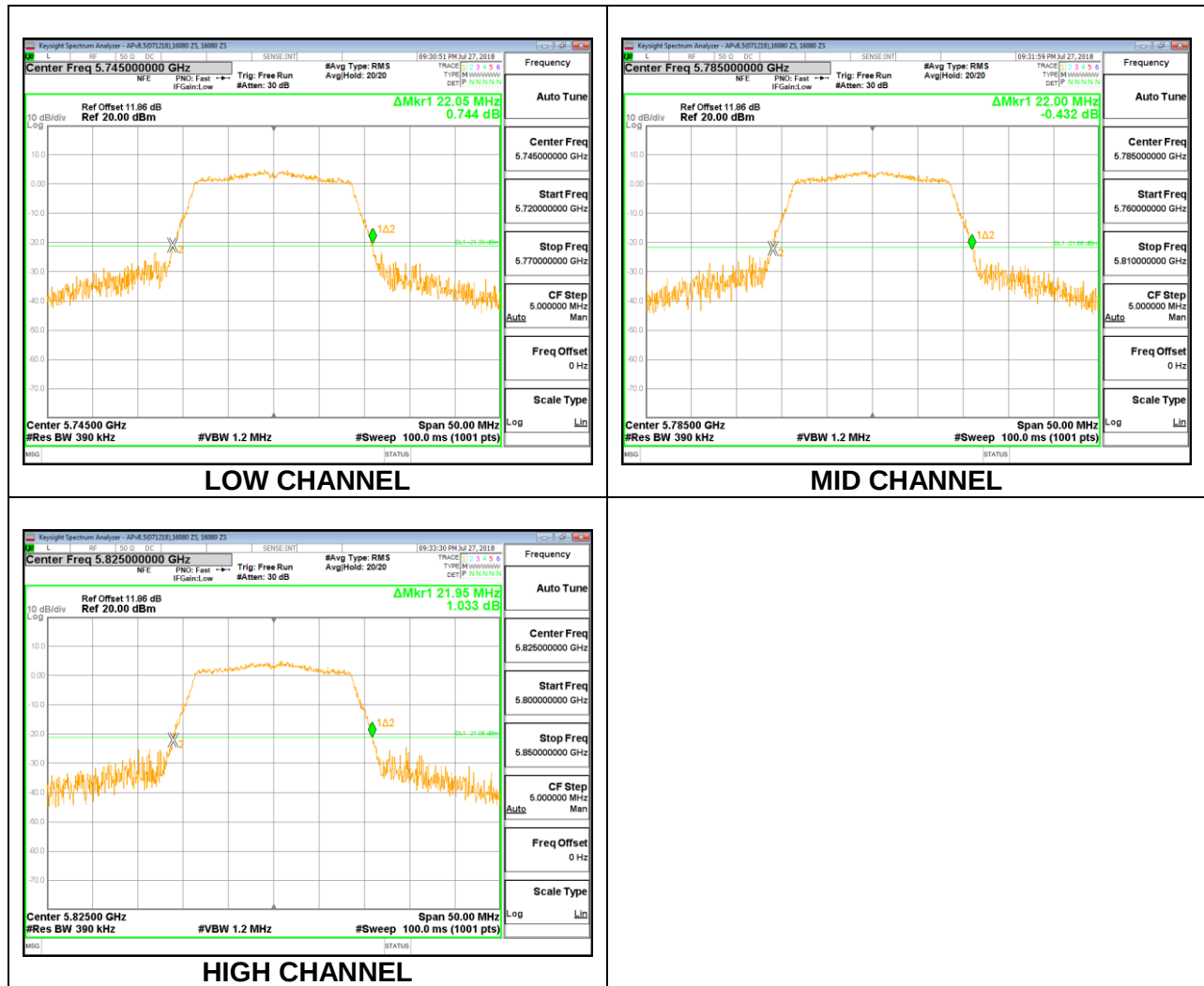
8.2.13. 802.11a MODE IN THE 5.8 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5745	21.65
Mid	5785	21.45
High	5825	21.55



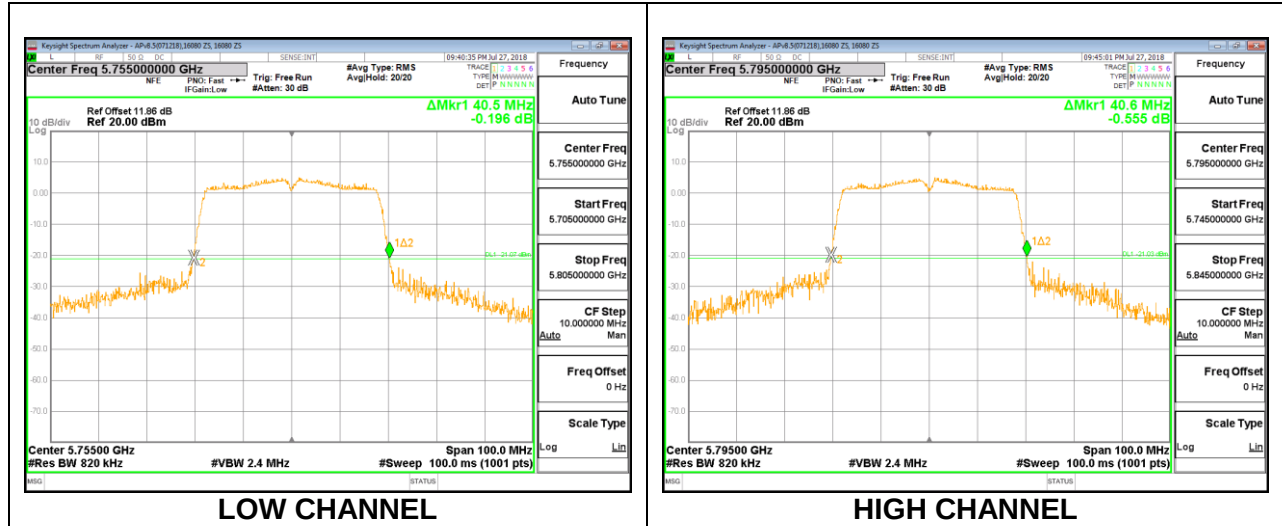
8.2.14. 802.11n HT20 MODE IN THE 5.8 GHz BAND

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5745	22.05
Mid	5785	22.00
High	5825	21.95



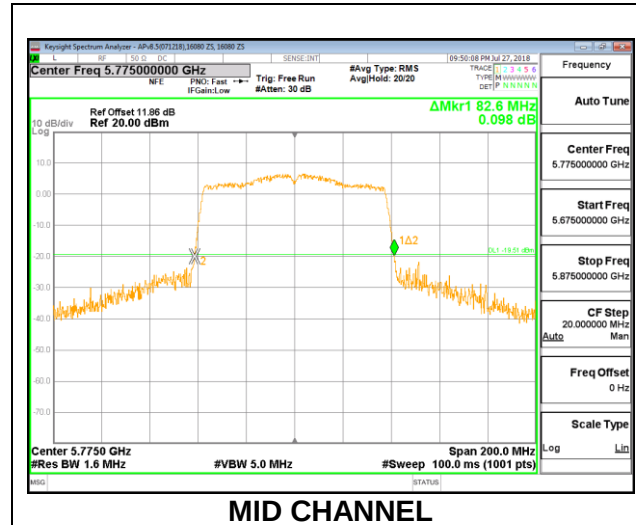
8.2.15. 802.11n HT40 MODE IN THE 5.8 GHz BAND

Channel	Frequency	26dB Bandwidth
	(MHz)	(MHz)
Low	5755	40.50
High	5795	40.60



8.2.16. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND

Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Mid	5775	82.60



8.3. 99% BANDWIDTH

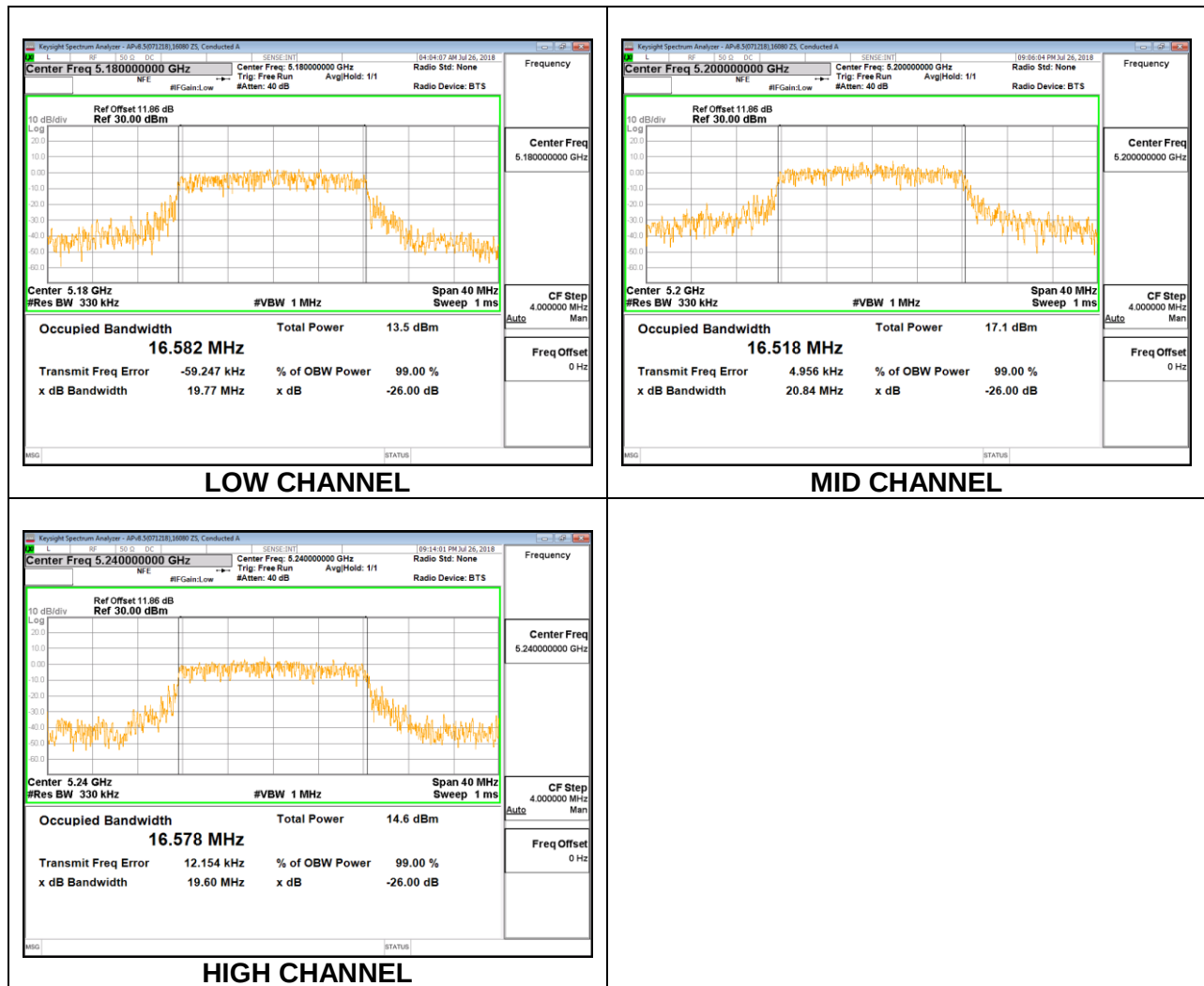
LIMITS

None; for reporting purposes only.

RESULTS

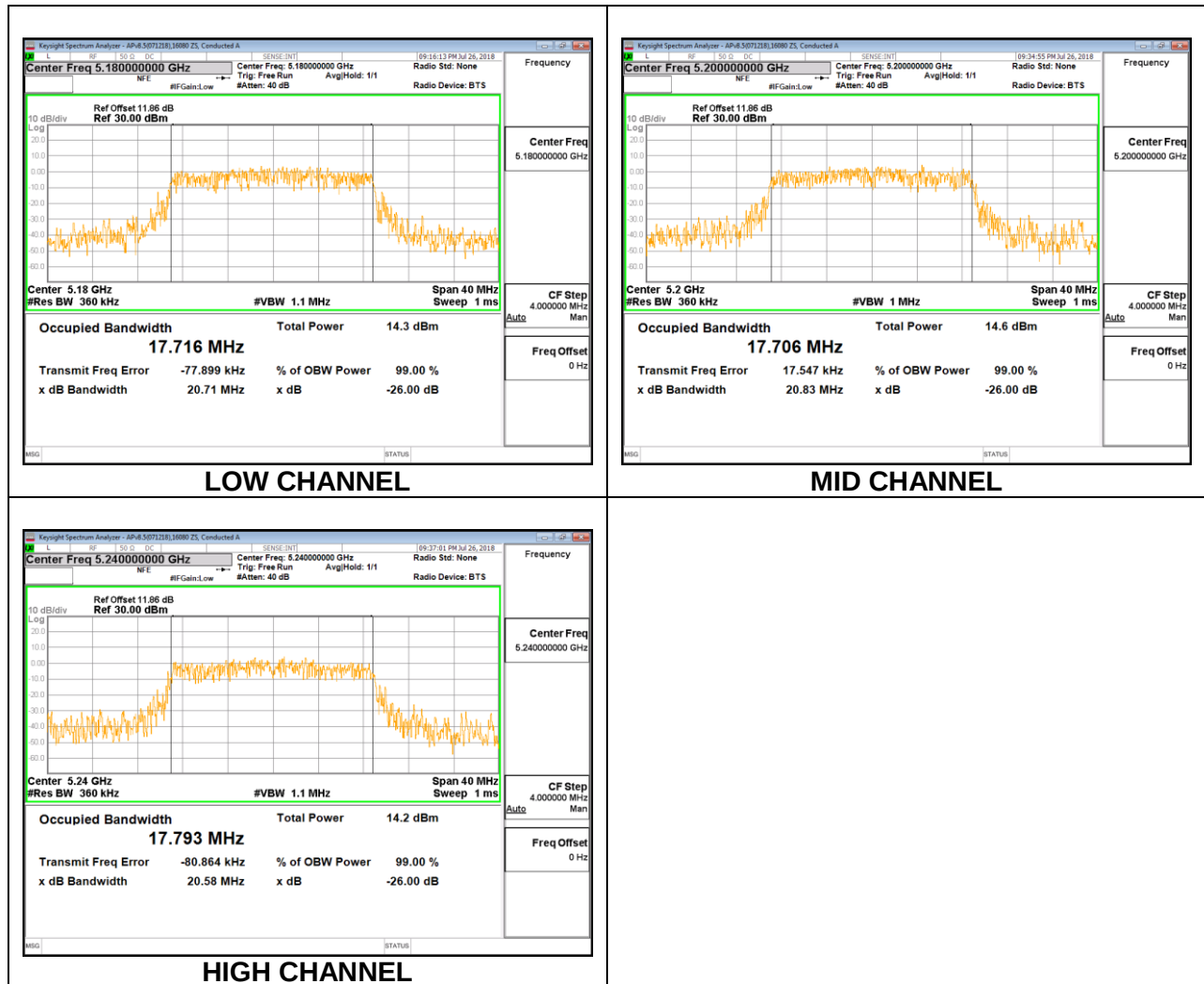
8.3.1. 802.11a MODE IN THE 5.2 GHz BAND

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5180	16.5820
Mid	5200	16.5180
High	5240	16.5780



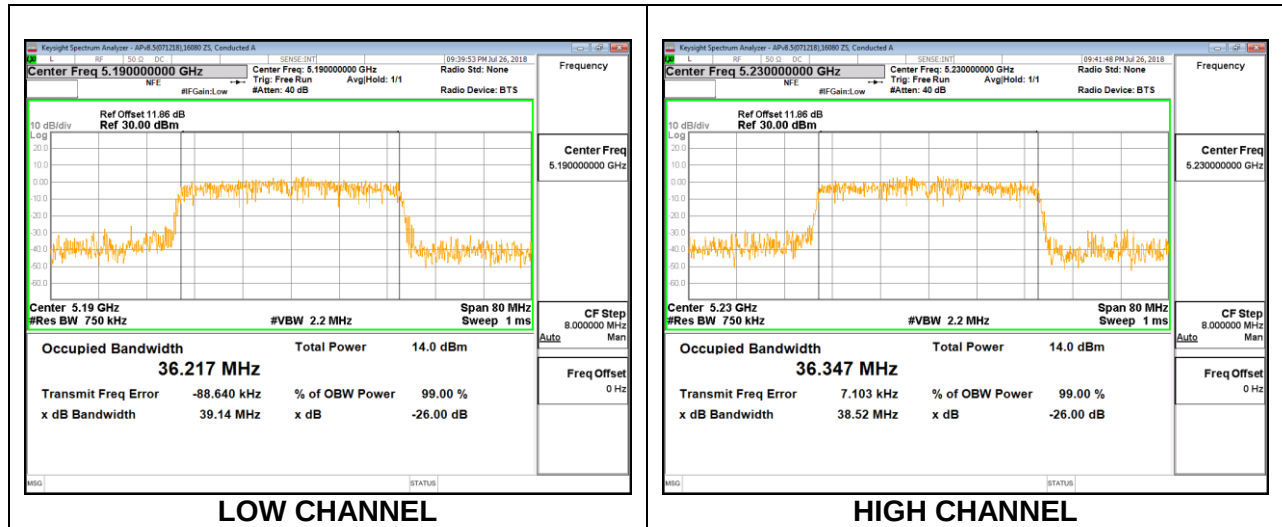
8.3.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5180	17.7160
Mid	5200	17.7060
High	5240	17.7930



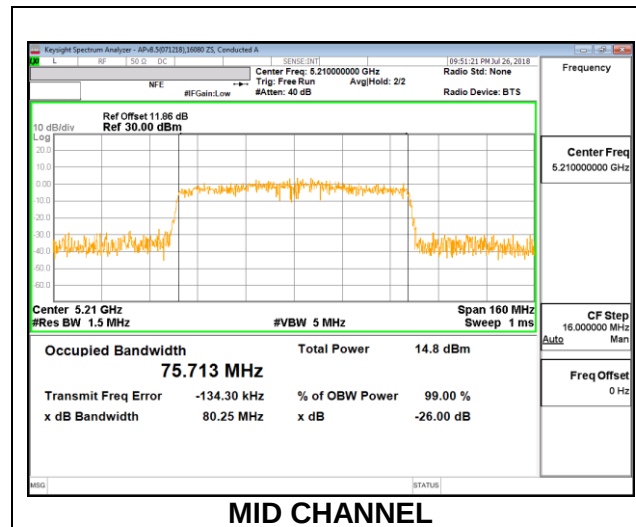
8.3.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND

Channel	Frequency	99% Bandwidth
	(MHz)	(MHz)
Low	5190	36.2170
High	5230	36.3470



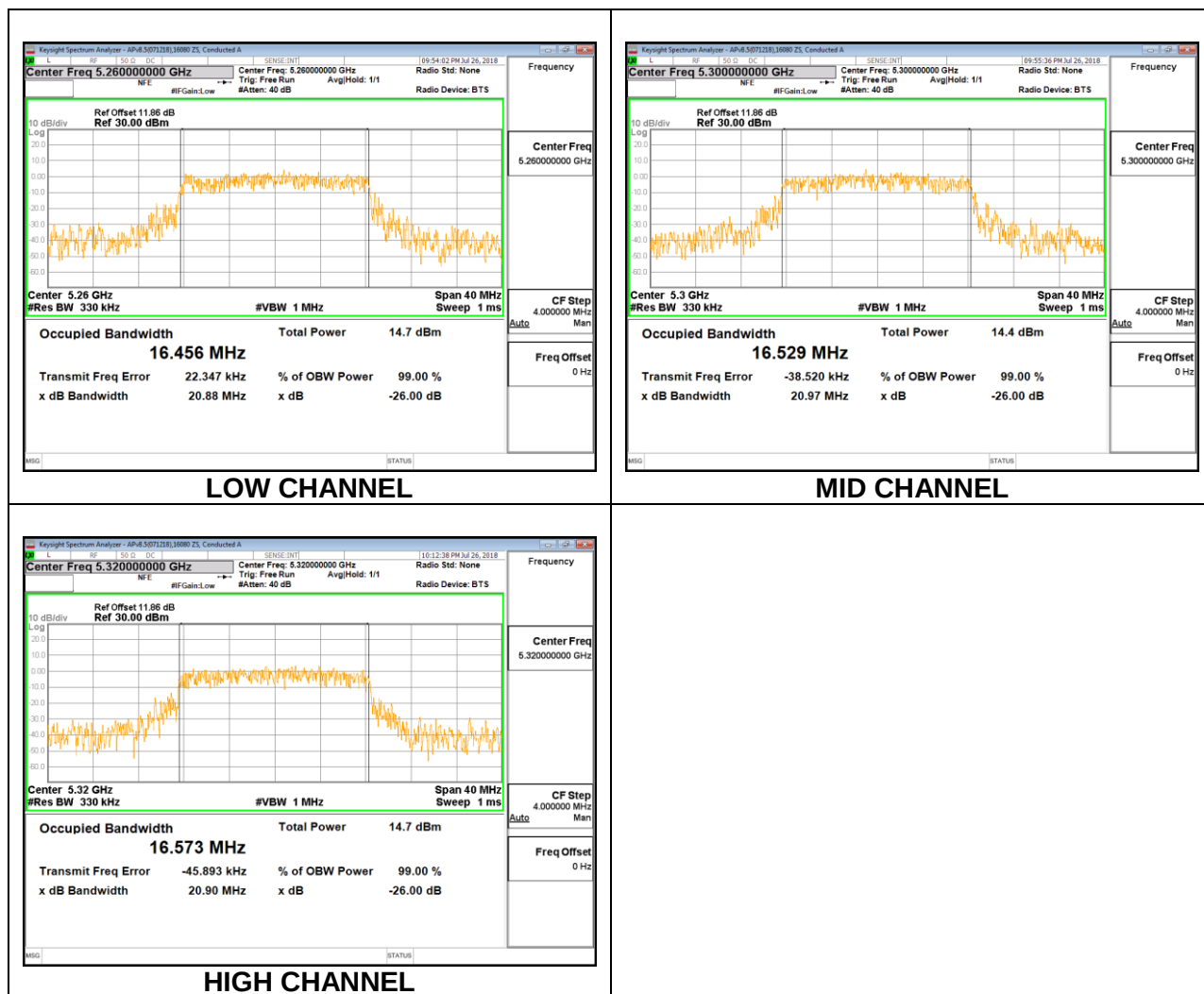
8.3.4. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND

Channel	Frequency	99% Bandwidth
	(MHz)	(MHz)
Mid	5210	75.7130



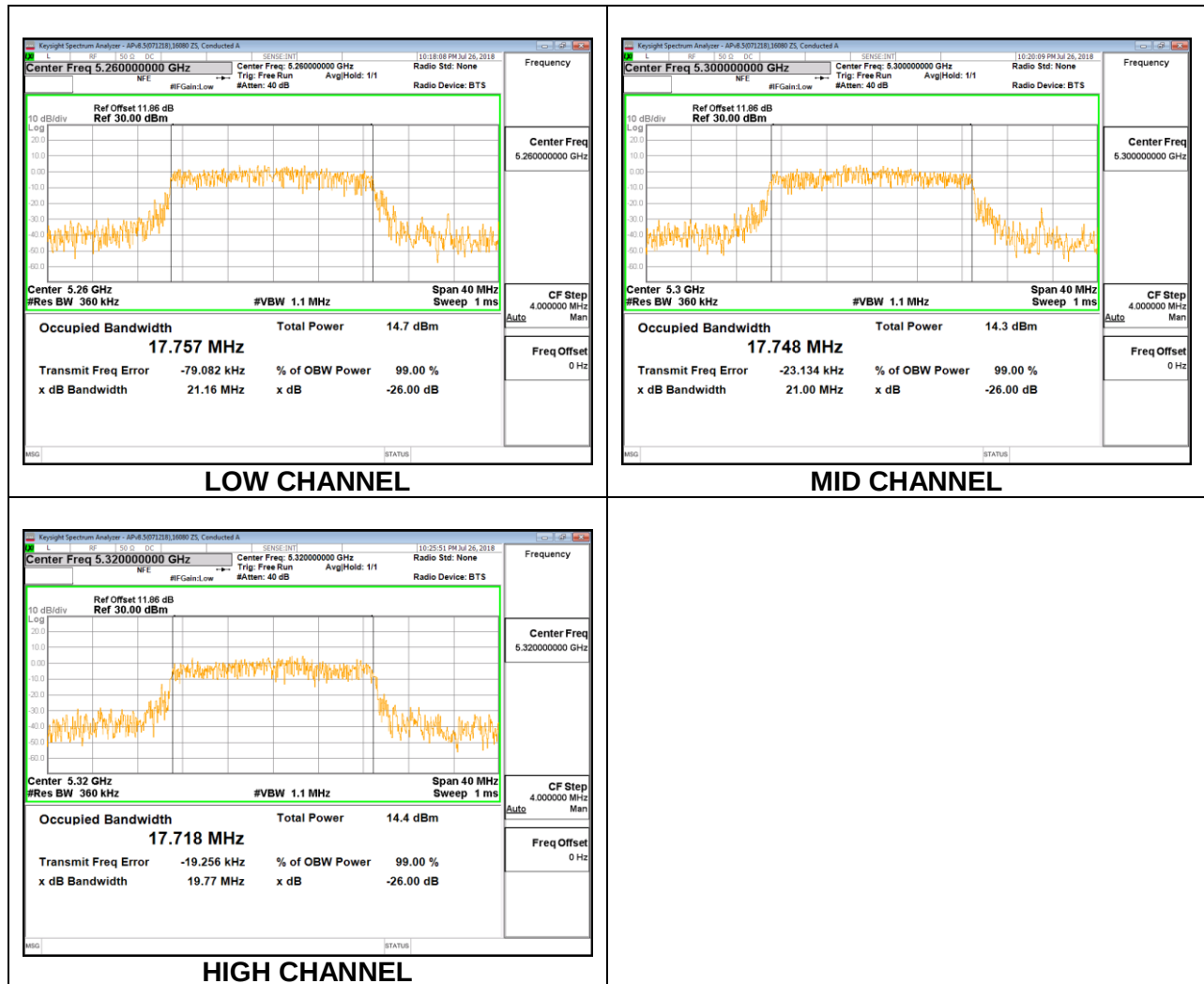
8.3.5. 802.11a MODE IN THE 5.3 GHz BAND

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5260	16.4560
Mid	5300	16.5290
High	5320	16.5730



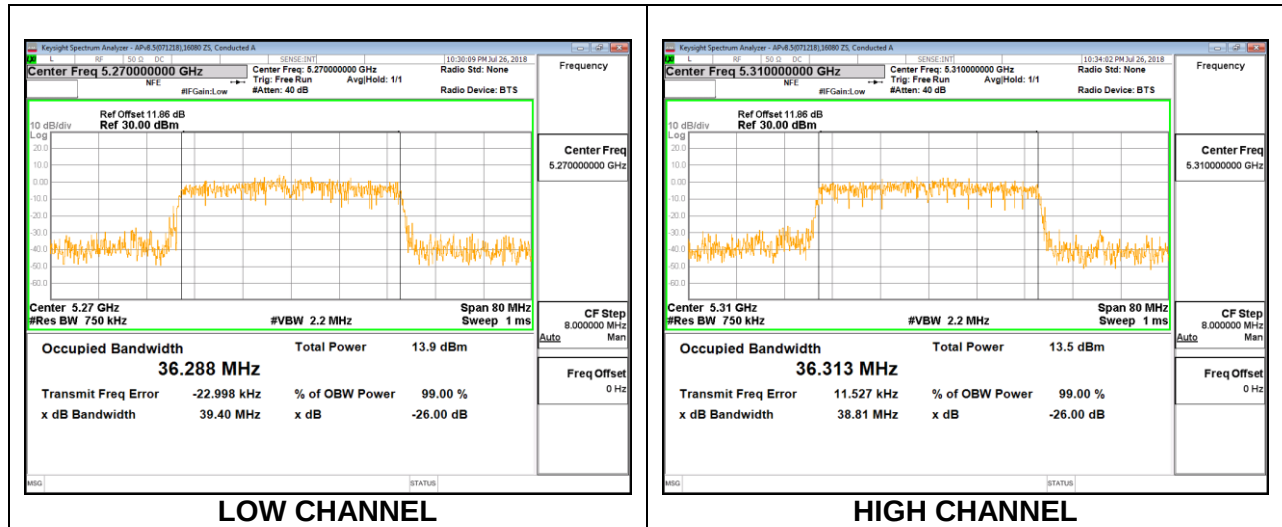
8.3.6. 802.11n HT20 MODE IN THE 5.3 GHz BAND

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5260	17.7570
Mid	5300	17.7480
High	5320	17.7180



8.3.7. 802.11n HT40 MODE IN THE 5.3 GHz BAND

Channel	Frequency	99% Bandwidth
	(MHz)	(MHz)
Low	5270	36.2880
High	5310	36.3130



8.3.8. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND

Channel	Frequency	99% Bandwidth
	(MHz)	(MHz)
Mid	5290	75.6480

