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CERTIFICATION TEST REPORT

Manufacturer: Grayshift LLC
931 Monroe Drive Northeast, Suite A 102-340
Atlanta, Georgia 30308 USA

Applicant: Same As Above

Product Name: GrayKey

Product Description: GrayKey - Digital Forensic Access Unit for Mobile Devices

Model: GK01

FCC ID: 2AV7EGK01

Testing Commenced: 2018-10-10

Testing Ended: 2020-07-08

Summary of Test Results: **In Compliance, with Modifications**

The EUT complies with the EMC requirements when manufactured identically as the unit tested in this report, including any required modifications. Any changes to the design or build of this unit subsequent to this testing may deem it non-compliant.

Standards:

- **FCC Part 15 Subpart C, Section 15.247**
- **FCC15.207 - Conducted Limits**
- **FCC Part 15.31(e)**
- **ANSI C63.10:2013**



Order Nos.: F2P19714A, F2P19714A-C1

Client: Grayshift LLC

Model: GK01

Evaluation Conducted by:

Julius Chiller, EMC/Wireless Engineer

Report Reviewed by:

Ken Littell, Director of EMC & Wireless Operations

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1 ADMINISTRATIVE INFORMATION

1.1 Measurement Location:

F2 Labs in Middlefield, Ohio. Site description and attenuation data are on file with the FCC's Sampling and Measurement Branch at the FCC Laboratory in Columbia, MD.

1.2 Measurement Procedure:

All measurements were performed according to the 2013 version of ANSI C63.10 and recommended FCC procedure of measurement of DTS operating under Section 15.247 and in KDB558074. A list of the measurement equipment can be found in Section 6.

1.3 Uncertainty Budget:

The uncertainty in EMC measurements arises from several factors which affect the results, some associated with environmental conditions in the measurement room, the test equipment being used and the measurement techniques adopted.

The measurement uncertainty budgets detailed below are calculated from the test and calibration data, and are expressed with a 95% confidence factor. Note: Only measurements listed below which relate to tests included in this Test Report are applicable to it.

Measurement Range	Expanded Uncertainty	Combined Uncertainty
Radiated Emissions <1 GHz @ 3m	$\pm 5.07\text{dB}$	± 2.54
Radiated Emissions <1 GHz @ 10m	$\pm 5.09\text{dB}$	± 2.55
Radiated Emissions 1 GHz to 2.7 GHz	$\pm 3.62\text{dB}$	± 1.81
Radiated Emissions 2.7 GHz to 18 GHz	$\pm 3.10\text{dB}$	± 1.55
AC Power Line Conducted Emissions, 150kHz to 30 MHz	$\pm 2.76\text{dB}$	± 1.38

This Uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

1.4 Document History

Document Number	Description	Issue Date	Approved By
F2P19714A-04E	First Issue	2020-07-09	K. Littell



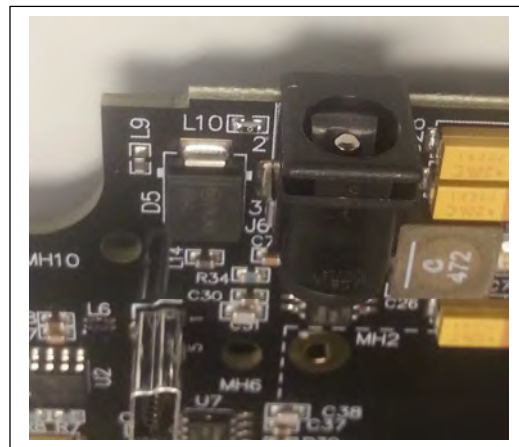
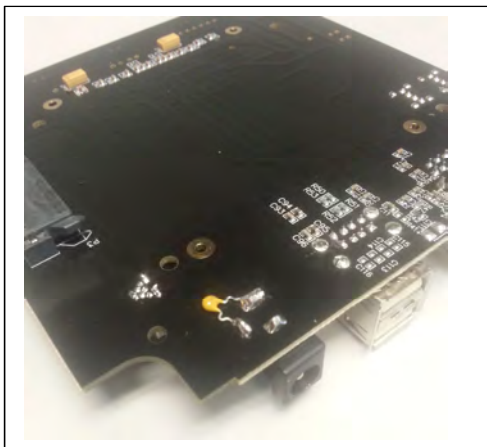
2 SUMMARY OF TEST RESULTS

Test Name	Standard(s)	Results
99% Occupied Bandwidth	CFR 47 Part 15.247(a)(2) / KDB558074	Complies
-6dB Occupied Bandwidth	CFR 47 Part 15.247(a)(2) / KDB558074	Complies
Conducted Output Power	CFR 47 Part 15.247(b)(3) / KDB558074	Complies
Voltage Variations	CFR 47 Part 15.31(e)	Complies
Conducted Spurious Emissions	CFR 47 Part 15.247(d) / Part 15.207 / KDB558074	Complies
Radiated Spurious Emissions	CFR 47 Part 15.247(d) / Part 15.209 / KDB558074	Complies*
Peak Power Spectral Density	CFR 47 Part 15.247(e) / KDB558074	Complies
Conducted Emissions	CFR 47 Part 15.207(a)	Complies

Modifications Made to the Equipment

*The following modifications were made to meet Radiated Spurious Emissions requirements:

- L10 removed from board.
- 1000pF capacitor placed across DC input jack.



**3 TABLE OF MEASURED RESULTS**

Test	Modulation		Low Channel 2412 MHz	Mid Channel 2437 MHz	High Channel 2462 MHz
Peak Power Spectral Density	CCK 802.11b		-6.55dBm	-7.09dBm	-6.64dBm
	OFDM 802.11g		-9.61	-10.10	-9.81
	HT20 (MCS7)		-10.31	-10.96	-10.61
Peak Power Spectral Density Limit			8dBm	8dBm	8dBm
-6dB Occupied Bandwidth	CCK 802.11b		9.679 MHz	9.103 MHz	10.107 MHz
	OFDM 802.11g		16.024	16.305	16.256
	HT20 (MCS7)		16.223	16.881	16.238
99% Occupied Bandwidth	CCK 802.11b		13.906	13.898	13.902
	OFDM 802.11g		16.382	16.394	16.390
	HT20 (MCS7)		17.446	17.454	17.442
Occupied Bandwidth Limit			>500kHz	>500kHz	>500kHz
Conducted Output Power (includes 0.2dB of correction for the coax cable).	CCK 802.11b		82.04mW, 19.14dBm	78.34mW, 18.94dBm	75.85mW, 18.80dBm
	OFDM 802.11g		264.2mW, 24.22dBm	256.4mW, 24.09dBm	243.2mW, 23.86dBm
	HT20 (MCS7)		246.6mW, 23.92dBm	233.3mW, 23.68dBm	217.8mW, 23.38dBm
Limit			1W 30dBm	1W 30dBm	1W 30dBm
E.I.R.P., using 1.97dBi antenna gain.	CCK 802.11b		129.2mW, 21.11dBm	123.3mW, 20.91dBm	119.4mW, 20.77dBm
	OFDM 802.11g		415.9mW, 26.19dBm	403.6mW, 26.06dBm	382.8mW, 25.83dBm
	HT20 (MCS7)		388.2mW, 25.89dBm	367.3mW, 25.65dBm	342.8mW, 25.35dBm
Limit			4W	4W	4W
Voltage Variations (@138VAC/102VAC)	CCK 802.11b	-15%	18.92dBm	18.87dBm	18.69dBm
		+15%	19.02dBm	18.96dBm	18.79dBm
	OFDM 802.11g	-15%	24.02dBm	24.0dBm	23.81dBm
		+15%	244.08dBm	24.29dBm	23.94dBm
	HT20 (MCS7)	-15%	23.65dBm	23.46dBm	23.51dBm
		+15%	23.82dBm	23.81dBm	23.52dBm
Limit			1W 30dBm	1W 30dBm	1W 30dBm

**To meet the requirements of 15.31, voltage was varied by $\pm 15\%$ of the nominal voltage. All tests were then performed at the highest output power voltage setting.*



4 ENGINEERING STATEMENT

This report has been prepared on behalf of Grayshift LLC to provide documentation for the testing described herein. This equipment has been tested and found to comply with Part 15.247 of the FCC Rules using ANSI C63.10:2013 and KDB558074 standards. The test results found in this test report relate only to the items tested.



5 EUT INFORMATION AND DATA

5.1 Equipment Under Test:

Product: GrayKey - Digital Forensic Access Unit for Mobile Devices

Model: GK01

Serial No.: S01

Firmware: Cypress/CYW4343W

Hardware: Rev.B

FCC ID: **2AV7EGK01**

5.2 Trade Name:

Grayshift LLC

5.3 Power Supply:

120VAC supplied adapters: MeanWell GST36U12-P15; CUI Inc. SMI3C-12.

5.4 Applicable Rules:

CFR 47, Part 15.247, subpart C

5.5 Equipment Category:

Radio Transmitter-DTS

5.6 Antenna:

Integral, 1.97dBi Gain

5.7 Accessories:

N/A

5.8 Test Item Condition:

The equipment to be tested was received in good condition.

5.9 Testing Algorithm:

EUT was operated on low, mid and high channels in the 2.4 GHz band. RF power output was set to provide the maximum power while maintaining full compliance to all parameter requirements. Worst case modulation settings were used with CCK 802.11b, OFDM 802.11g and HT20 (MCS7) modulation schemes. The WL Command Scripts were embedded in the Operating System to allow for test mode. The power setting was set to the 17 dBm setting, OS Ver. 1.33.11.

**6 LIST OF MEASUREMENT INSTRUMENTATION**

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shielded Chamber 2014	CL166-E	AlbatrossProjects	B83117-DF435-T261	US140023	2021-01-03
Temp/Hum. Recorder	CL232	Extech	445814	01	2021-04-23
Temp/Hum. Recorder	CL234	Extech	445814	03	2021-04-23
Temp/Hum. Recorder	CL261	Extech	445814	04	2021-02-12
Spectrum Analyzer	CL147	Agilent	E7402A	MY45101241	2021-01-06
Receiver	CL151	Rohde & Schwarz	ESU40	100319	2020-10-21
Receiver	CL204	Rohde & Schwarz	ESR7	101714	2020-10-16
Horn Antenna	CL098	Emco	3115	9809-5580	2021-01-31
Low Loss Cable Set	--	Pasternack	PE3C0666-252 / PE3C066-50CM	None Spec.	2020-07-16
Antenna, 18" Active Loop	CL194	AH Systems	SAS-562B	281	2022-02-21
Software:	Tile Version 3.4.B		Software Verified: 2018-10-10		
Software:	EMC 32, Version 8.53.0		Software Verified: 2018-10-10, 2020-04-29		
Antenna, JB3 Combination	CL175	Sunol Sciences	JB3	A030315	2020-10-14
Pre-Amplifier	CL153	Agilent	83006-69007	MY39500791	2020-08-05
Pre-Amplifier	0197	Hewlett Packard	8447D	1726A01006	2021-02-17
Horn Antenna	CL114	AH Systems	SAS-572	237	2021-02-04
Spectrum Analyzer	0204	Hewlett Packard	HP8591A	3149A02546	2020-07-29
Software:	EMC Analyzer 85712D Rev. A.00.01			Date Verified:	2020-06-24
Transient Limiter	0202	Hewlett Packard	11947A	3107A00729	2020-07-29
LISN	CL181	Com-Power	LI-125A	191226	2020-09-06
LISN	CL182	Com-Power	LI-125A	191225	2020-09-06



7 OCCUPIED BANDWIDTH

7.1 Requirements:

The 6dB bandwidth shall be greater than 500 kHz.

Bandwidth measurements were made at the low, mid and high frequencies with the resolution bandwidth set at 100kHz (video bandwidth set at 300 kHz) while the span was set at 3 MHz. The bandwidth was measured using the analyzer's marker function.

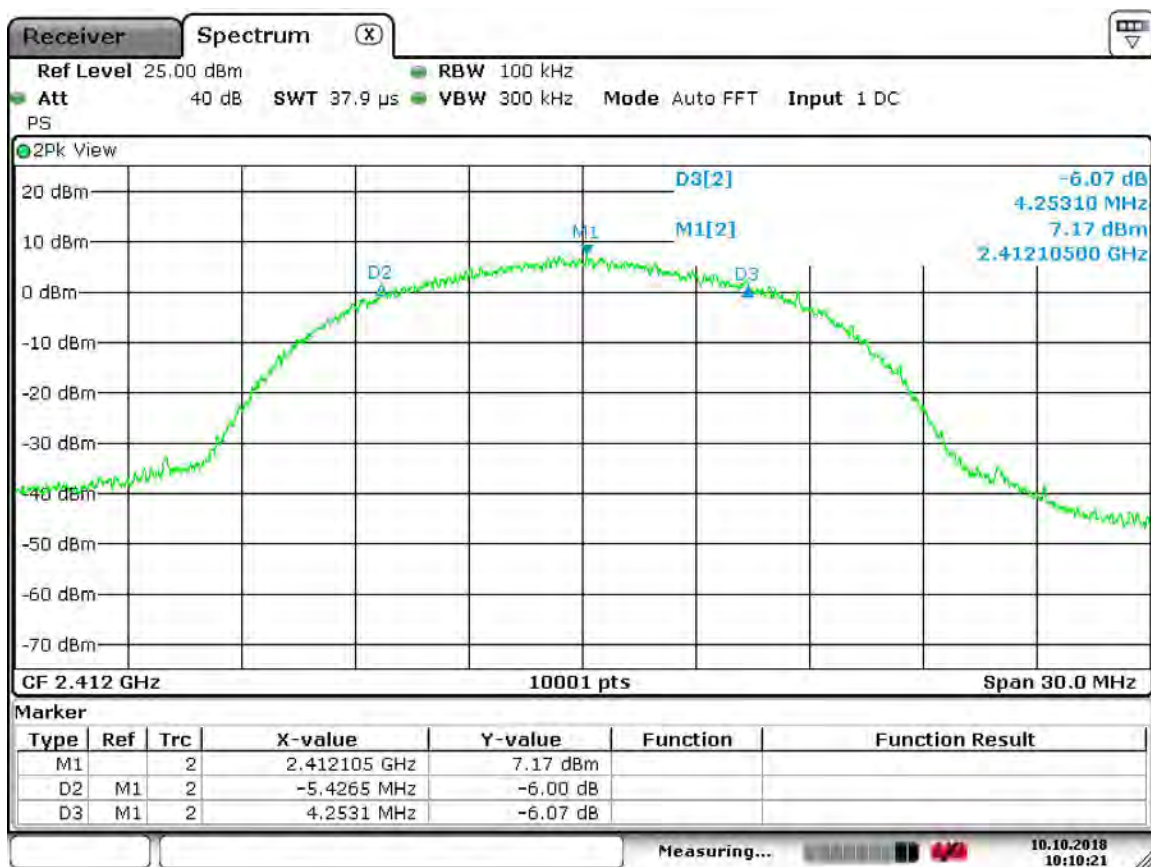


7.2 Occupied Bandwidth Test Data

Test Date:	2018-10-10*	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(a)(2); KDB558074	Air Temperature:	20.1°C
		Relative Humidity:	46%

*2020-04-29: The EUT was scanned to confirm the data from the previous testing had not changed.

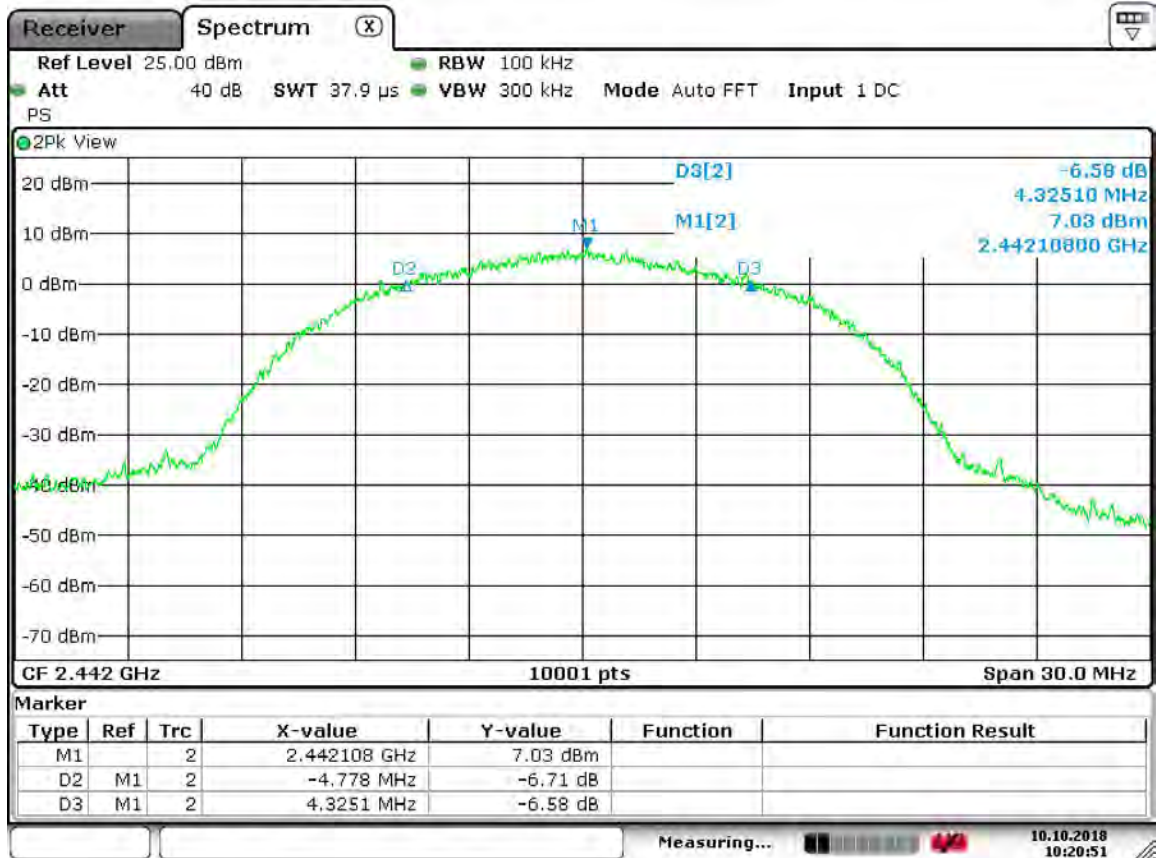
6dB: CCK 802.11b, Low Channel



Date: 10.OCT.2018 10:10:21



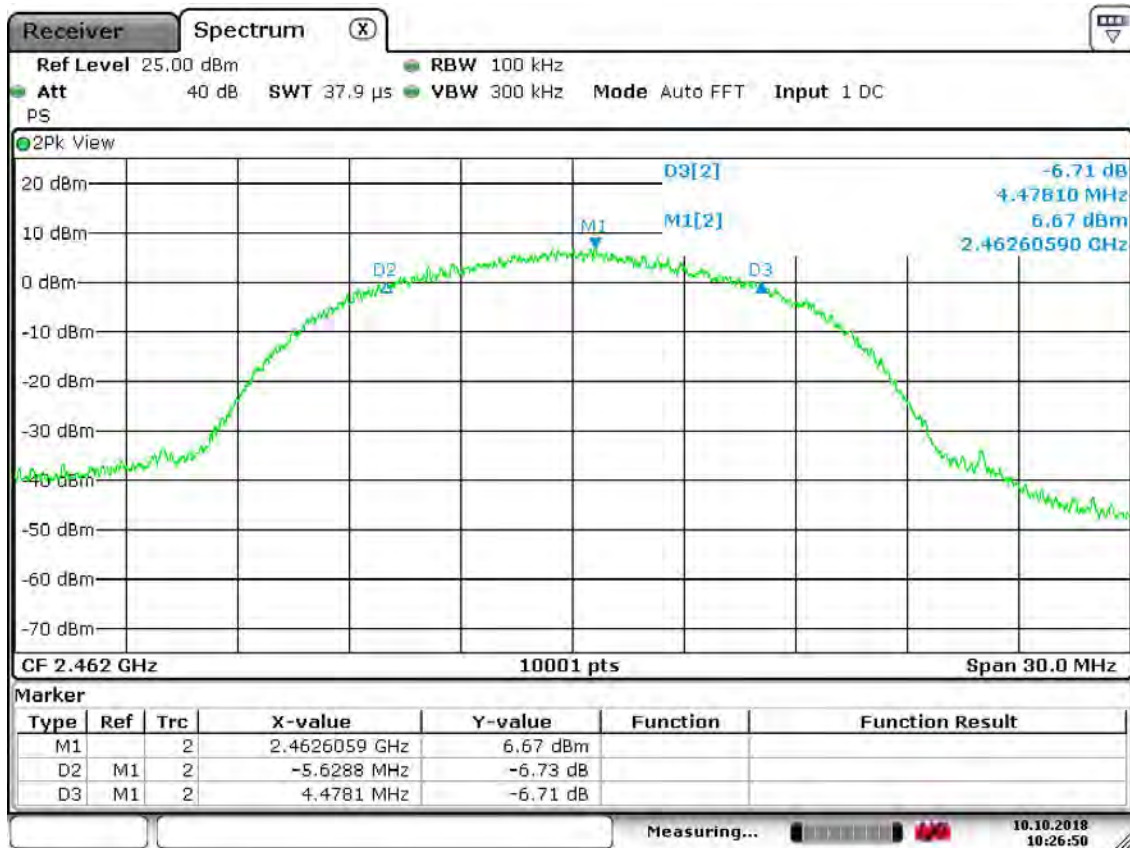
6dB: CCK 802.11b, Mid Channel



Date: 10.OCT.2018 10:20:51



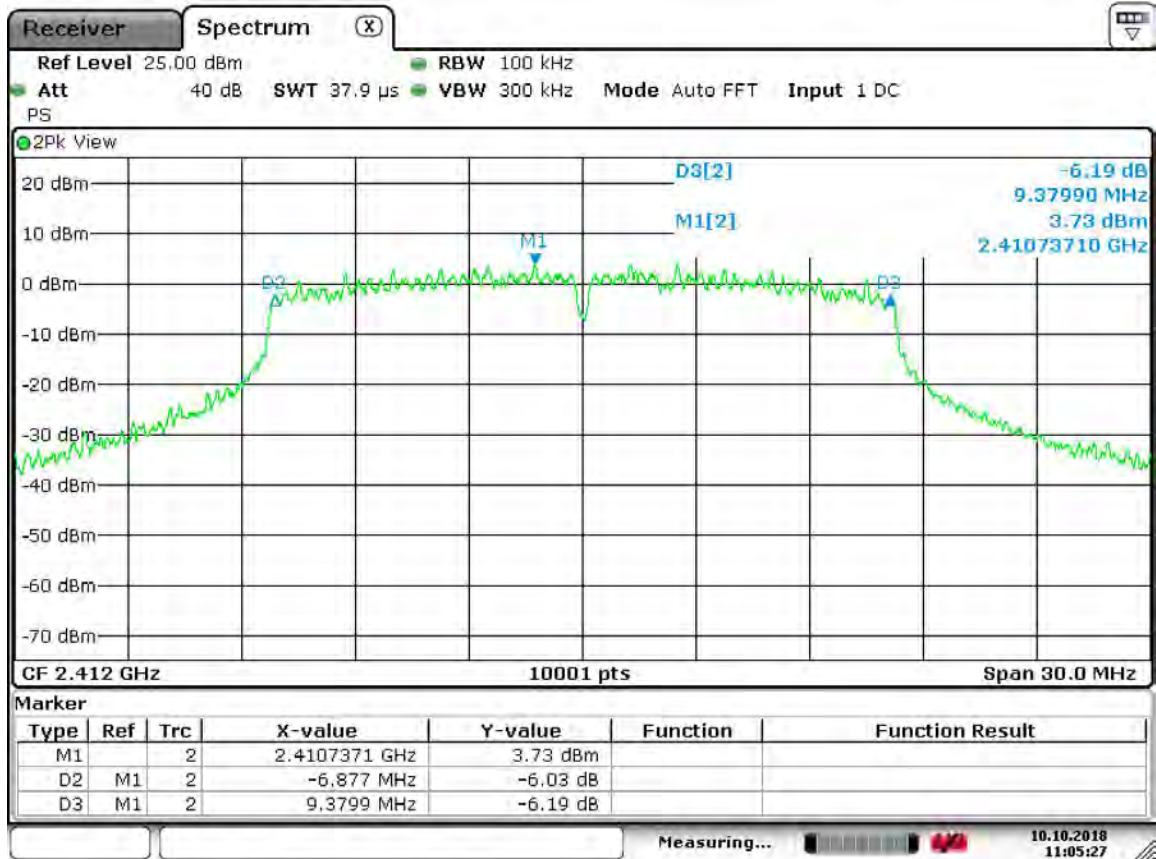
6dB: CCK 802.11b, High Channel



Date: 10.OCT.2018 10:26:51



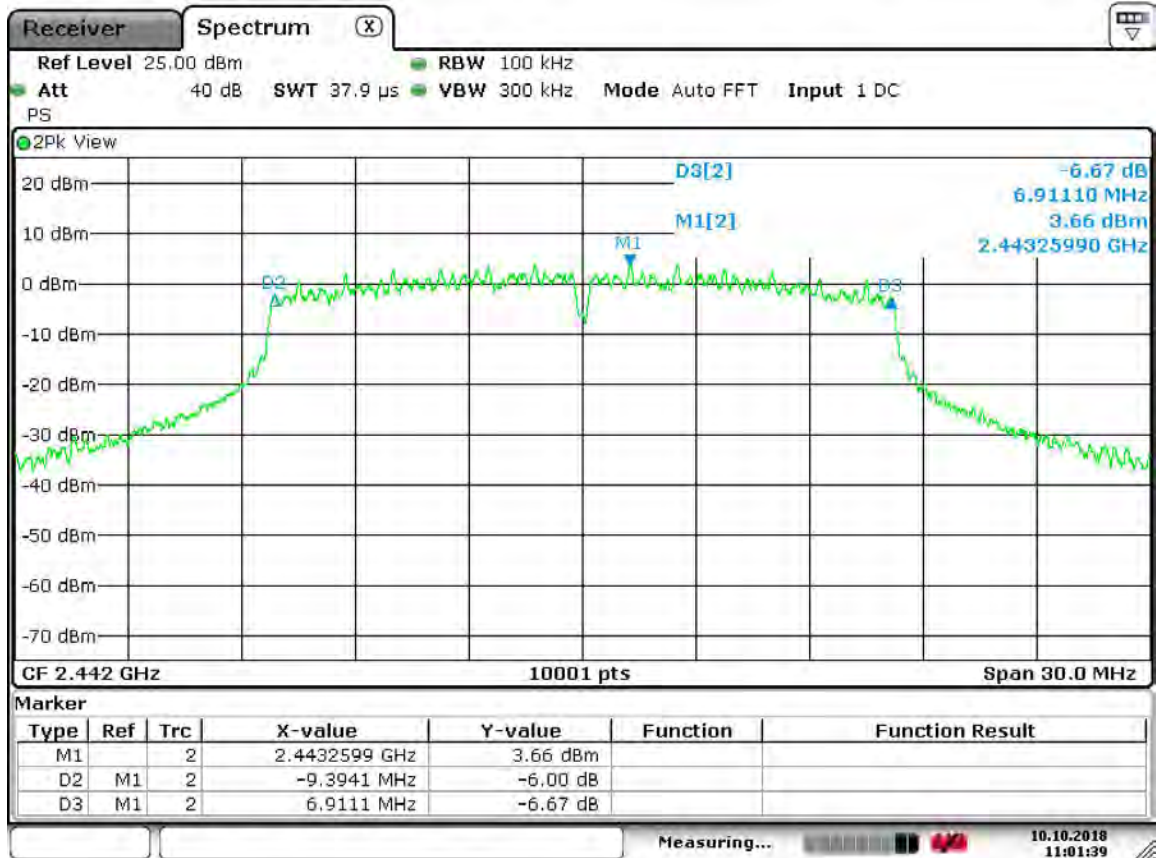
6dB: OFDM 802.11g, Low Channel



Date: 10.OCT.2018 11:05:27



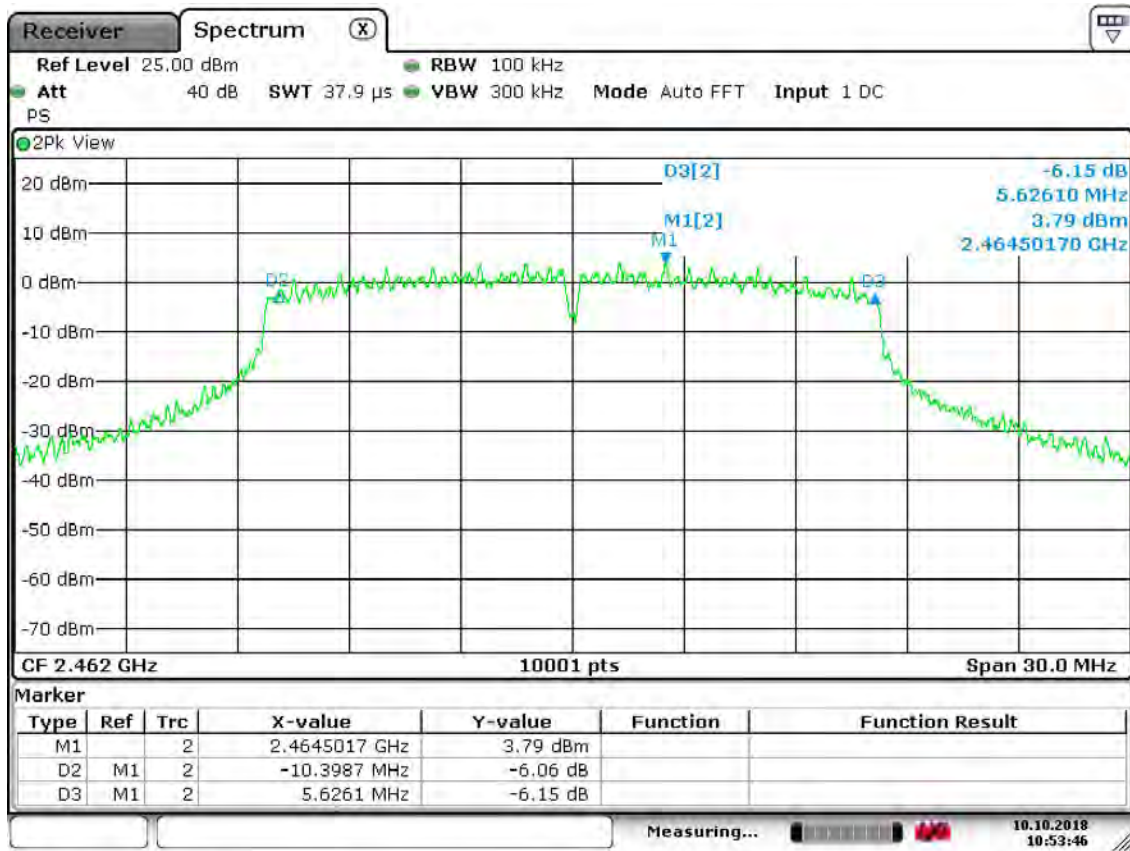
6dB: OFDM 802.11g, Mid Channel



Date: 10.OCT.2018 11:01:39



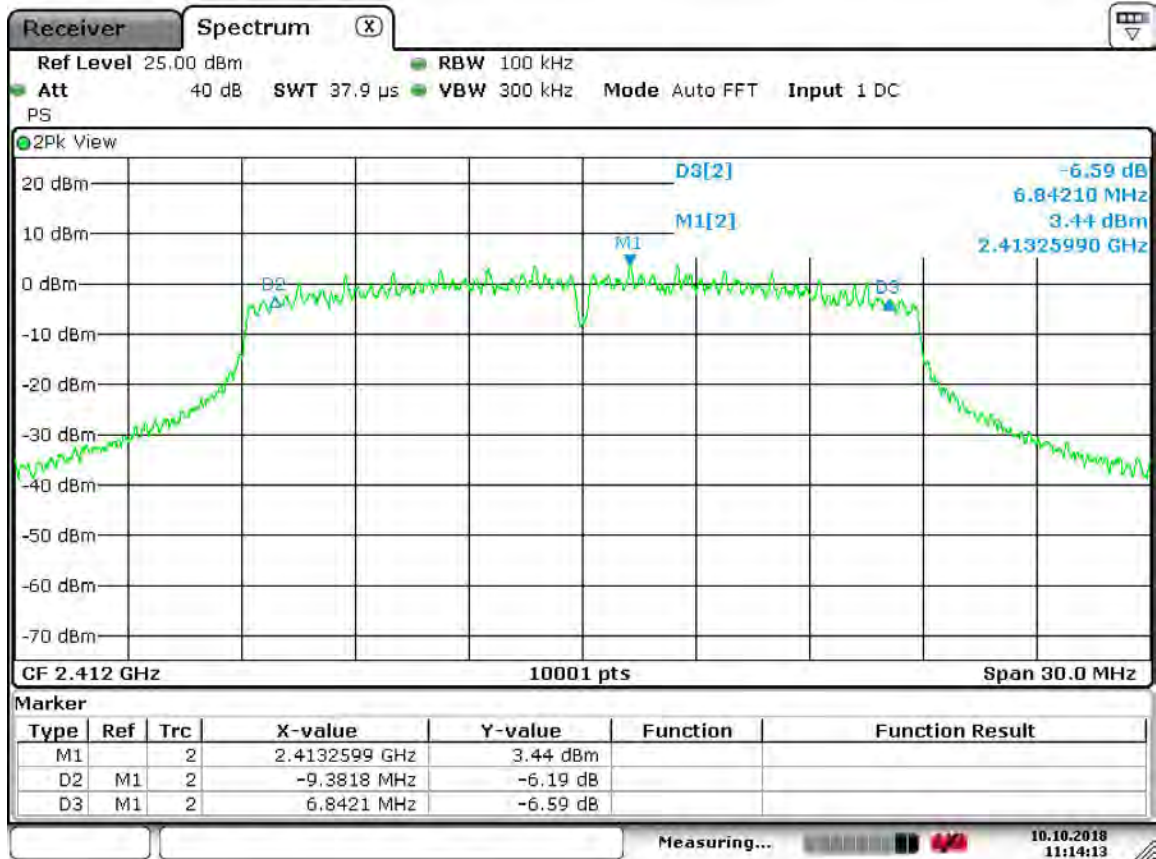
6dB: OFDM 802.11g, High Channel



Date: 10.OCT.2018 10:53:46



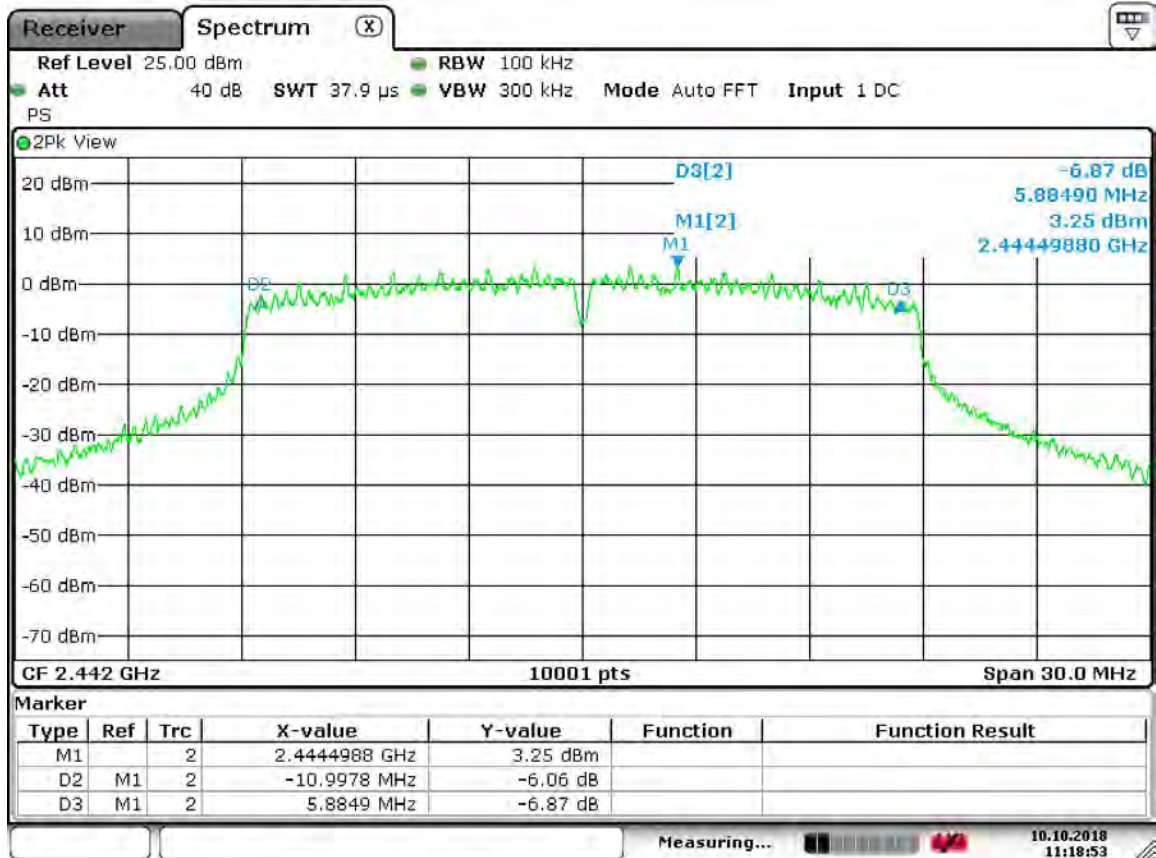
6dB: HT20 (MCS7), Low Channel



Date: 10.OCT.2018 11:14:12



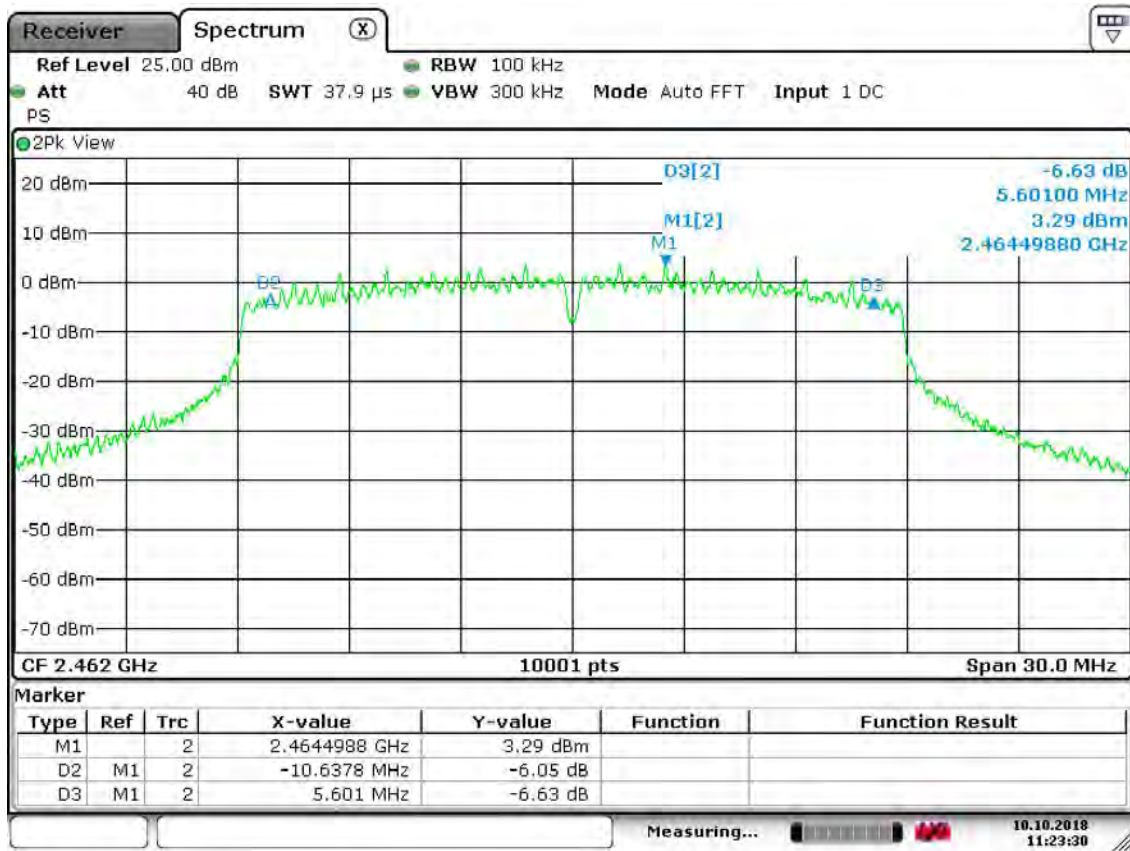
6dB: HT20 (MCS7), Mid Channel



Date: 10.OCT.2018 11:18:53



6dB: HT20 (MCS7), High Channel



Date: 10.OCT.2018 11:23:31



99%: CCK 802.11b, Low Channel



Date: 5.OCT.2018 09:52:13



99%: CCK 802.11b, Mid Channel



Date: 5.OCT.2018 09:50:58

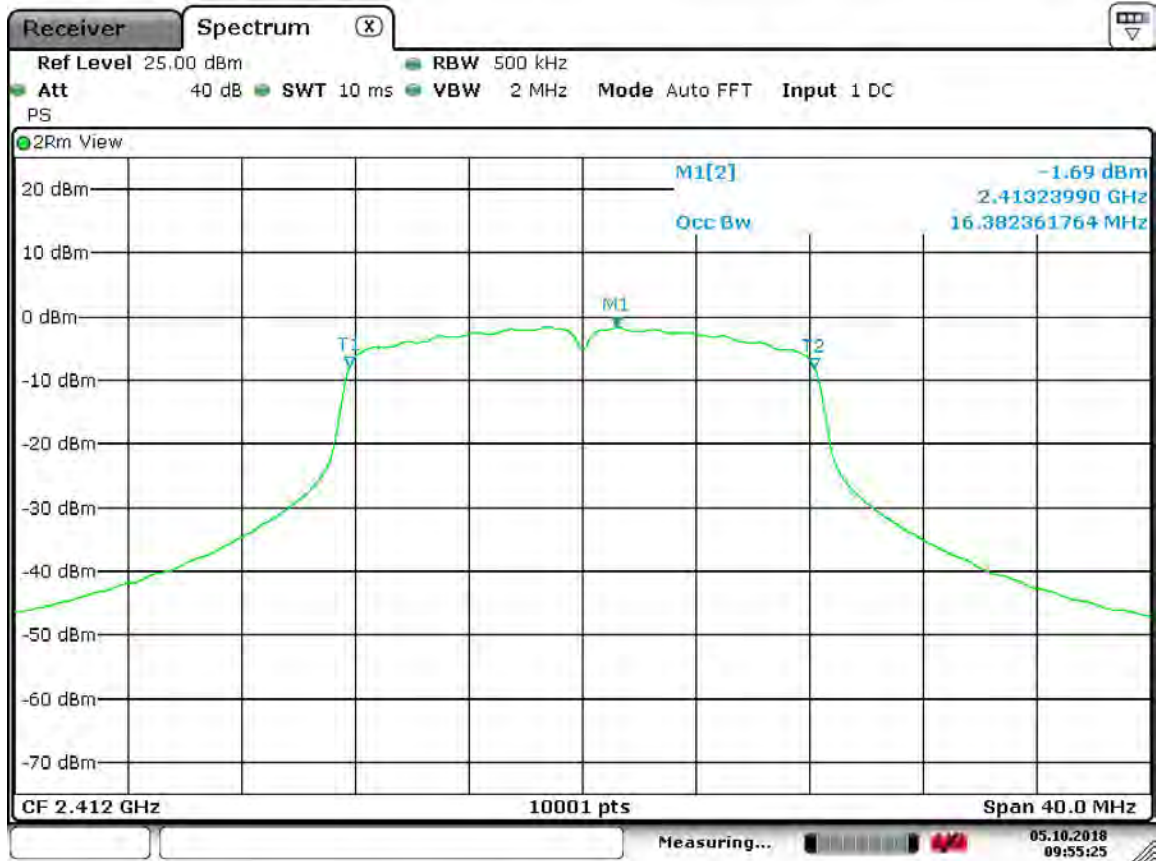


99%: CCK 802.11b, High Channel



Date: 5.OCT.2018 09:49:52

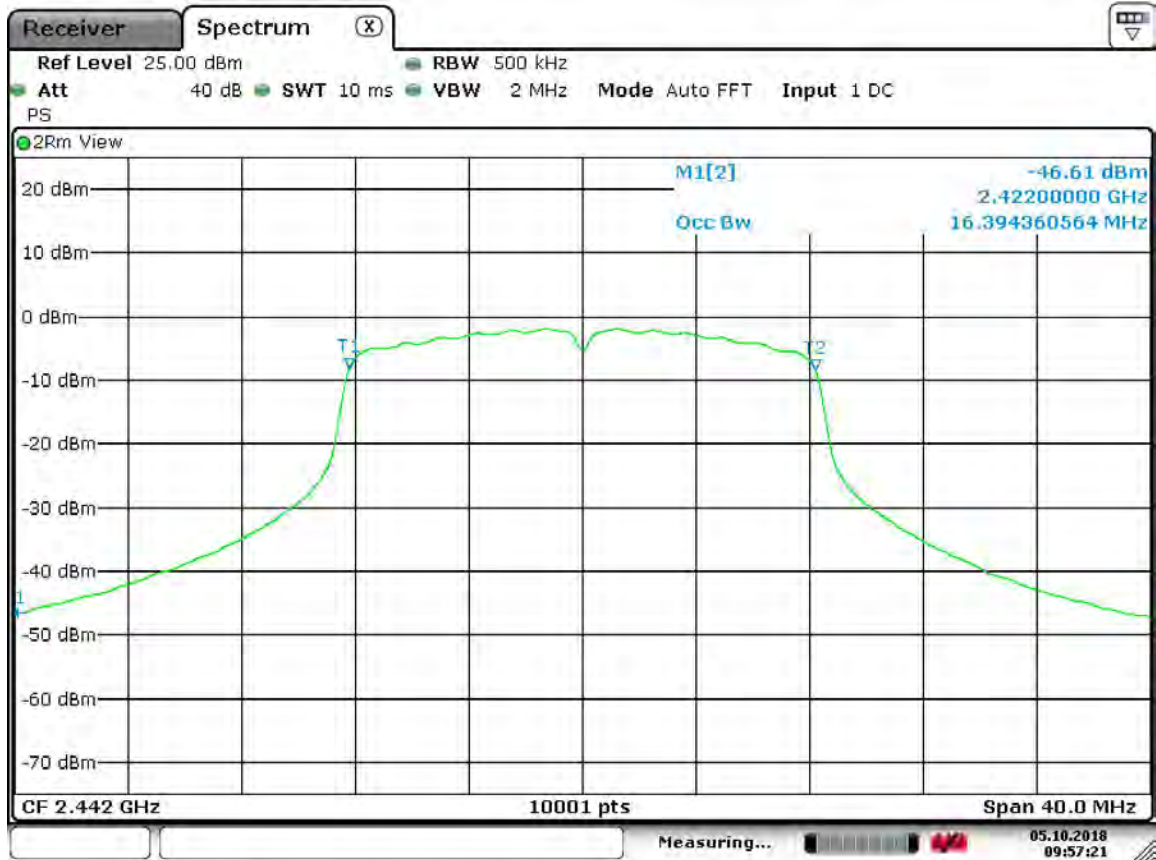
99%: OFDM 802.11g, Low Channel



Date: 5.OCT.2018 09:55:26



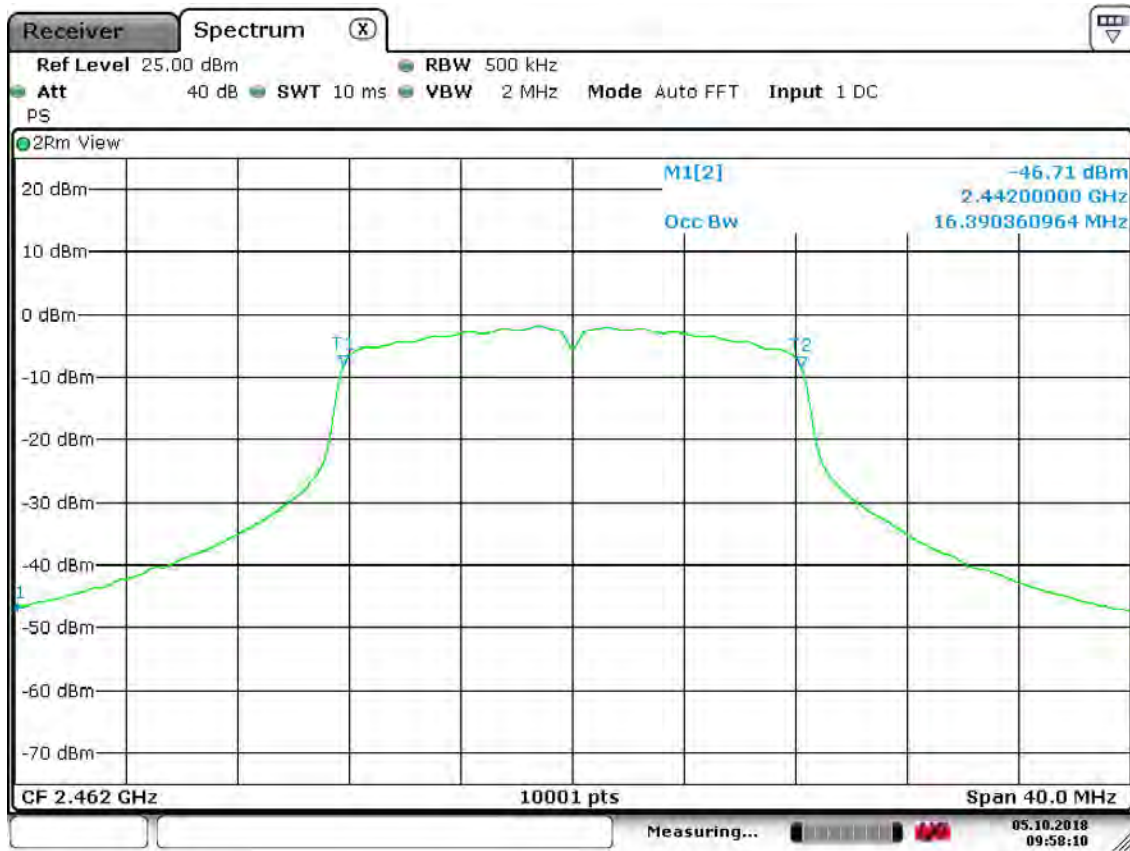
99%: OFDM 802.11g, Mid Channel



Date: 5.OCT.2018 09:57:21



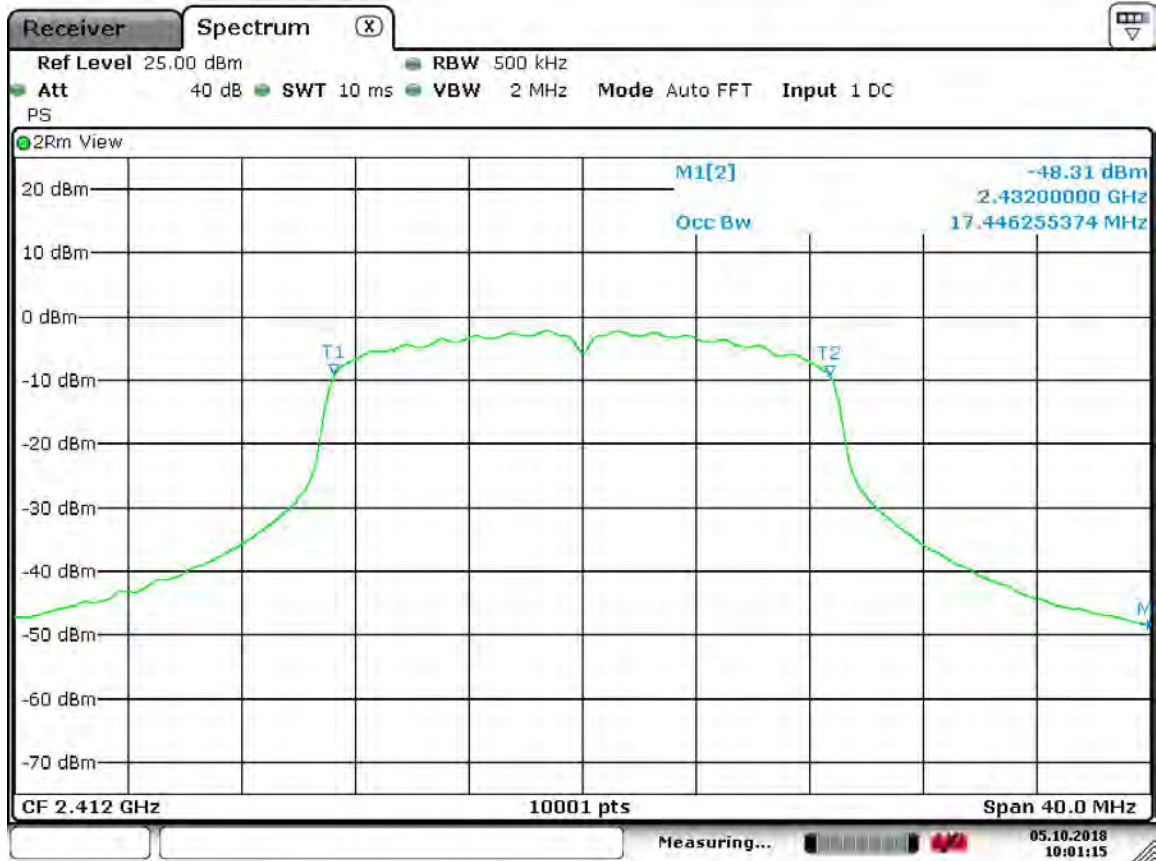
99%: OFDM 802.11g, High Channel



Date: 5.OCT.2018 09:58:09



99%: HT20 (MCS7), Low Channel



Date: 5.OCT.2018 10:01:15



99%: HT20 (MCS7), Mid Channel



Date: 5.OCT.2018 10:02:51



99%: HT20 (MCS7), High Channel



Date: 5.OCT.2018 10:03:49



8 CONDUCTED OUTPUT POWER

The EUT antenna port was fitted with an SMA connector and directly connected to the input of the receiver. The peak power output was measured.

8.1 Requirements:

The peak power output shall be 1 watt (30 dBm) or less when using an antenna with a gain of less than 6dBi. For antennas having a gain of more than 6dBi, the limit is reduced by 1dB for every dB the antenna gain is over 6dBi.



8.2

Conducted Output Power Test CCK 802.11b, Low Channel



Date: 24.JUN.2020 12:23:14



CCK 802.11b, Mid Channel





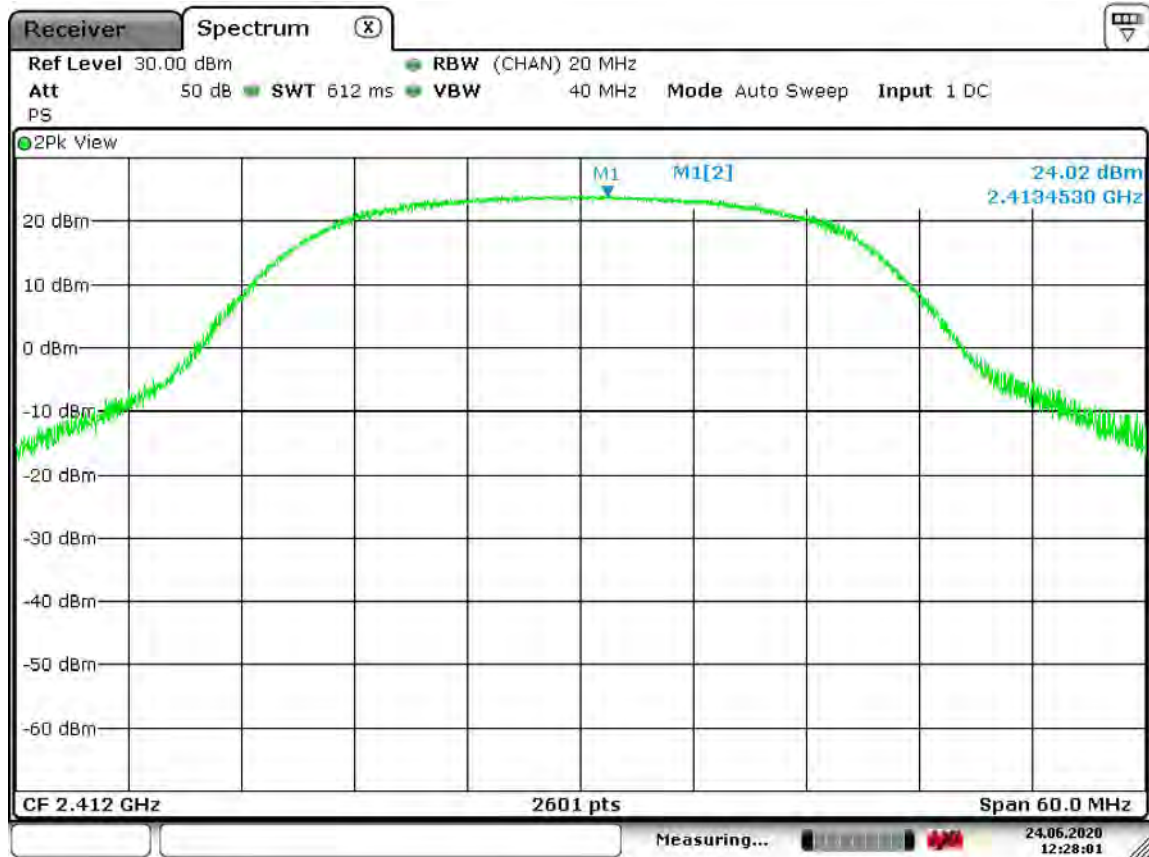
CCK 802.11b, High Channel



Date: 24.JUN.2020 12:26:33



OFDM 802.11g, Low Channel



Date: 24.JUN.2020 12:28:01



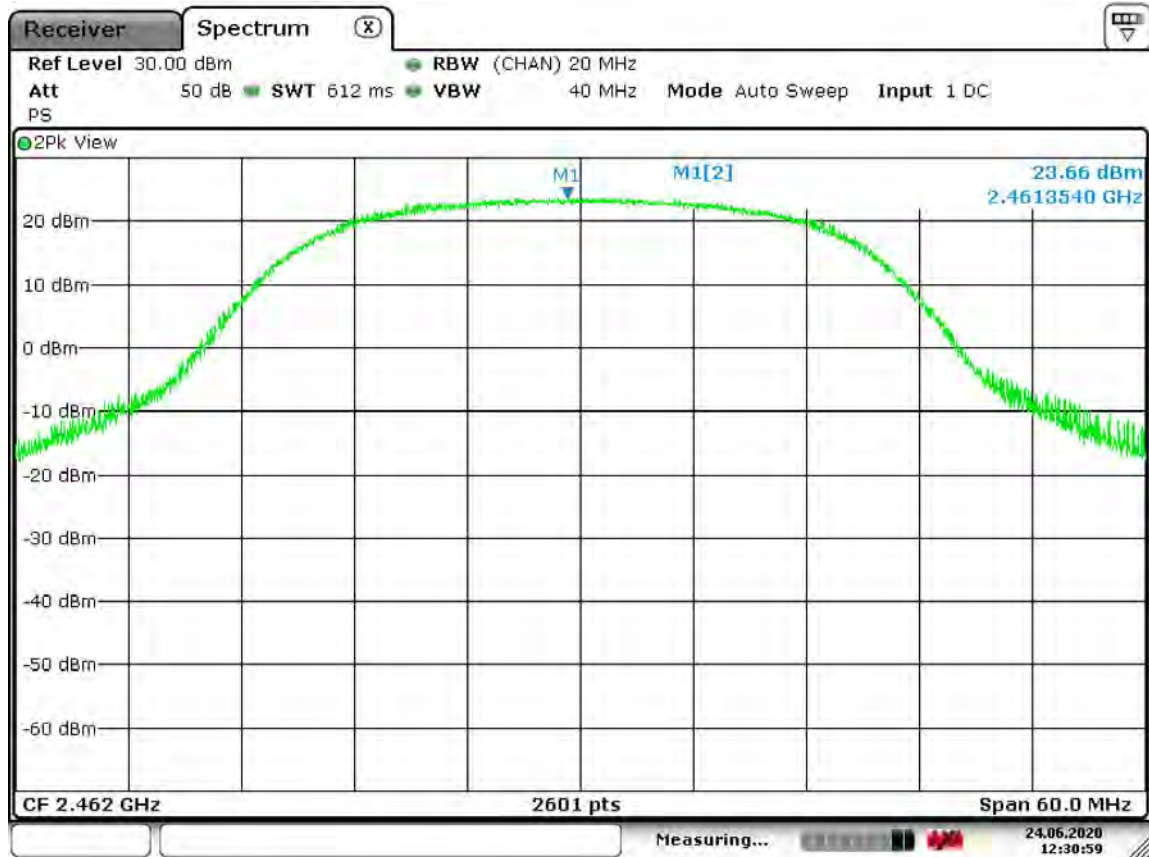
OFDM 802.11g, Mid Channel



Date: 24.JUN.2020 12:29:41



OFDM 802.11g, High Channel



Date: 24.JUN.2020 12:30:59



HT20 (MCS7), Low Channel



Date: 24.JUN.2020 12:32:46



HT20 (MCS7), Mid Channel



Date: 24.JUN.2020 12:34:04



HT20 (MCS7), High Channel



Date: 24.JUN.2020 12:35:27



FCC PART 15.31(e) – VOLTAGE VARIATIONS

9.1 Requirements

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. Nominal AC line voltage was 120VAC. For battery-operated equipment, the equipment tests shall be performed using a new battery.



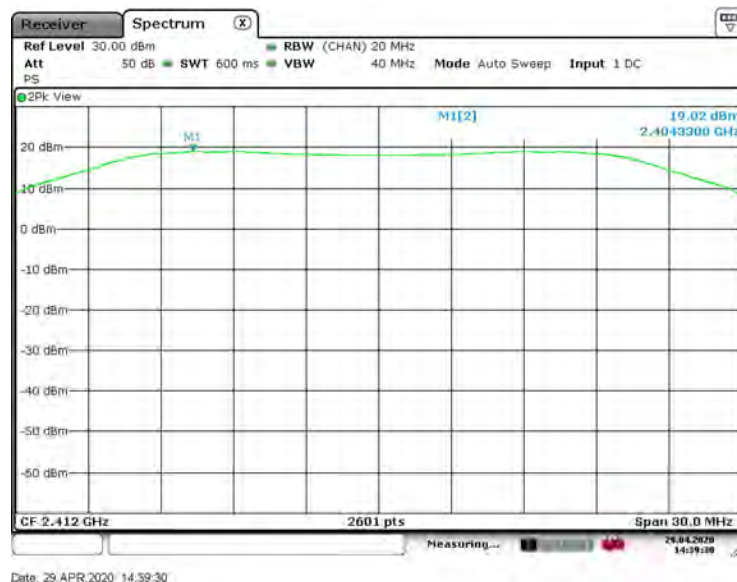
9.2 Voltage Variations Test Data

Test Date(s):	2020-04-29	Test Engineer:	J. Chiller
Rule:	15.31(e)	Air Temperature:	22.9° C
Test Results:	Complies	Relative Humidity:	34%

CCK: Low Channel, -15%

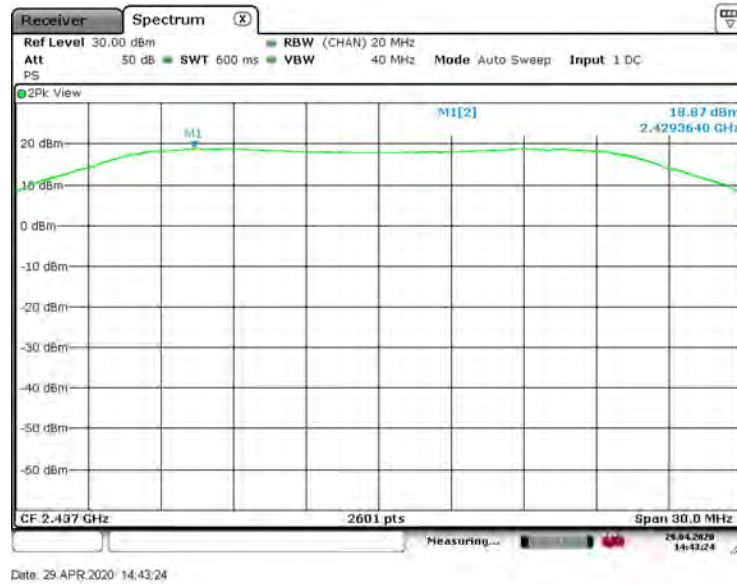


CCK: Low Channel, +15%





CCK: Mid Channel, -15%



CCK: Mid Channel, +15%

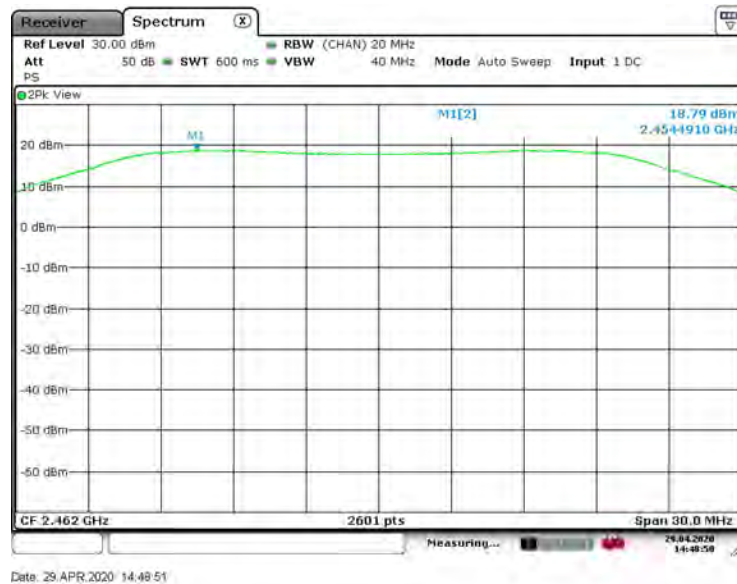




CCK: High Channel, -15%

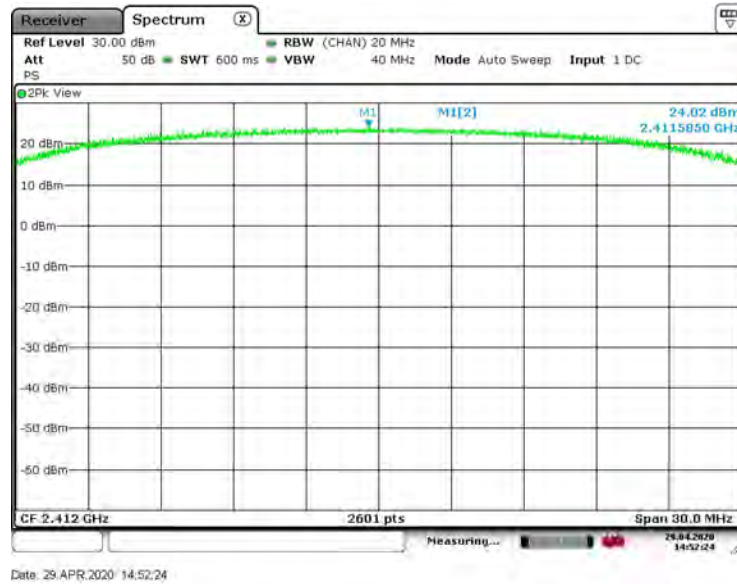


CCK: High Channel, +15%

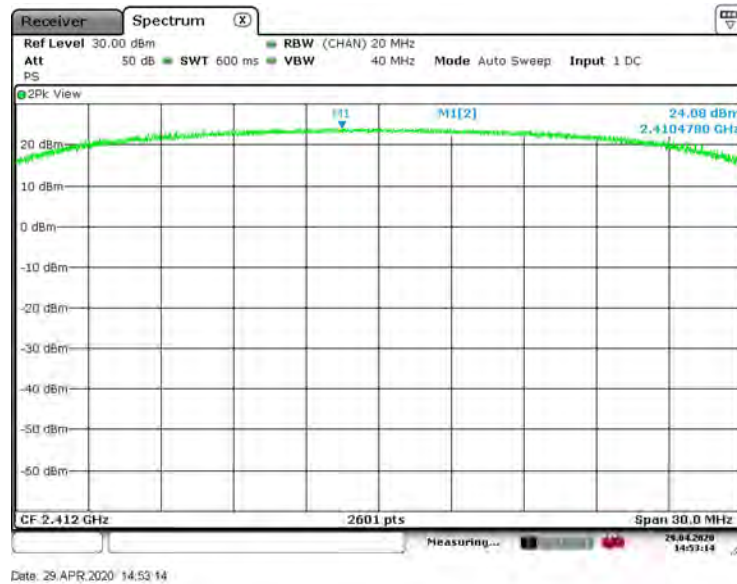




OFDM: Low Channel, -15%

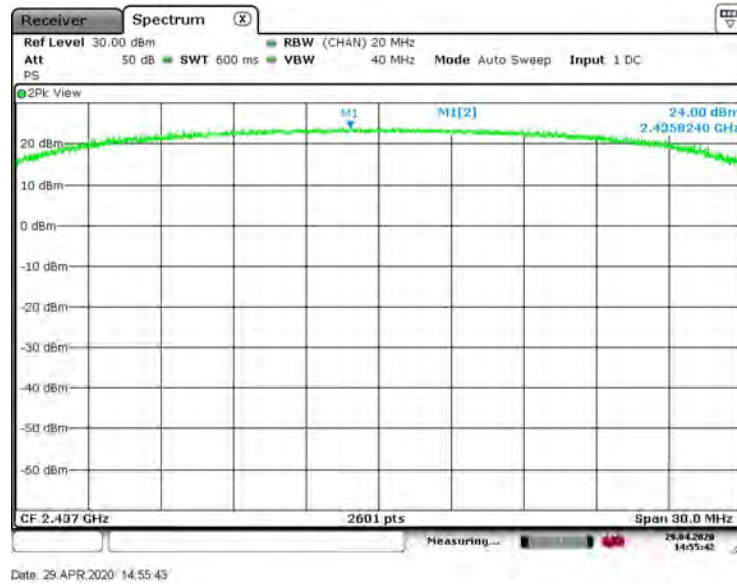


OFDM: Low Channel, +15%

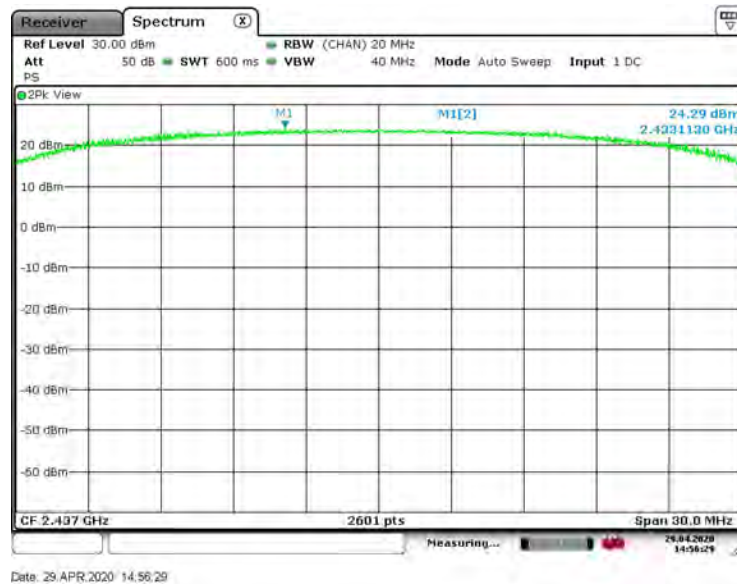




OFDM: Mid Channel, -15%

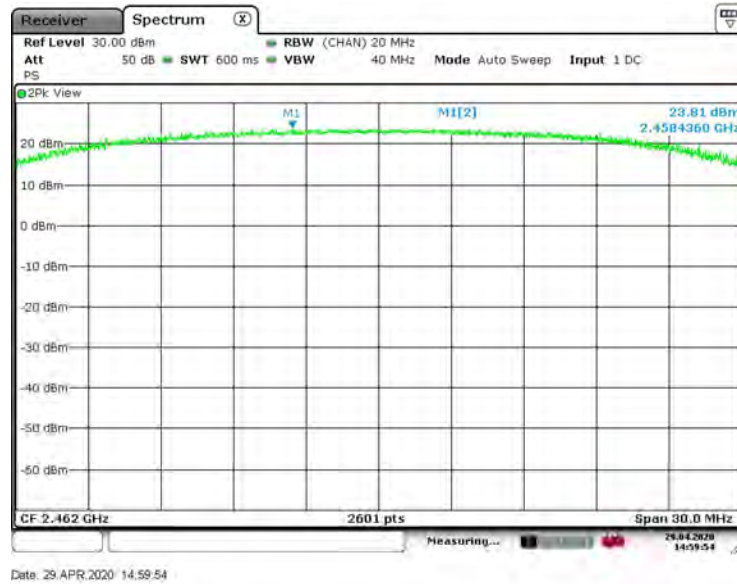


OFDM: Mid Channel, +15%

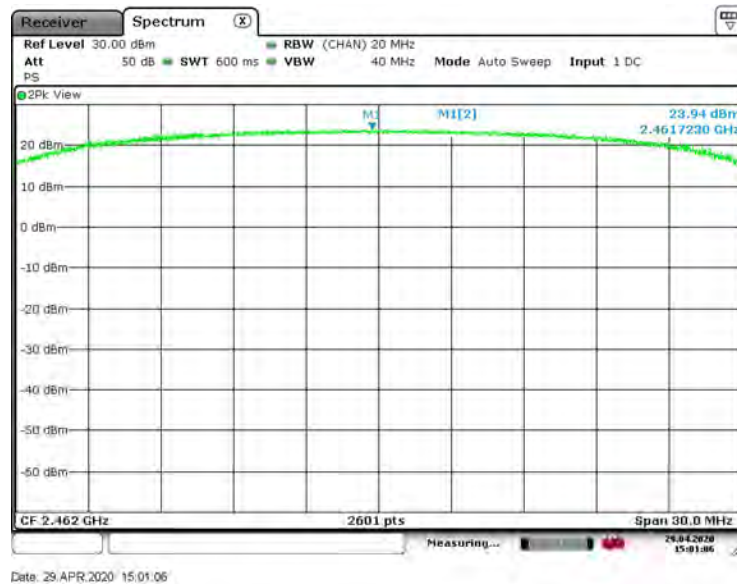




OFDM: High Channel, -15%

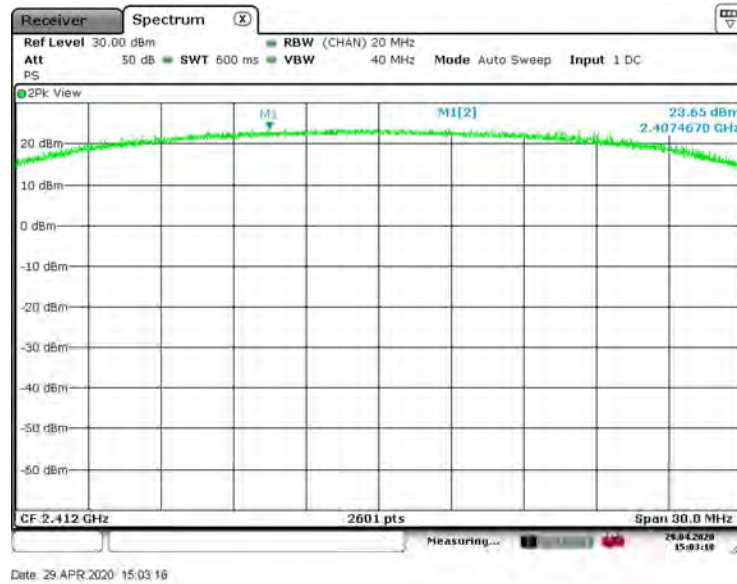


OFDM: High Channel, +15%

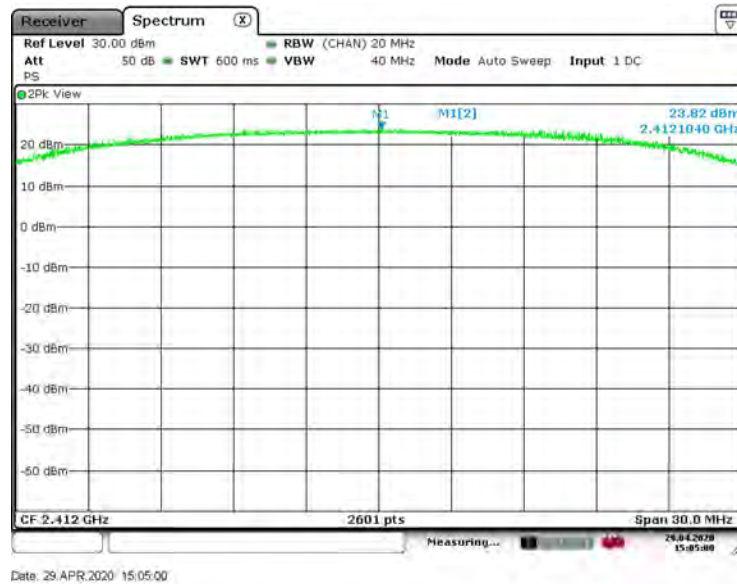




HT20 (MCS7): Low Channel, -15%

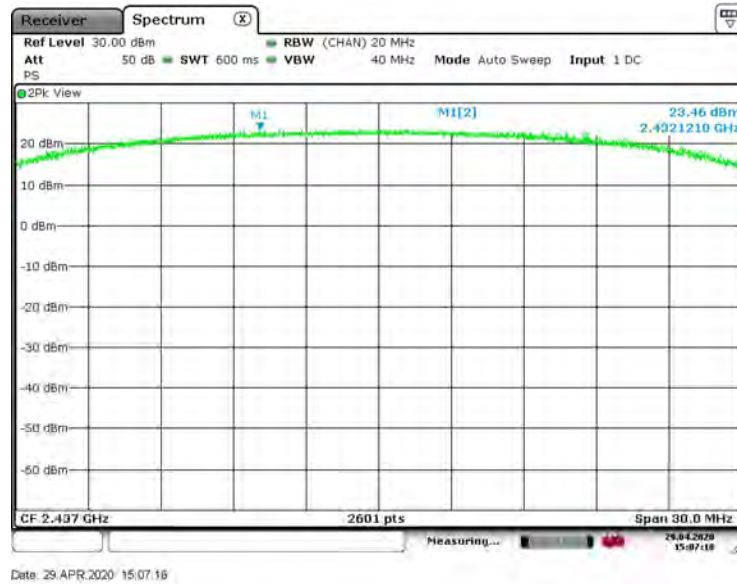


HT20 (MCS7): Low Channel, +15%

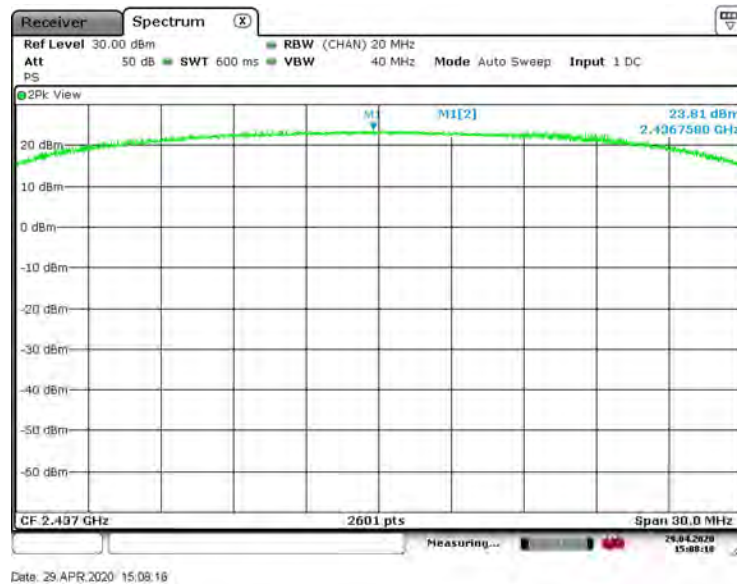




HT20 (MCS7): Mid Channel, -15%

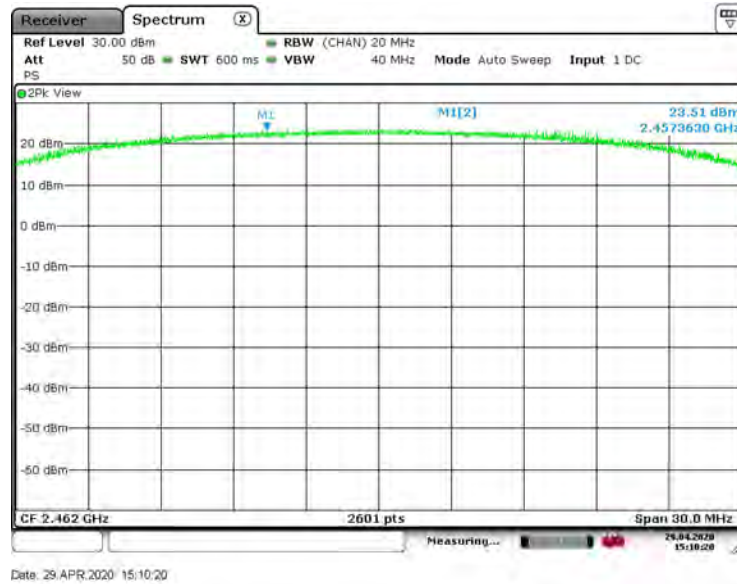


HT20 (MCS7): Mid Channel, +15%

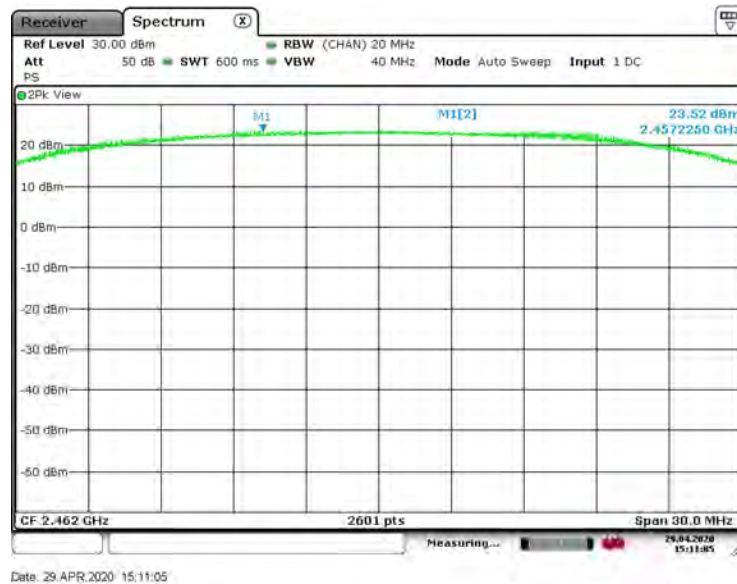




HT20 (MCS7): High Channel, -15%



HT20 (MCS7): High Channel, +15%





10 FCC Part 15.247(d) – CONDUCTED SPURIOUS EMISSIONS

The following tests were performed to demonstrate compliance.

RF Antenna Conducted Test

The EUT antenna port was fitted with an SMA connector and directly connected to the input of the spectrum analyzer.

10.1 Requirements:

All Spurious Emissions must be at least 20dB down from the highest emission level measured within the authorized band up through the tenth harmonic.

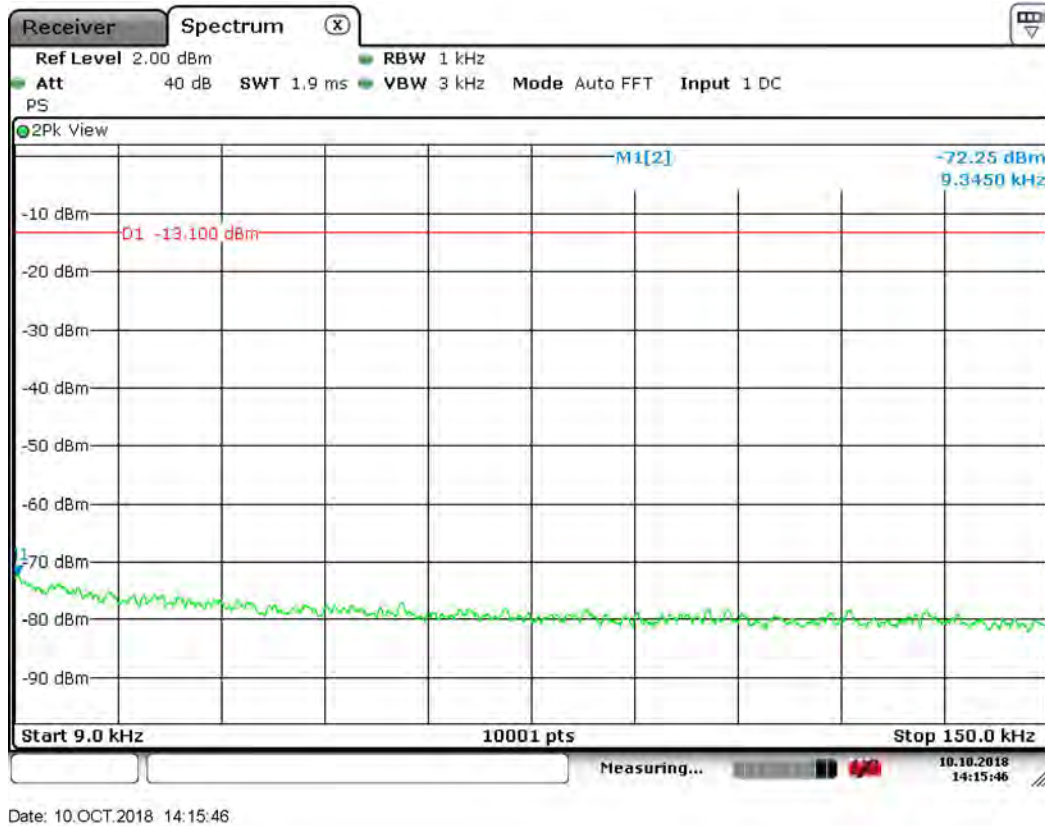
Spurious emissions measurements were made at the low, mid, and upper channels with the appropriate spectrum analyzer impulse bandwidth. Additionally, 20dB down points were measured for the low and high channels to verify band edge compliance.



10.2 Conducted Spurious Emissions Test Data

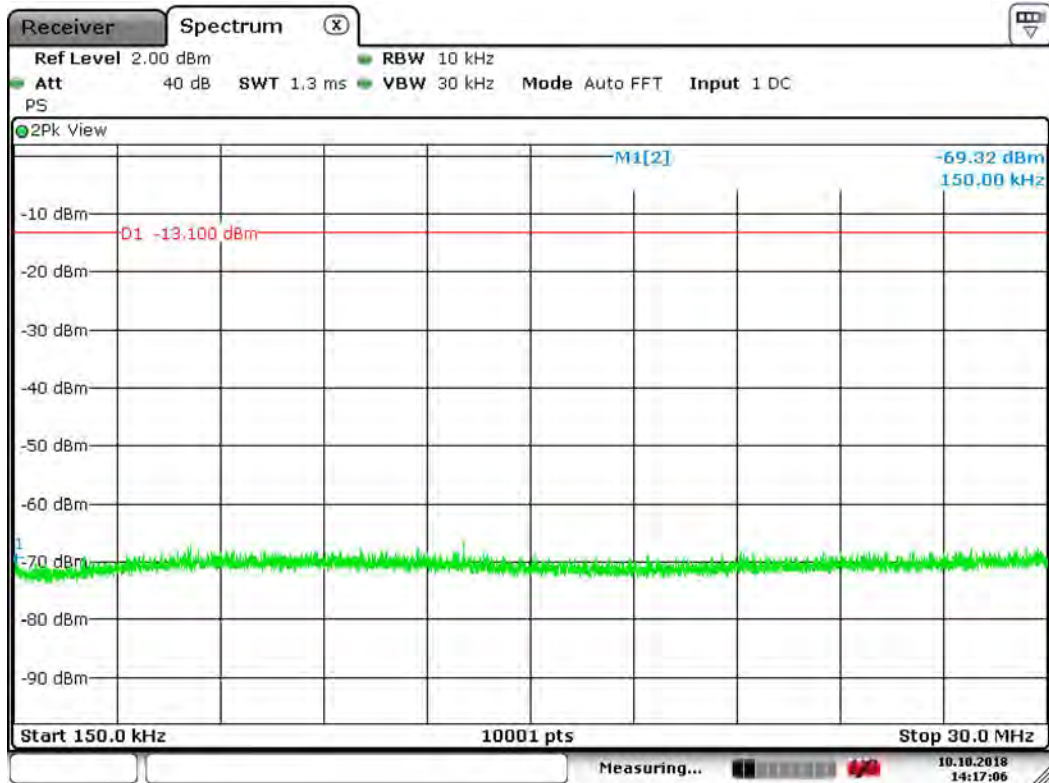
Test Date:	2018-10-10, 2020-04-29, 2020-07-08	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(d) / Part 15.207 KDB558074	Air Temperature:	21.4°C
		Relative Humidity:	46%

CCK 802.11b: 0.009 MHz to 0.15 MHz





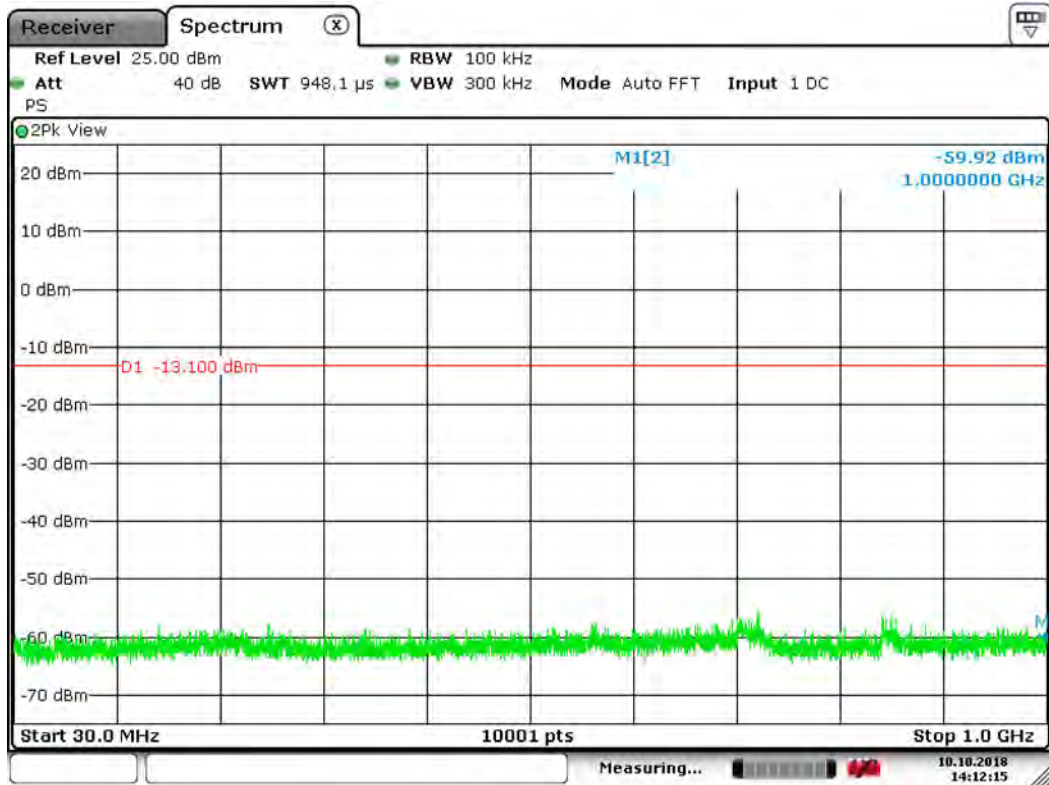
CCK 802.11b: 0.15 MHz to 30 MHz



Date: 10.OCT.2018 14:17:06



CCK 802.11b: 30 MHz to 1000 MHz



Date: 10.OCT.2018 14:12:15

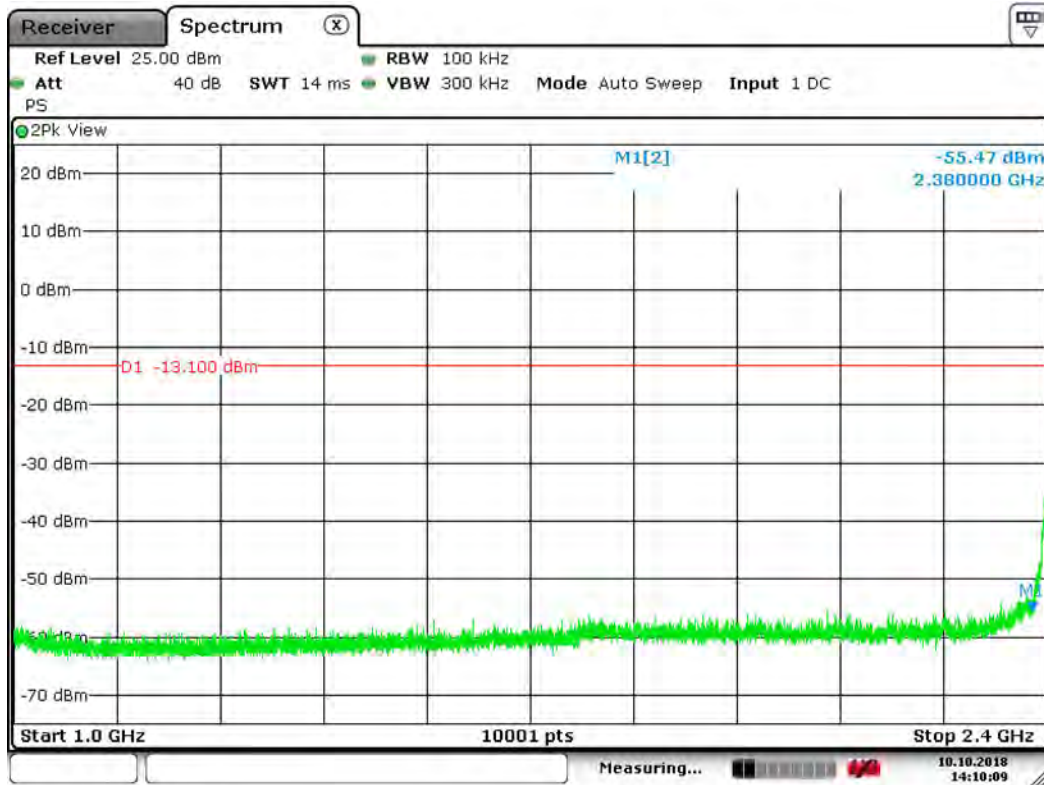


Order Nos.: F2P19714A, F2P19714A-C1

Client: Grayshift LLC

Model: GK01

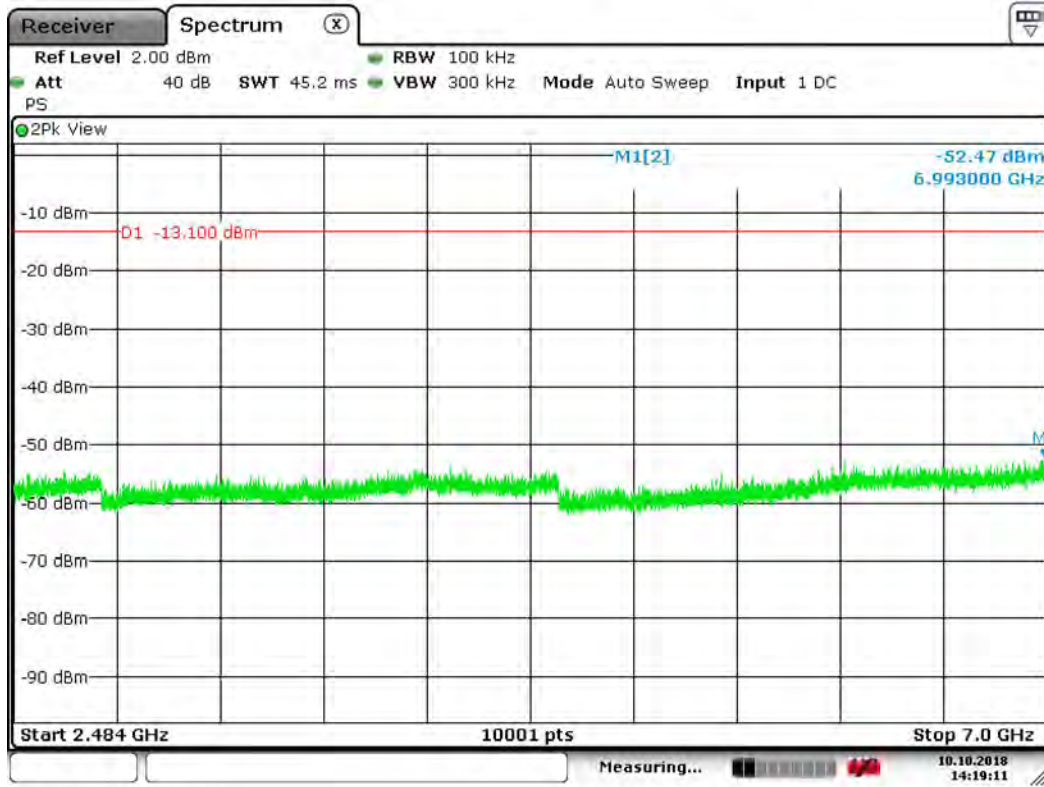
CCK 802.11b: 1 GHz to 2.4 GHz



Date: 10.OCT.2018 14:10:10



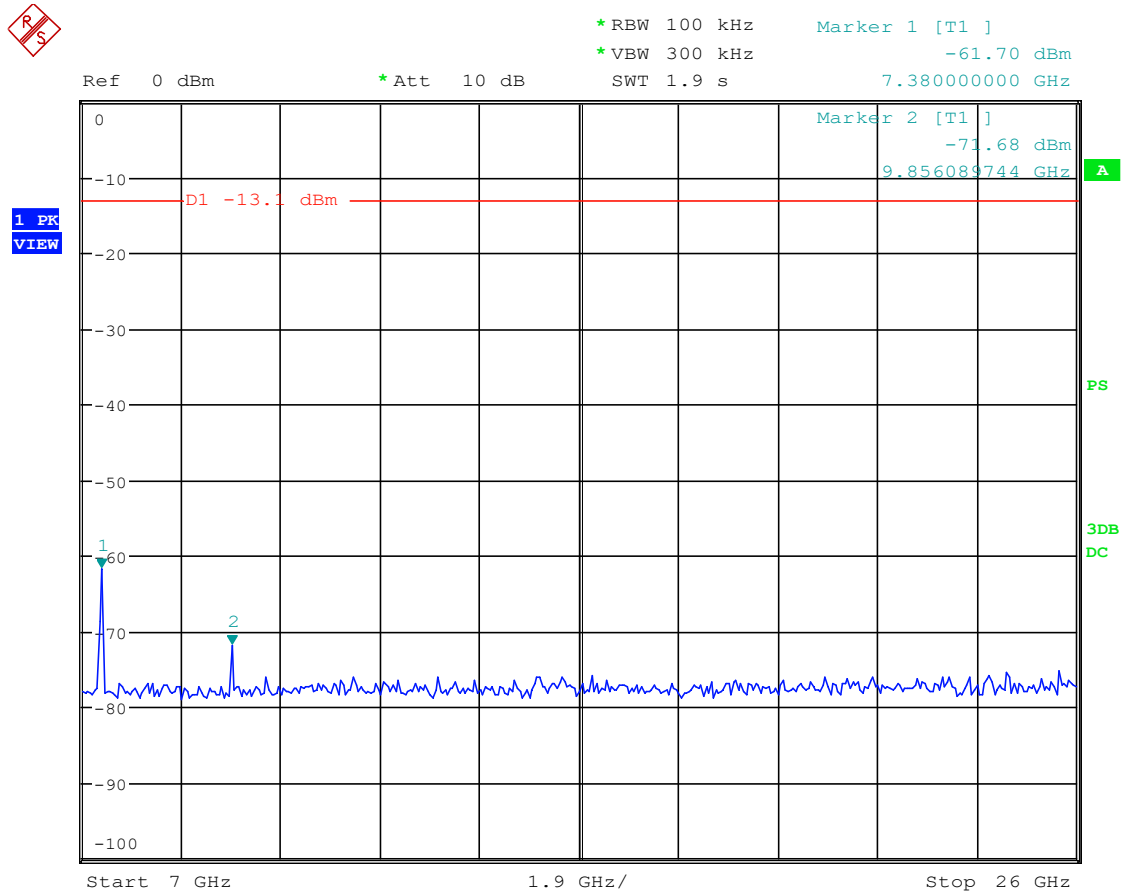
CCK 802.11b: 2.484 GHz to 7 GHz



Date: 10.OCT.2018 14:19:11



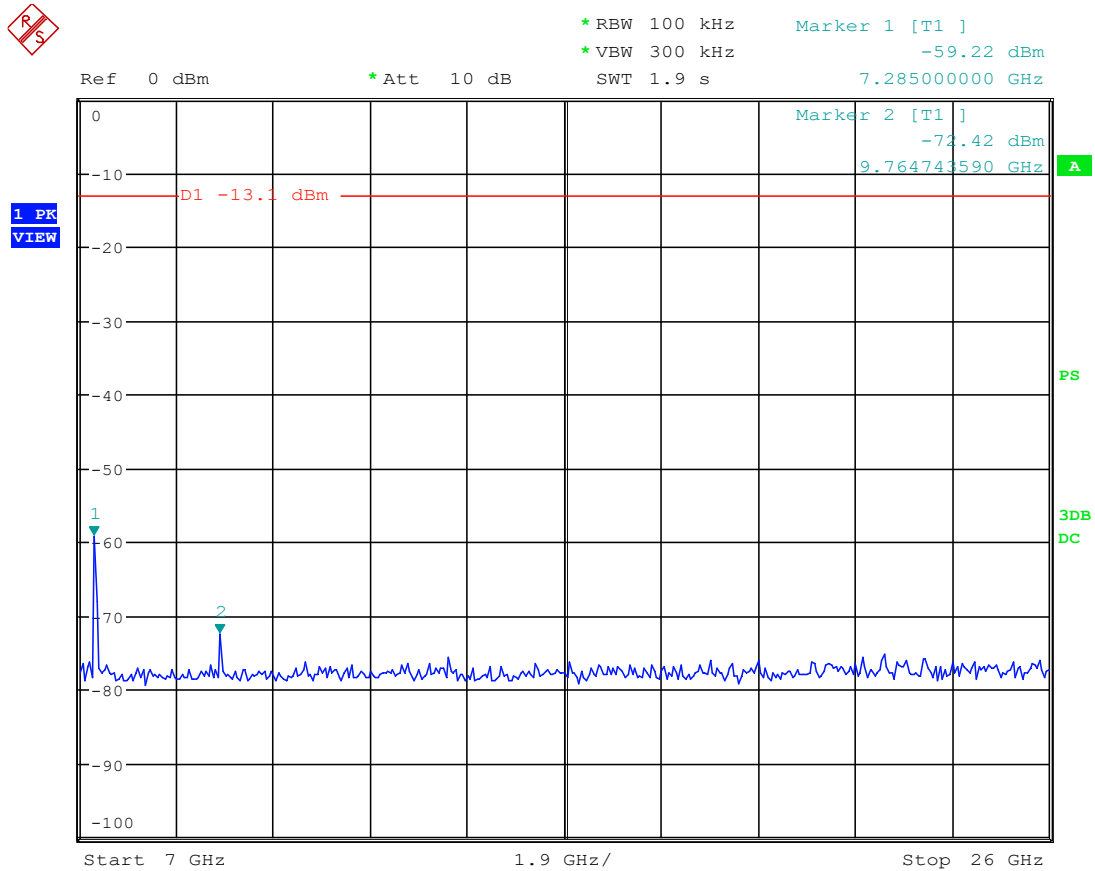
CCK 802.11b: 7 GHz to 26 GHz, High Channel



Date: 8.JUL.2020 14:28:01



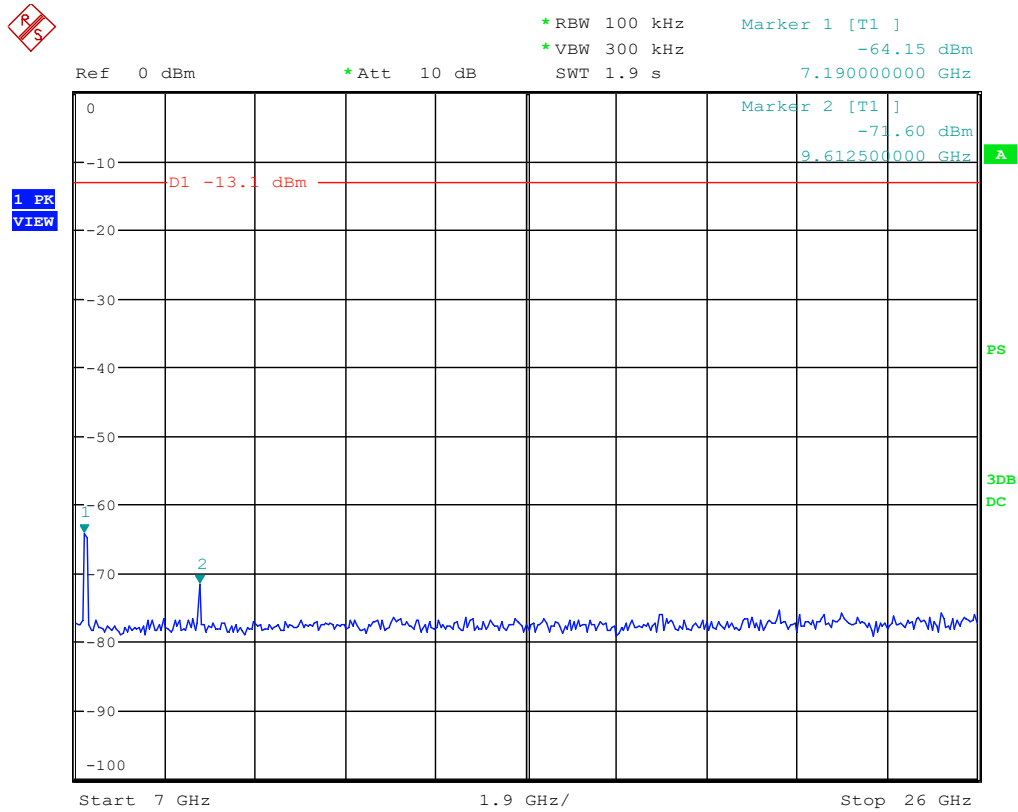
CCK 802.11b: 7 GHz to 26 GHz, Mid Channel



Date: 8.JUL.2020 14:25:22



CCK 802.11b: 7 GHz to 26 GHz, Low Channel



Date: 8.JUL.2020 14:24:11



CCK 802.11b: Band Edge Reference



Date: 10.OCT.2018 14:00:05



CCK 802.11b: Lower Band Edge



Date: 10.OCT.2018 13:37:25



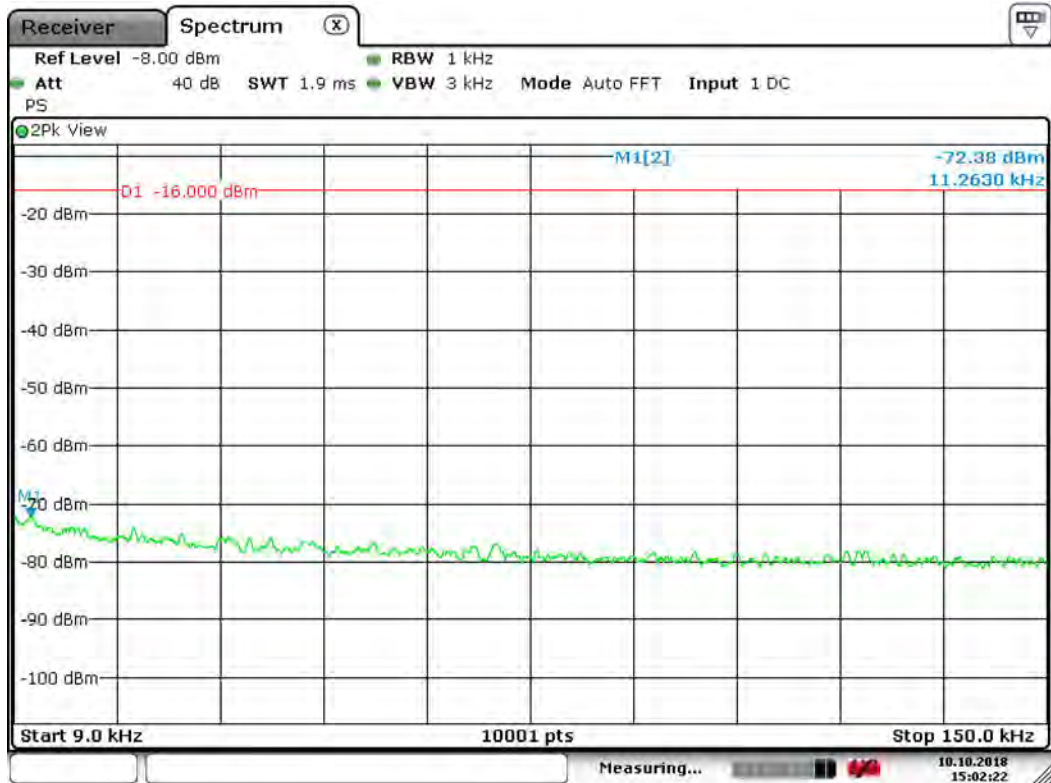
CCK 802.11b: Upper Band Edge



Date: 10.OCT.2018 13:34:11



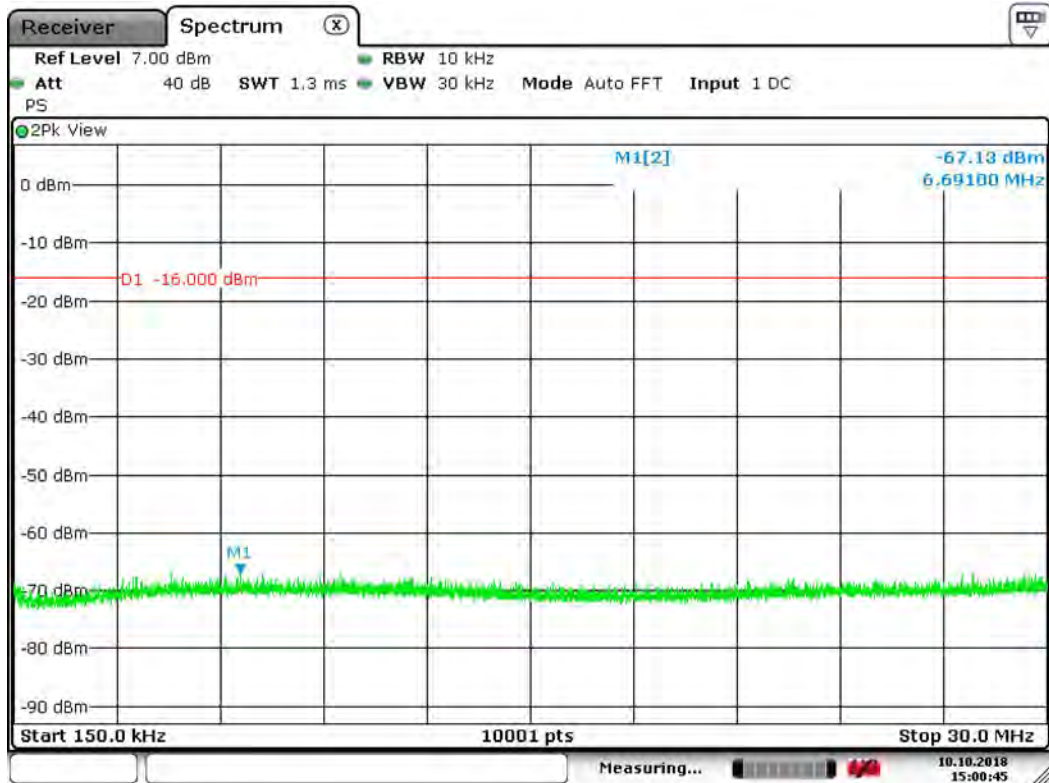
OFDM 802.11g: 0.009 MHz to 0.15 MHz



Date: 10.OCT.2018 15:02:22



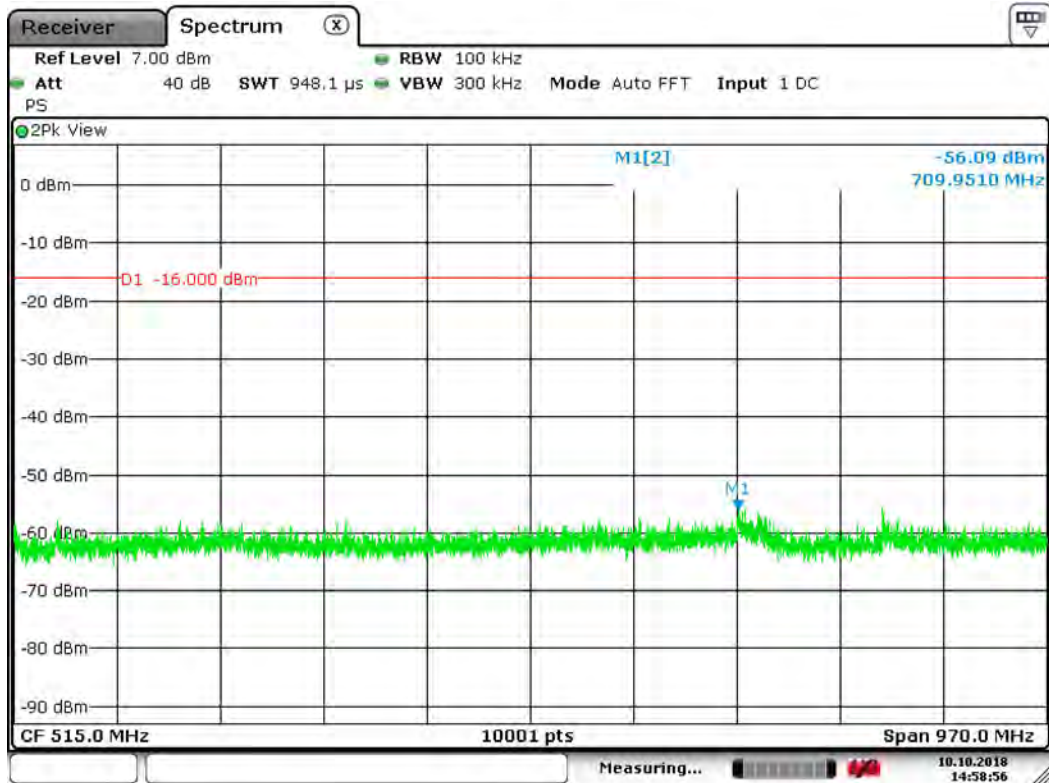
OFDM 802.11g: 0.15 MHz to 30 MHz



Date: 10.OCT.2018 15:00:46



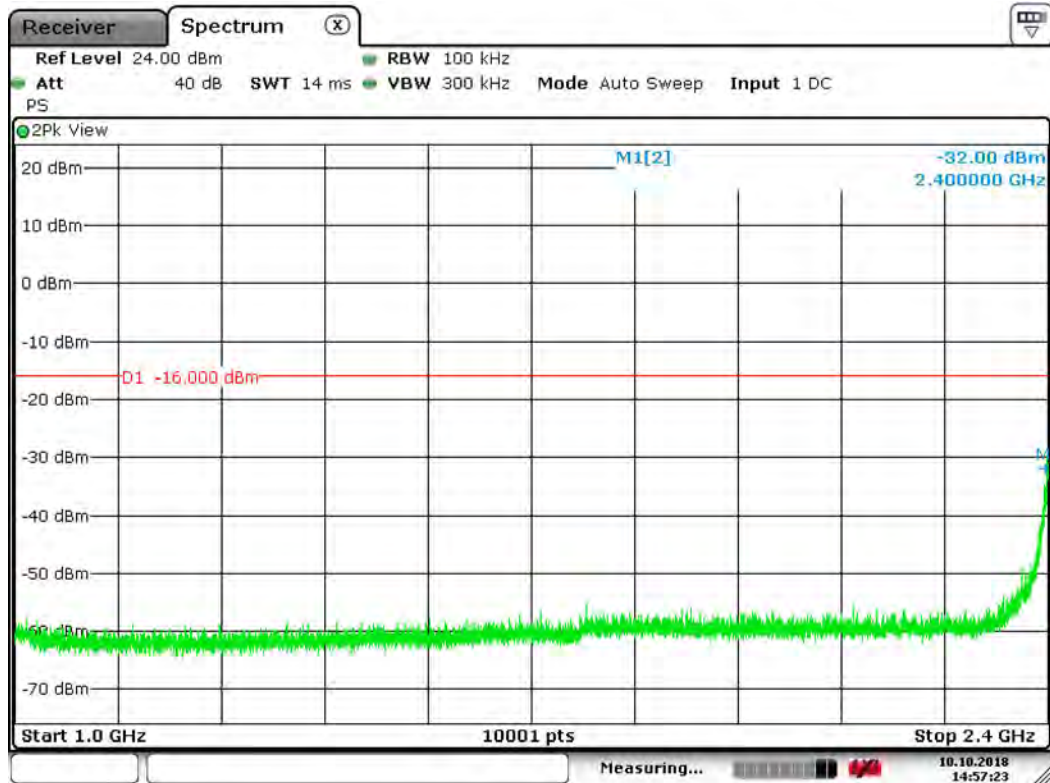
OFDM 802.11g: 30 MHz to 1000 MHz



Date: 10.OCT.2018 14:58:56



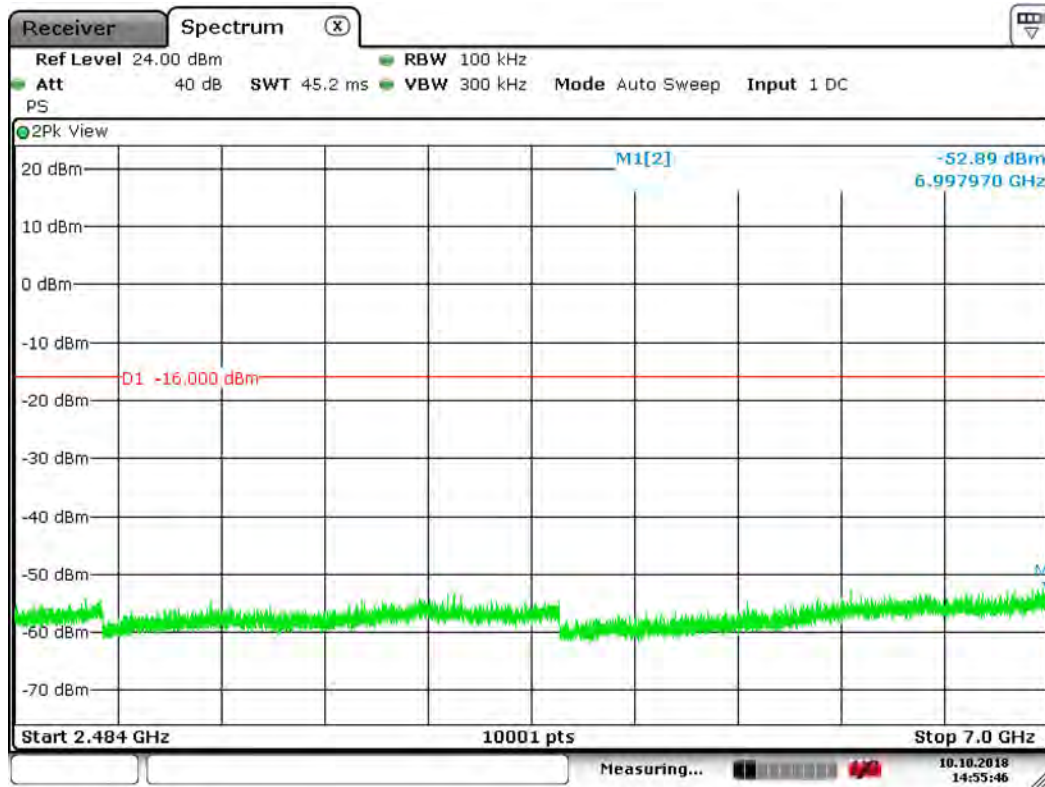
OFDM 802.11g: 1 GHz to 2.4 GHz



Date: 10.OCT.2018 14:57:23



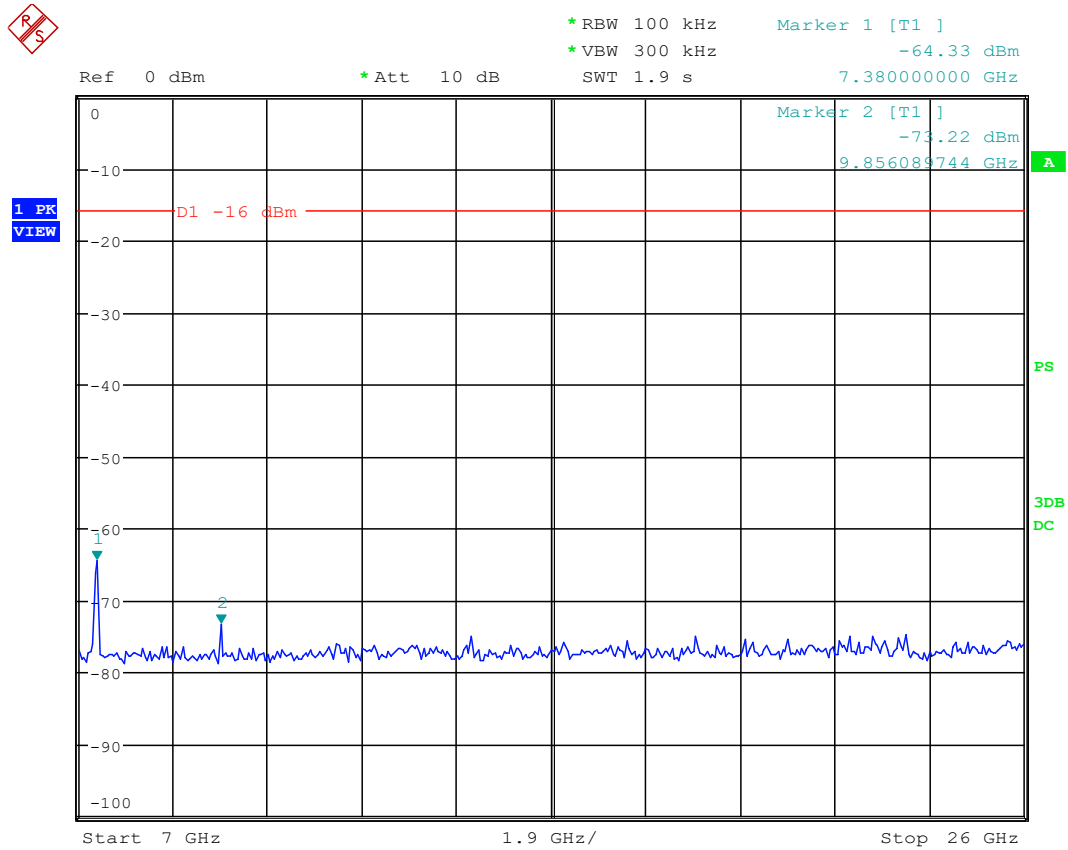
OFDM 802.11g: 2.484 GHz to 7 GHz



Date: 10.OCT.2018 14:55:46



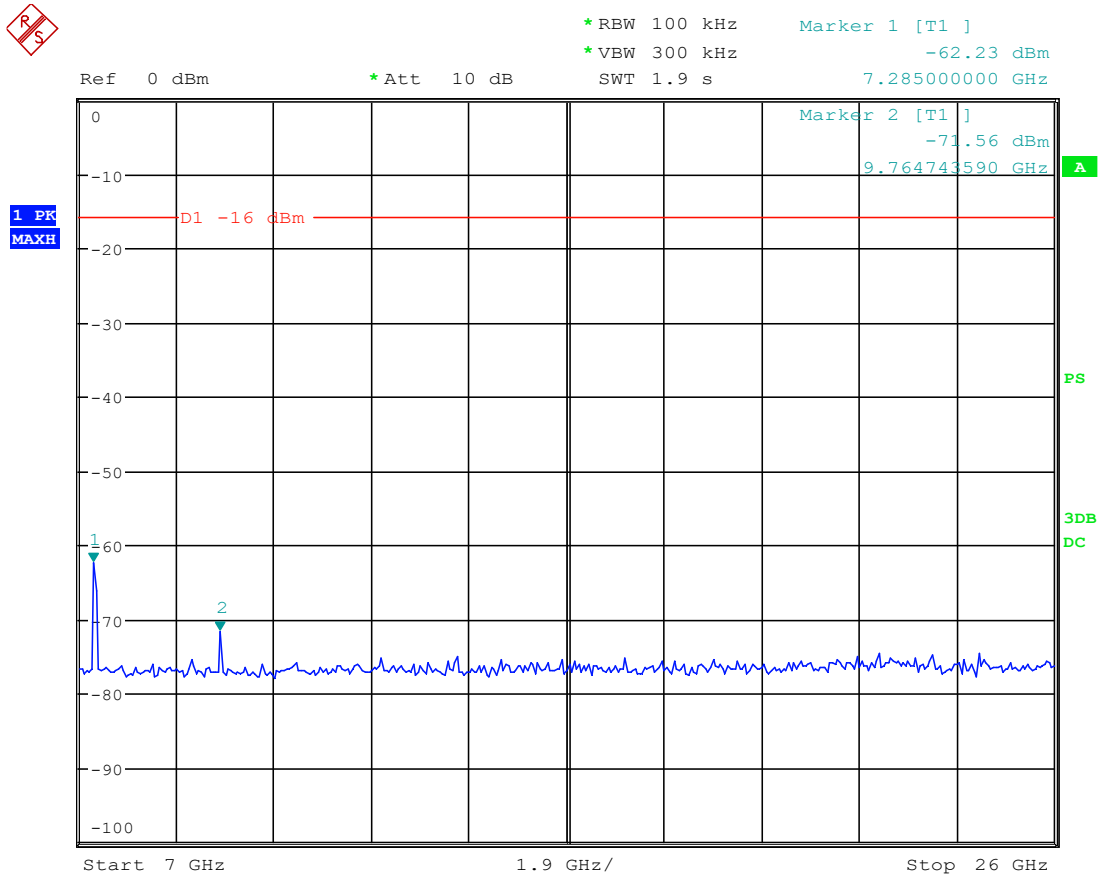
OFDM 802.11g: 7 GHz to 26 GHz High Channel



Date: 8.JUL.2020 14:33:35



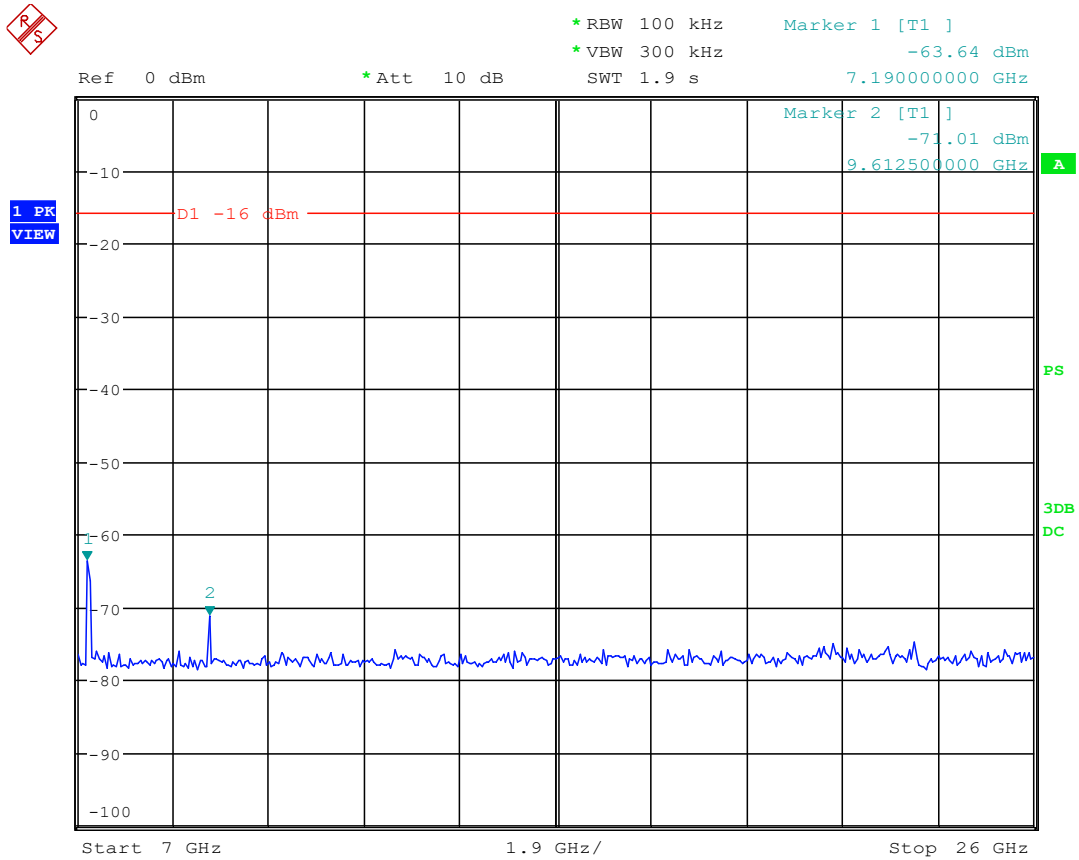
OFDM 802.11g: 7 GHz to 26 GHz Mid Channel



Date: 8.JUL.2020 14:32:27



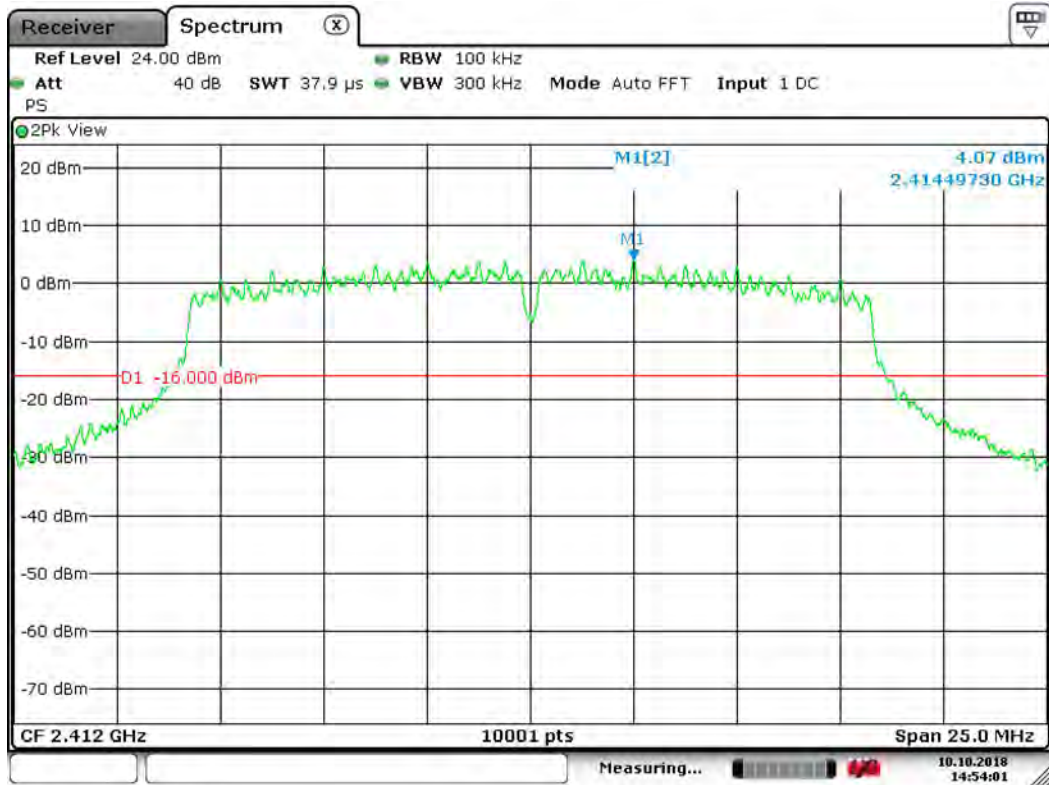
OFDM 802.11g: 7 GHz to 26 GHz Low Channel



Date: 8.JUL.2020 14:30:45



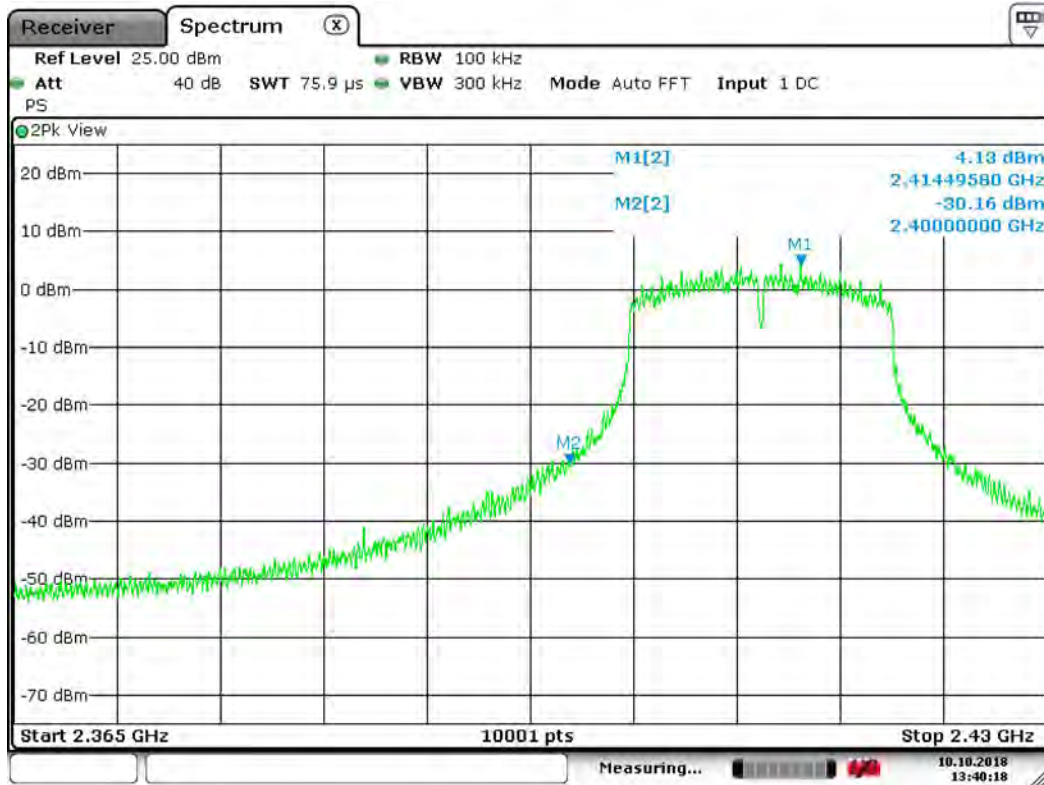
OFDM 802.11g: Band Edge Reference



Date: 10.OCT.2018 14:54:01



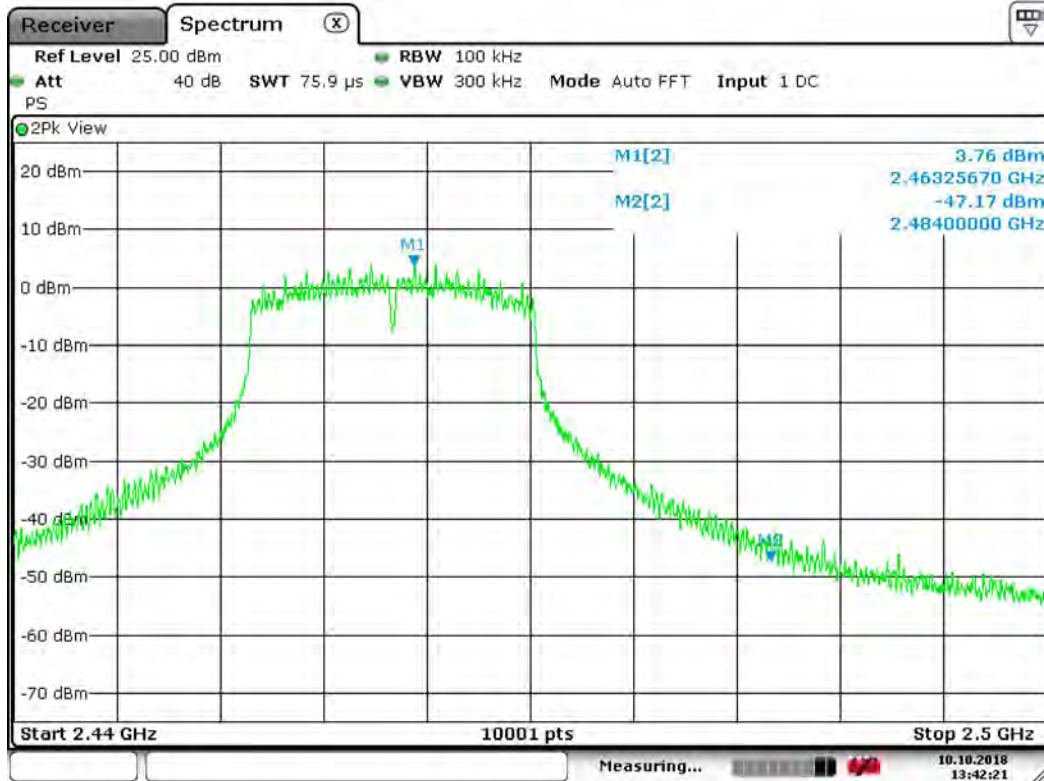
OFDM 802.11g: Lower Band Edge



Date: 10.OCT.2018 13:40:18



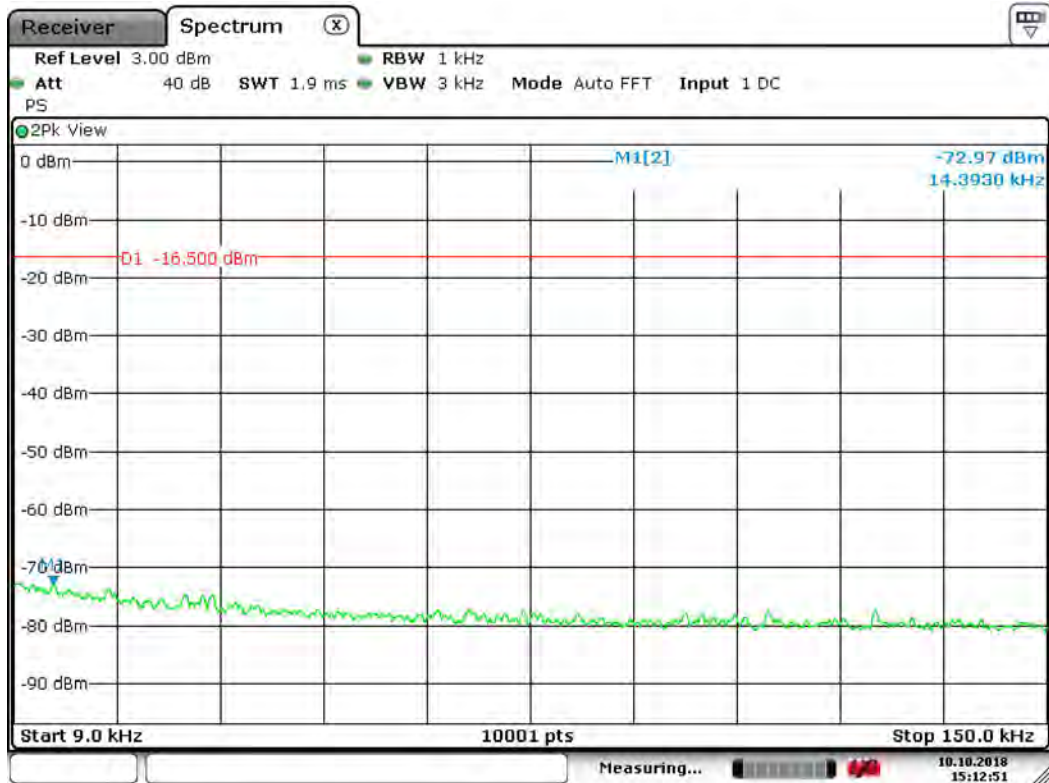
OFDM 802.11g: Upper Band Edge



Date: 10.OCT.2018 13:42:21



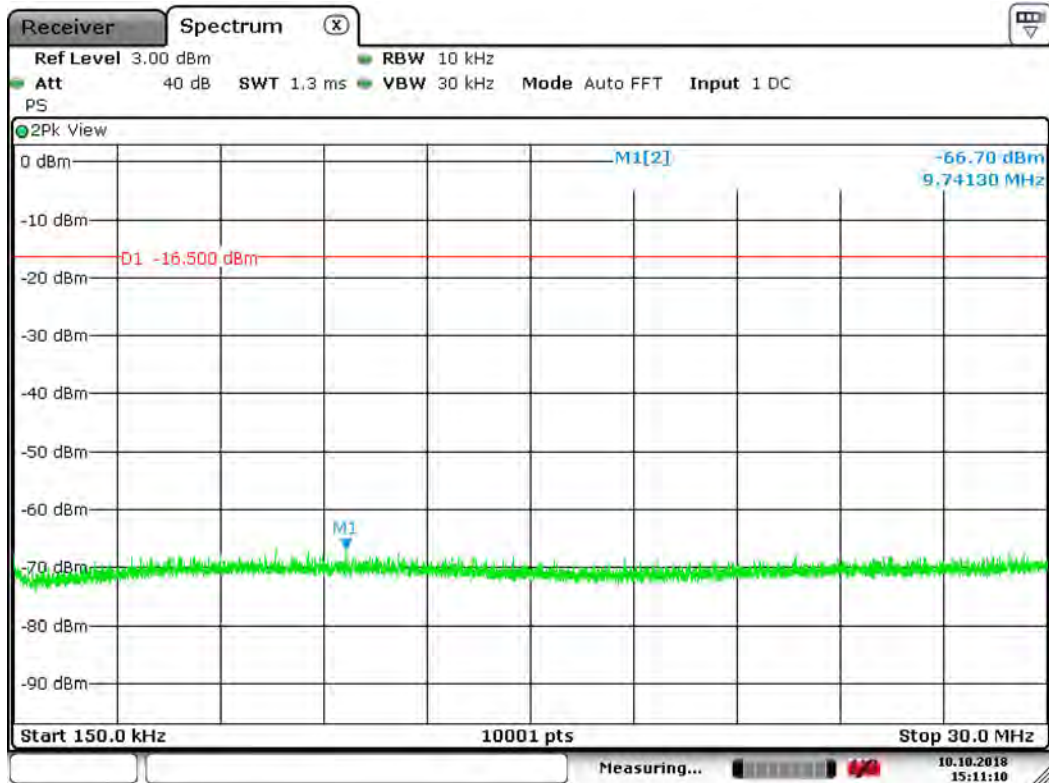
HT20 (MCS7): 0.009 MHz to 0.15 MHz



Date: 10.OCT.2018 15:12:51



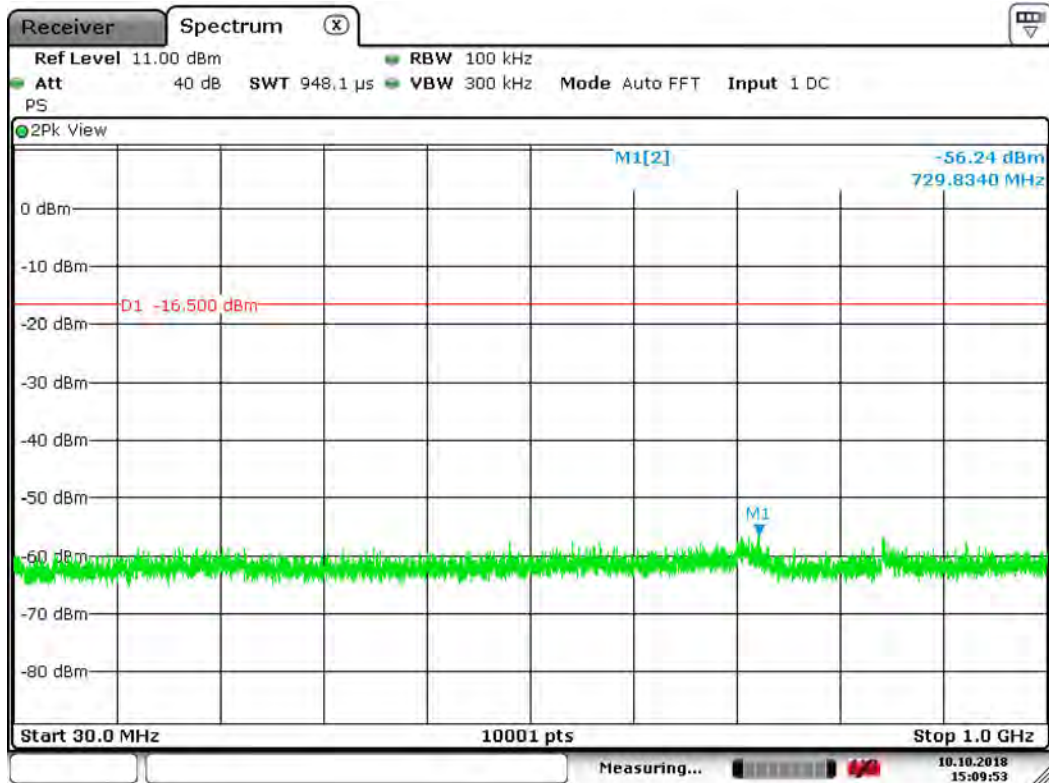
HT20 (MCS7): 0.15 MHz to 30 MHz



Date: 10.OCT.2018 15:11:10



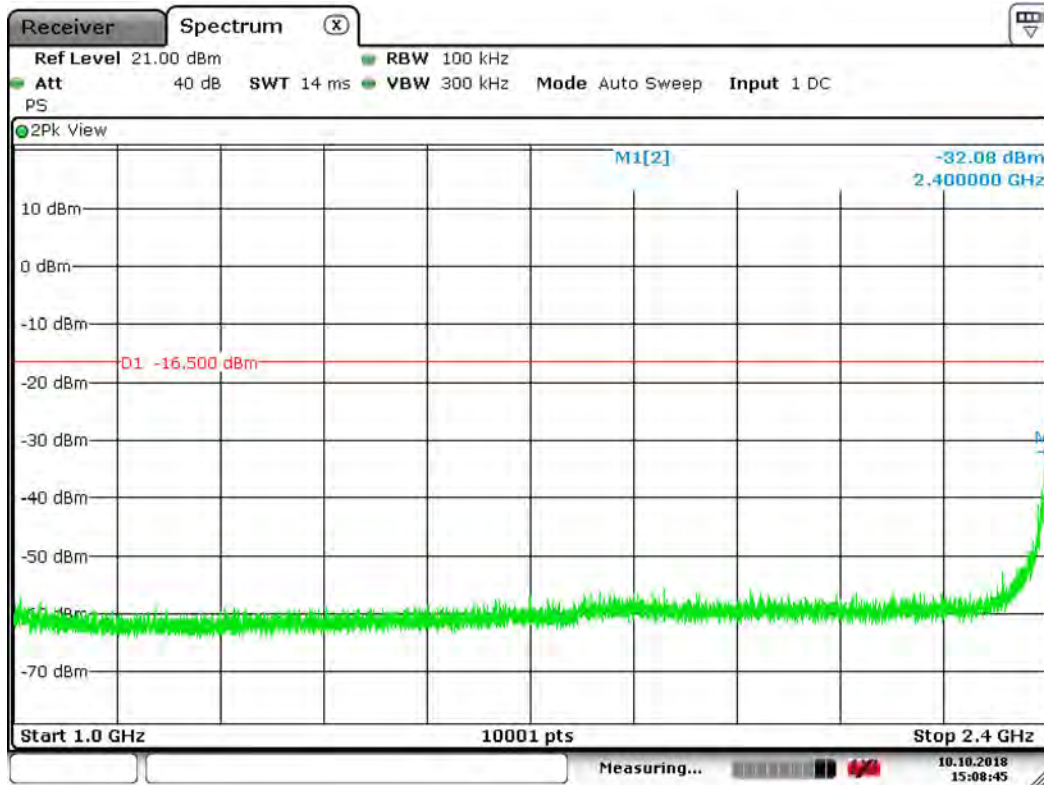
HT20 (MCS7): 30 MHz to 1000 MHz



Date: 10.OCT.2018 15:09:53



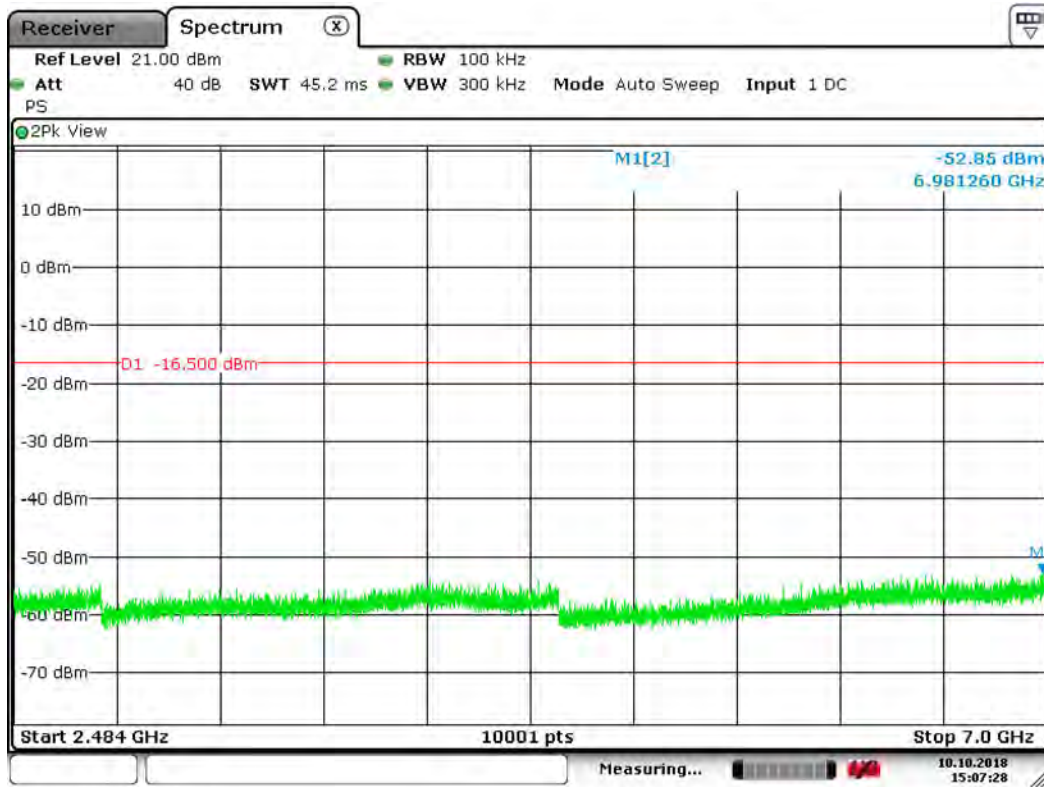
HT20 (MCS7): 1 GHz to 2.4 GHz



Date: 10.OCT.2018 15:08:45



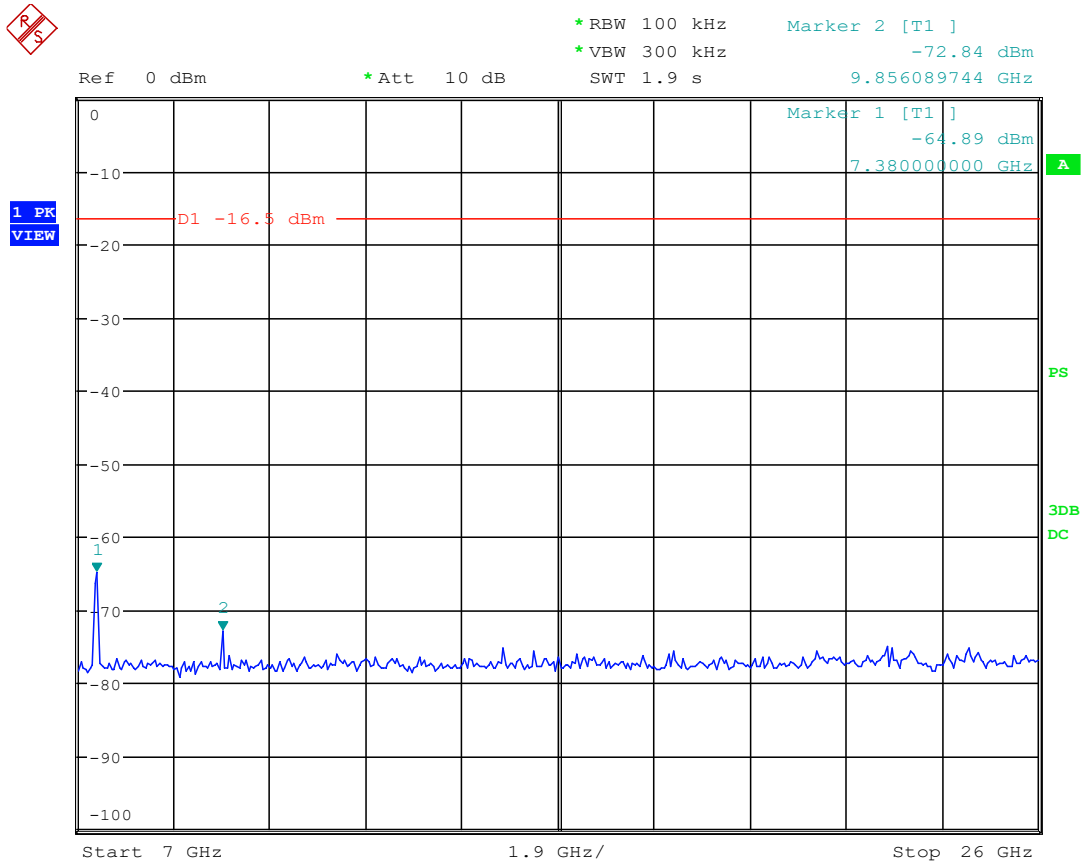
HT20 (MCS7): 2.484 GHz to 7 GHz



Date: 10.OCT.2018 15:07:28



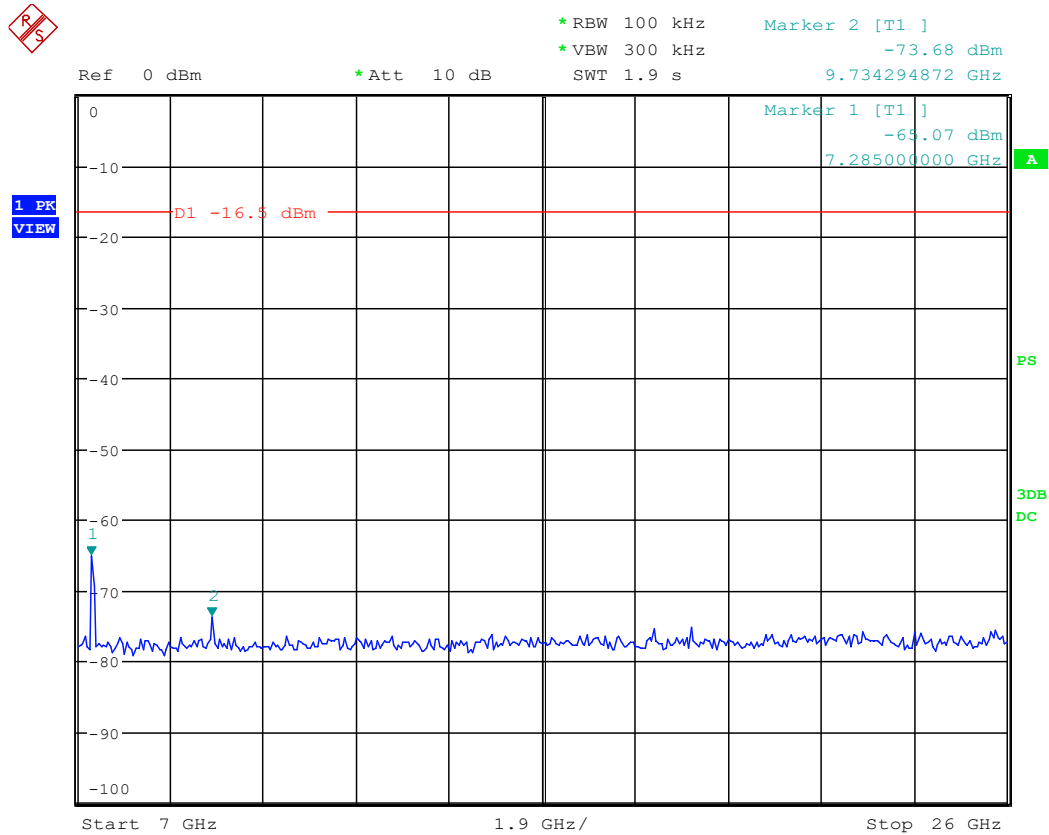
HT20 (MCS7): 7 GHz to 26 GHz, High Channel



Date: 8.JUL.2020 14:40:28



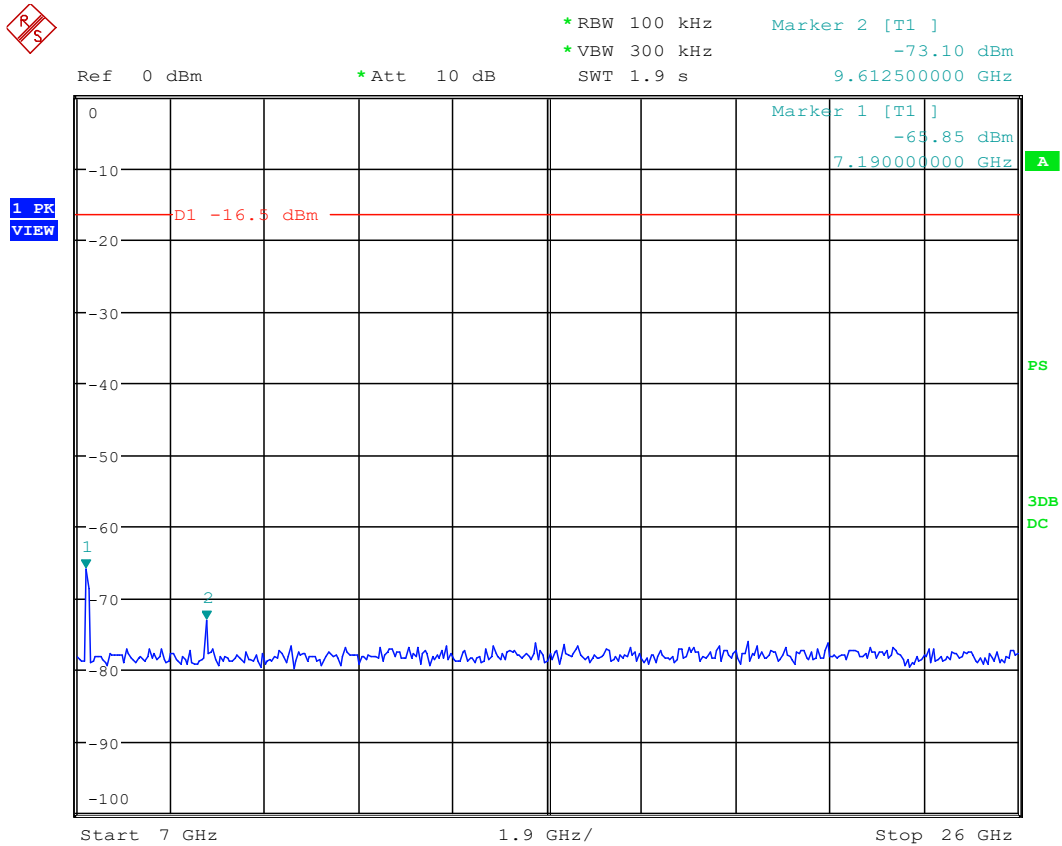
HT20 (MCS7): 7 GHz to 26 GHz, Mid Channel



Date: 8.JUL.2020 14:39:35



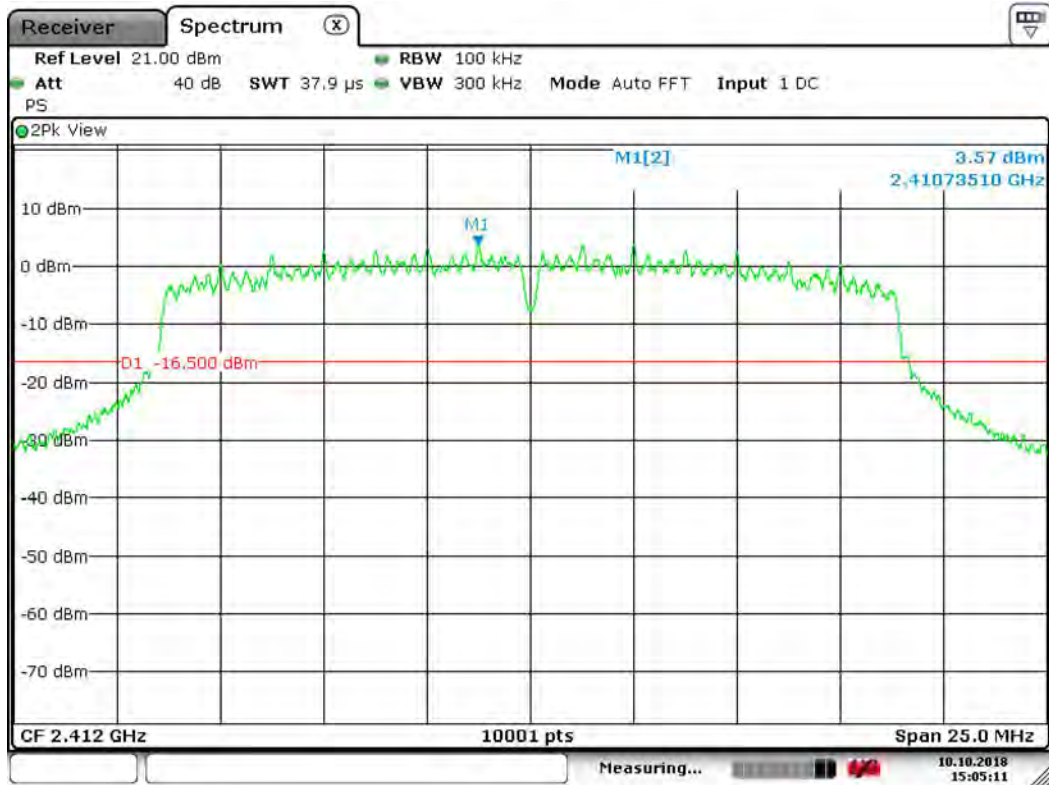
HT20 (MCS7): 7 GHz to 26 GHz, Low Channel



Date: 8.JUL.2020 14:38:42



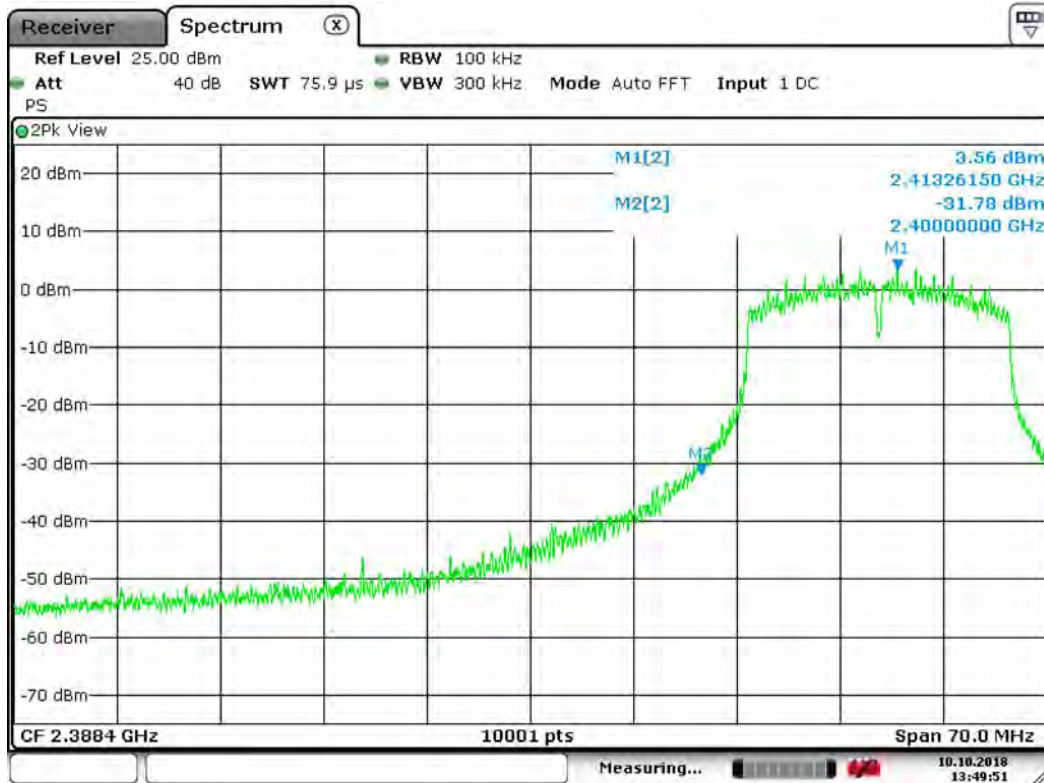
HT20 (MCS7): Band Edge Reference



Date: 10.OCT.2018 15:05:12



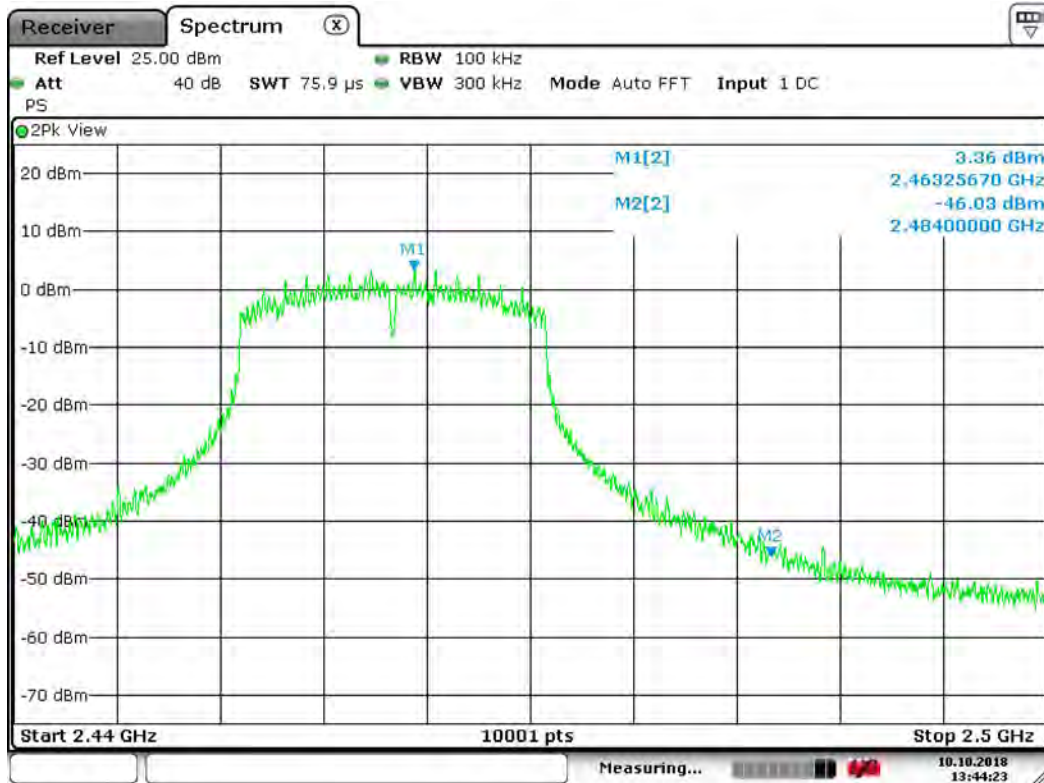
HT20 (MCS7): Lower Band Edge



Date: 10.OCT.2018 13:49:51



HT20 (MCS7): Upper Band Edge



Date: 10.OCT.2018 13:44:23



11 RADIATED SPURIOUS EMISSION

The EUT antenna port was fitted with its integral/internal chip antenna. Radiated emissions were measured in a Semi-Anechoic Chamber. All emissions generated that fall in the restricted bands per FCC Part 15.205 were examined.

11.1 Requirements:

All emissions that fall in the restricted bands defined in FCC Part 15.205 shall not exceed the maximum field strength listed in FCC Part 15.209(a).



11.2 Radiated Spurious Emission Test Data

Test Date(s):	2018-10-11*	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(d); Part 15.209 / KDB558074	Air Temperature:	21.7°C
		Relative Humidity:	58%

**2020-04-29: The EUT was scanned to confirm the data from the previous testing had not changed.*

Notes: Plots are peak, max hold prescan data included only to determine what frequencies to investigate and measure. The EUT was initially placed in a semi-anechoic chamber and rotated in all three orthogonal positions to maximize the emissions. Characterization measurements were then performed to determine at which frequencies significant emissions occurred. These graphs are shown below.

The equipment was fully exercised with all cabling attached to the EUT and was positioned on the OATS for maximum emissions. While the equipment was energized, the receiving antenna was scanned from 1.0 meter to 4.0 meters in both vertical and horizontal polarities while the turntable was adjusted 360 degrees to determine the maximum field strength. The tables of measured results can be found below.

Some of the frequencies did not change with the EUT on or off. At those frequencies, the test distance was shortened to 1 meter and still no emissions from the EUT were visible or over the ambient or limit.

In the following plots, the black line indicates ambient noise and the red line indicates the measurement with the EUT on. Emissions to be found by the EUT were measured and listed in tables. The plots are for reference only and the limit lines are not actual limit lines but merely a guide.

The 20 MHz 802.11n bandwidth was found to be the worst case emissions and the plots are for this protocol, but the emissions data table includes data from all channels.

**Measurements****Low Channel - MaxPeak**

Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Cable Loss & Antenna Factor (dB)	Emission (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
2770.000000	V	50.3	16.7	67.00	74.0	-7.0
3693.119000	V	45.2	19.9	65.10	74.0	-8.9

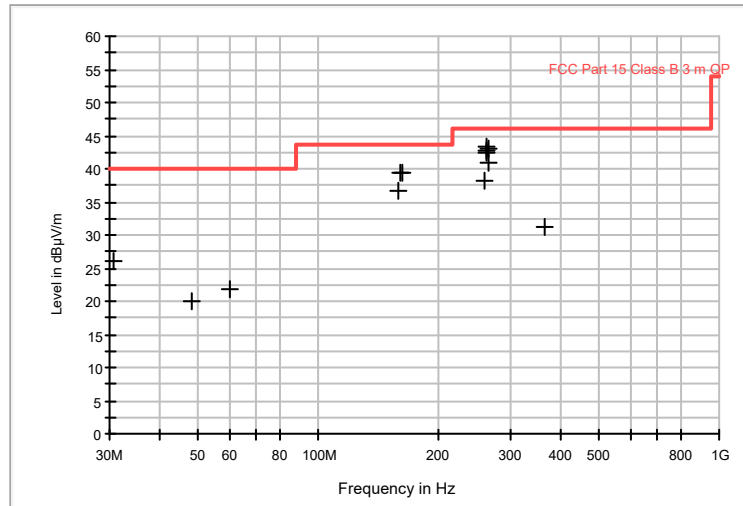
Low Channel - Average

Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Cable Loss & Antenna Factor (dB)	Emission (dB μ V/m)	Emission w/DCCF	Limit (dB μ V/m)	Margin (dB)
2770.000000	V	41.3	16.7	58.00	38.35	54.0	-15.7
3693.119000	V	32.7	19.9	52.60	32.95	54.0	-21.1



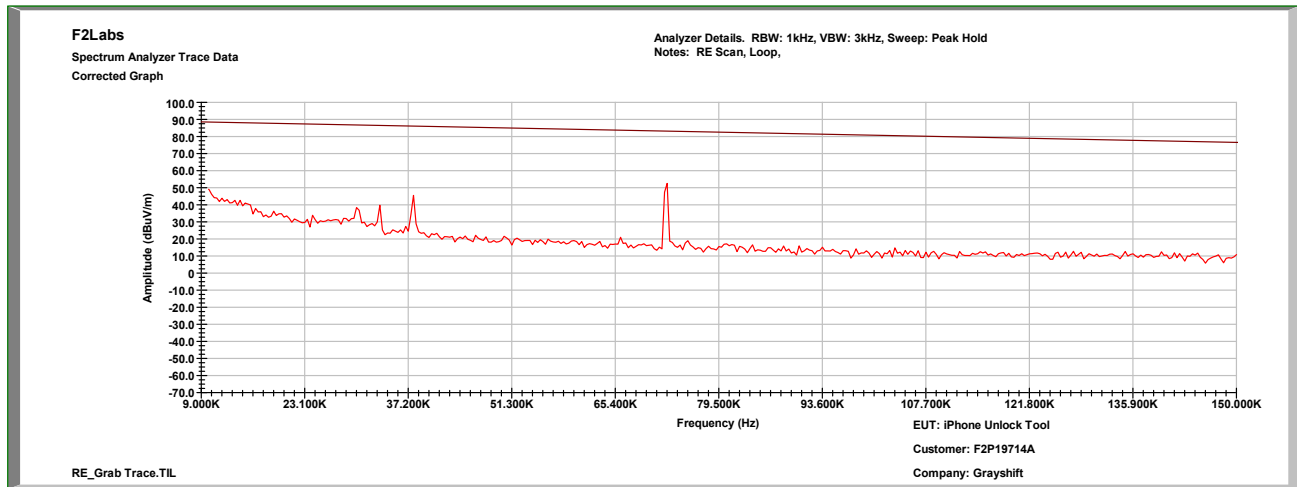
Low Channel - QuasiPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (degrees)	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
30.720000	V	100.00	0.00	21.2	4.8	26.00	40.0	-14.0
47.920000	V	100.00	12.00	27.3	-7.3	20.00	40.0	-20.0
59.920000	V	100.00	0.00	30.8	-8.9	21.90	40.0	-18.1
157.600000	V	100.00	348.00	39.7	-2.9	36.80	40.0	-3.2
158.920000	V	100.00	8.00	42.3	-2.9	39.40	40.0	-0.6
161.600000	V	100.00	0.00	42.2	-2.9	39.30	40.0	-0.7
258.160000	H	100.00	16.00	40.3	-2.1	38.20	47.0	-8.8
261.320000	V	100.00	327.00	44.0	-1.6	42.40	47.0	-4.6
262.720000	V	100.00	90.00	44.0	-1.4	42.60	47.0	-4.4
263.280000	H	100.00	99.00	44.5	-1.3	43.20	47.0	-3.8
264.680000	H	100.00	0.00	44.3	-1.2	43.10	47.0	-3.9
265.200000	V	100.00	49.00	42.2	-1.1	41.10	47.0	-5.9
365.880000	H	100.00	313.00	29.7	1.6	31.30	47.0	-15.7

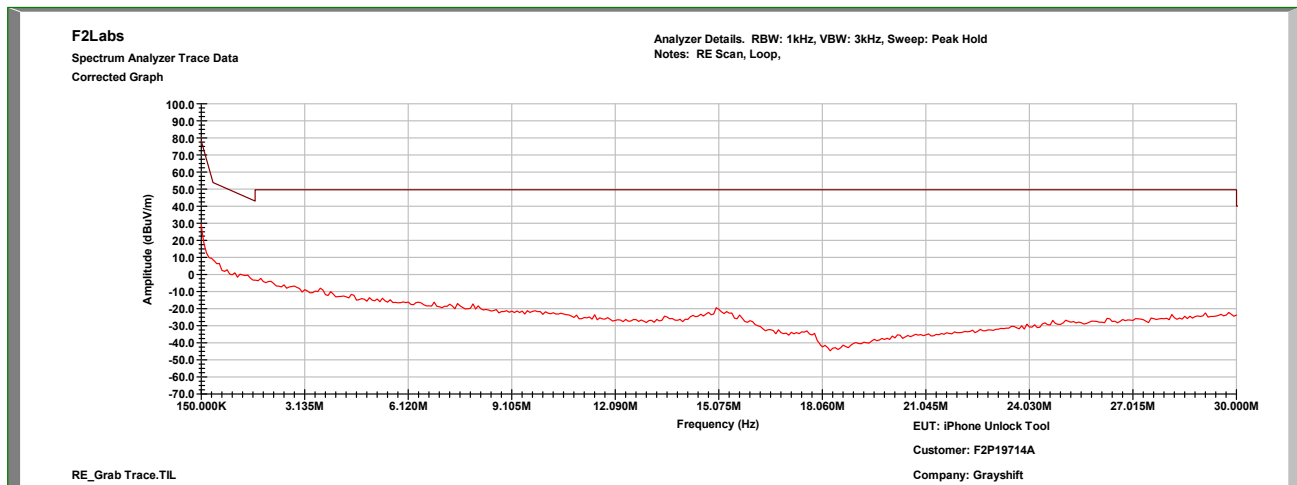




Characterization Scan, 9 kHz to 150 kHz

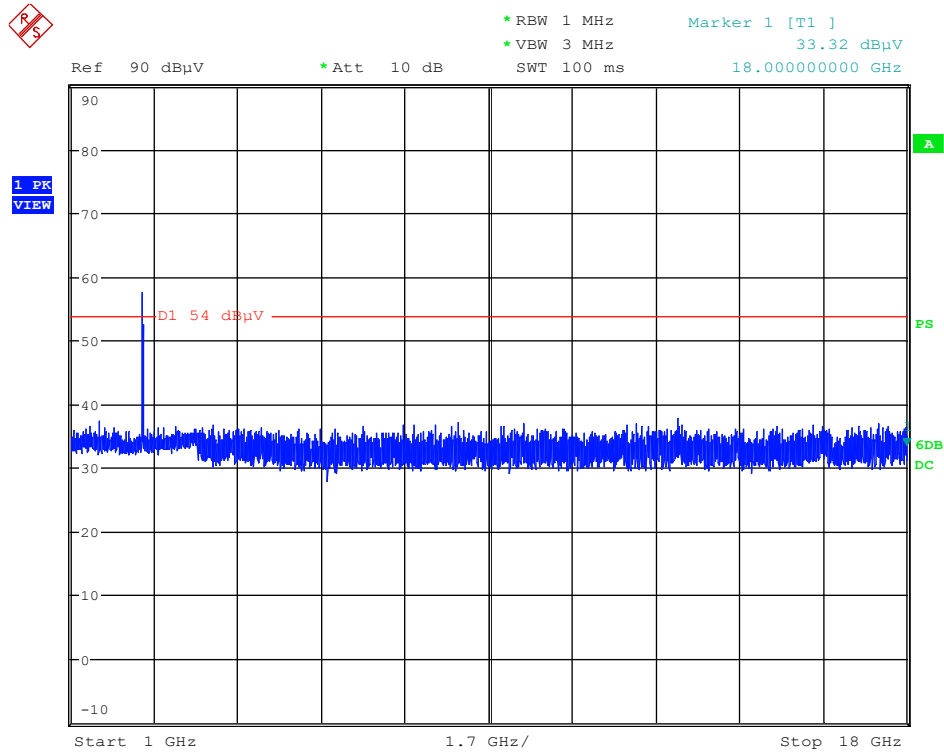


Characterization Scan, 150 kHz to 30 MHz





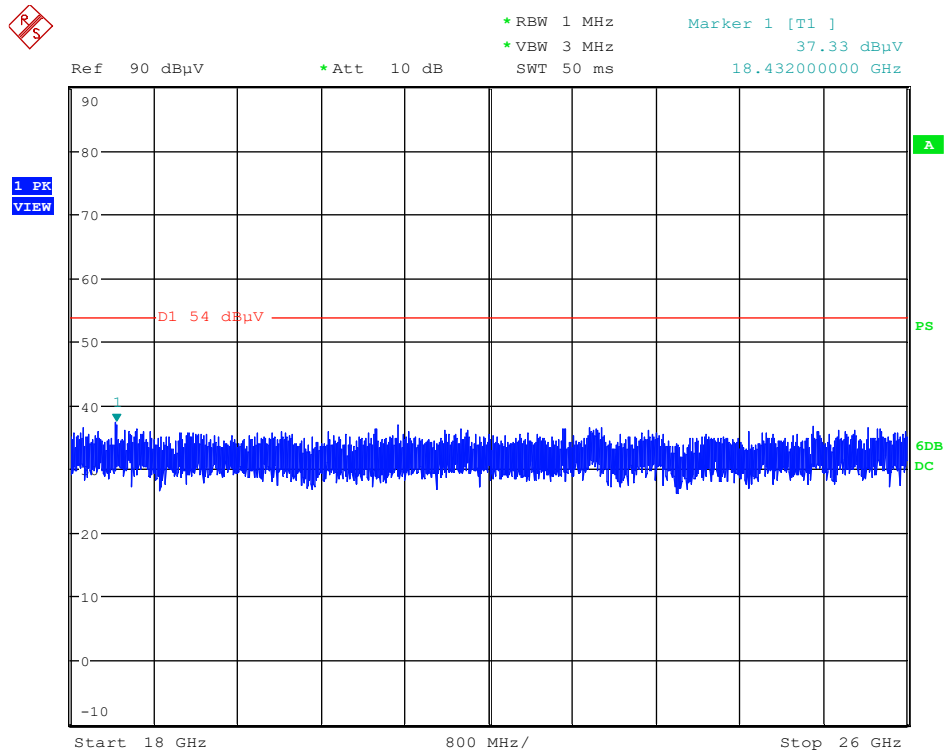
Low Channel, 1 GHz to 18 GHz, Vertical



Date: 22.OCT.2018 16:49:48



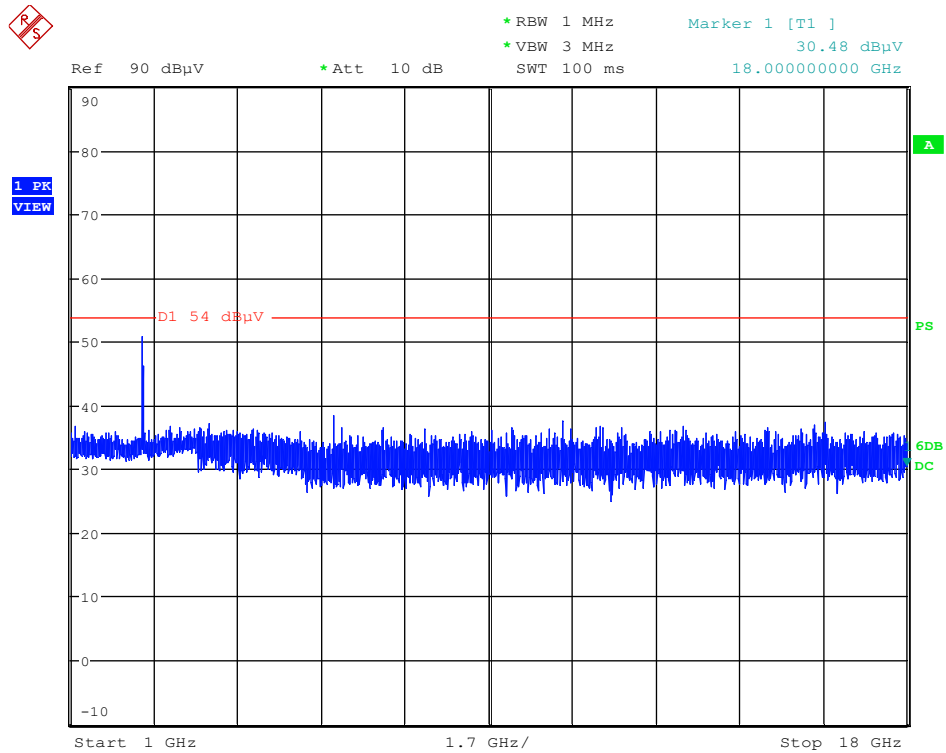
Low Channel, 18 GHz to 26 GHz, Vertical



Date: 22.OCT.2018 15:01:27



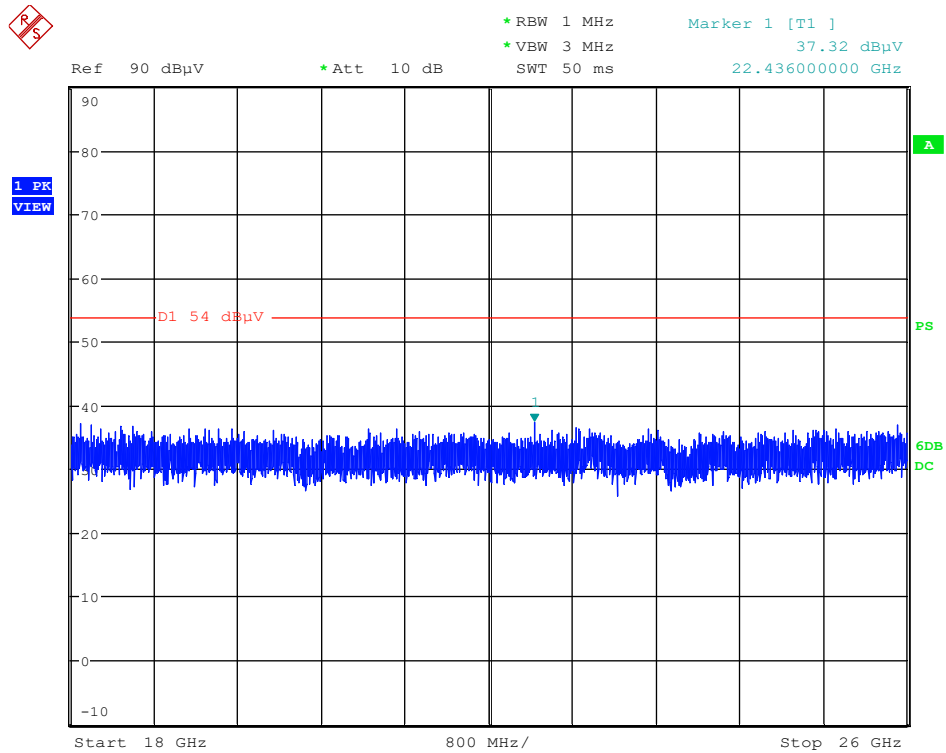
Low Channel, 1 GHz to 18 GHz, Horizontal



Date: 22.OCT.2018 16:51:44



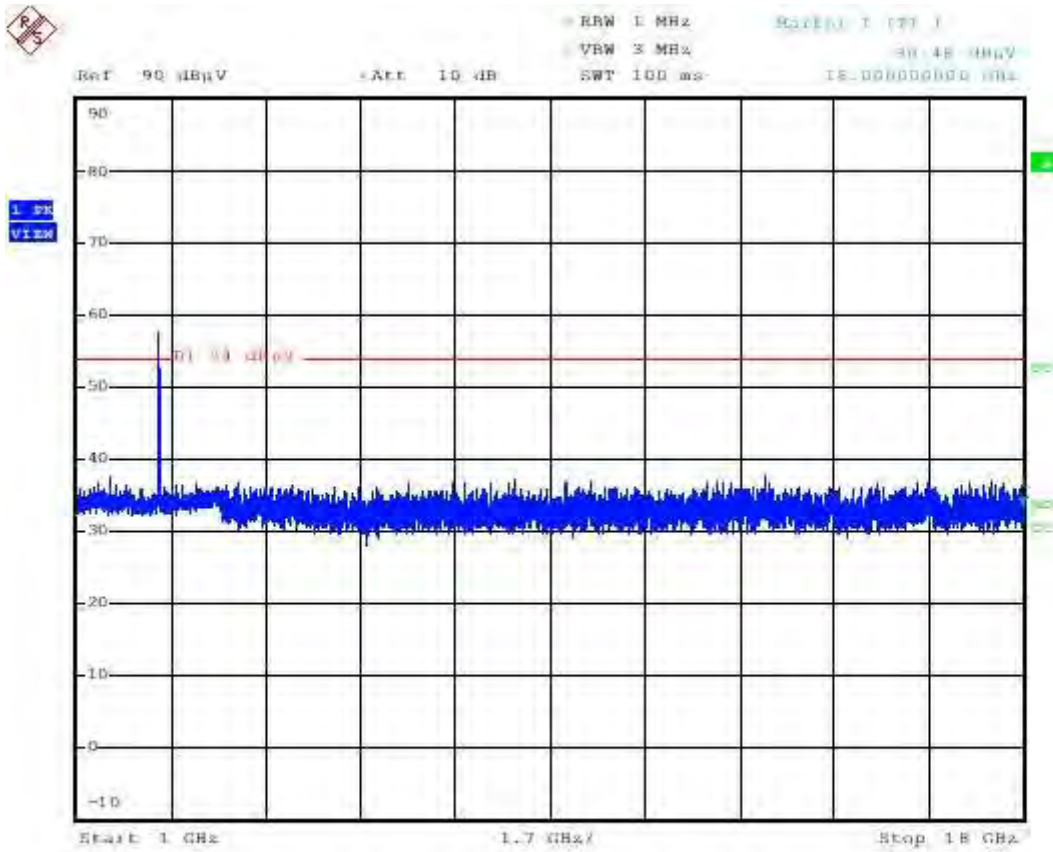
Low Channel, 18 GHz to 26 GHz, Horizontal



Date: 22.OCT.2018 15:00:57



Mid Channel, 1 GHz to 18 GHz, Vertical



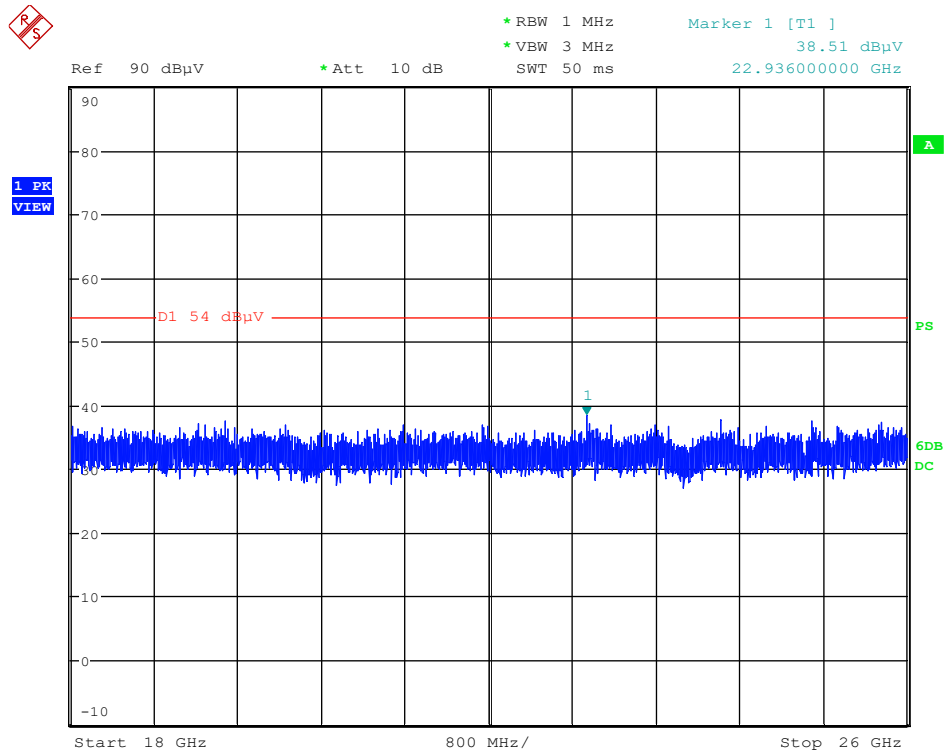
Date: 23.OCT.2018 16:49:48



Order Nos.: F2P19714A, F2P19714A-C1

Client: Grayshift LLC
Model: GK01

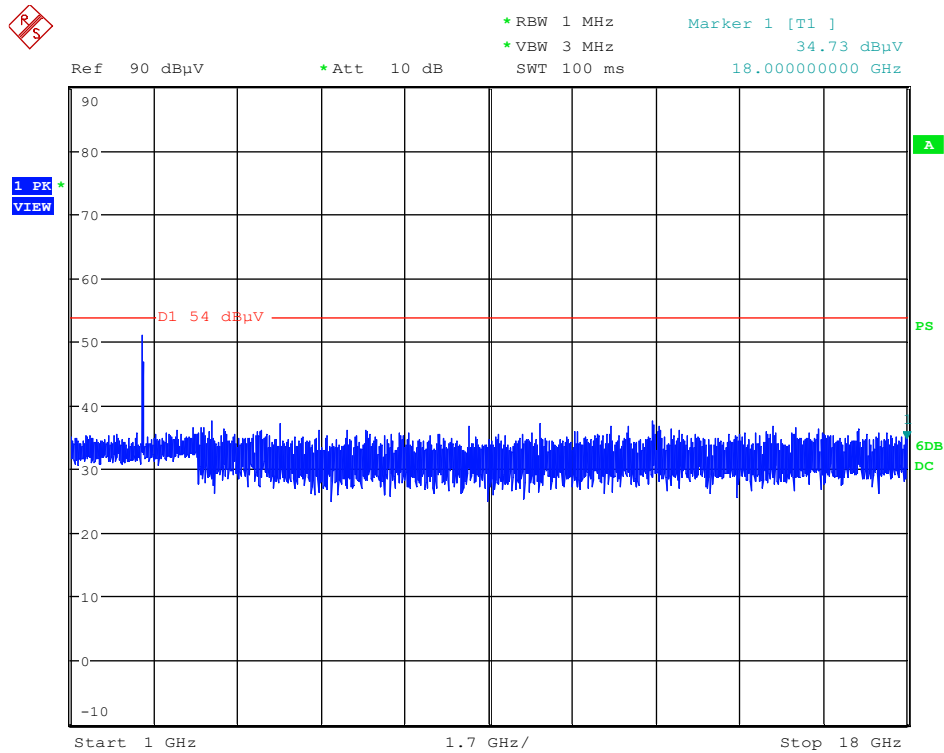
Mid Channel, 18 GHz to 26 GHz, Vertical



Date: 22.OCT.2018 14:59:28



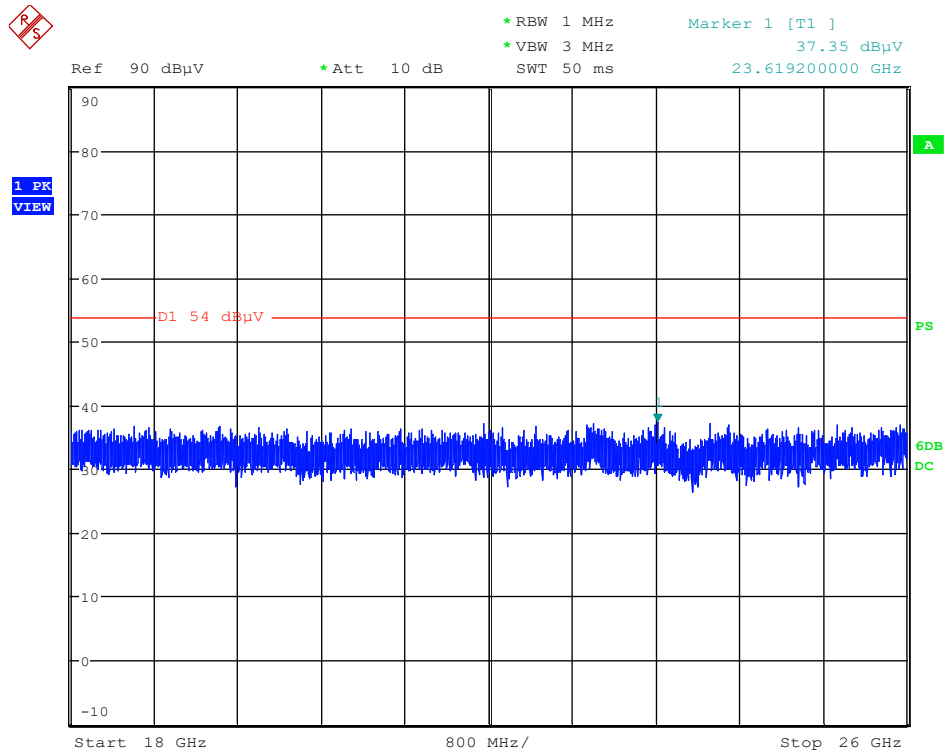
Mid Channel, 1 GHz to 18 GHz, Horizontal



Date: 22.OCT.2018 16:52:14

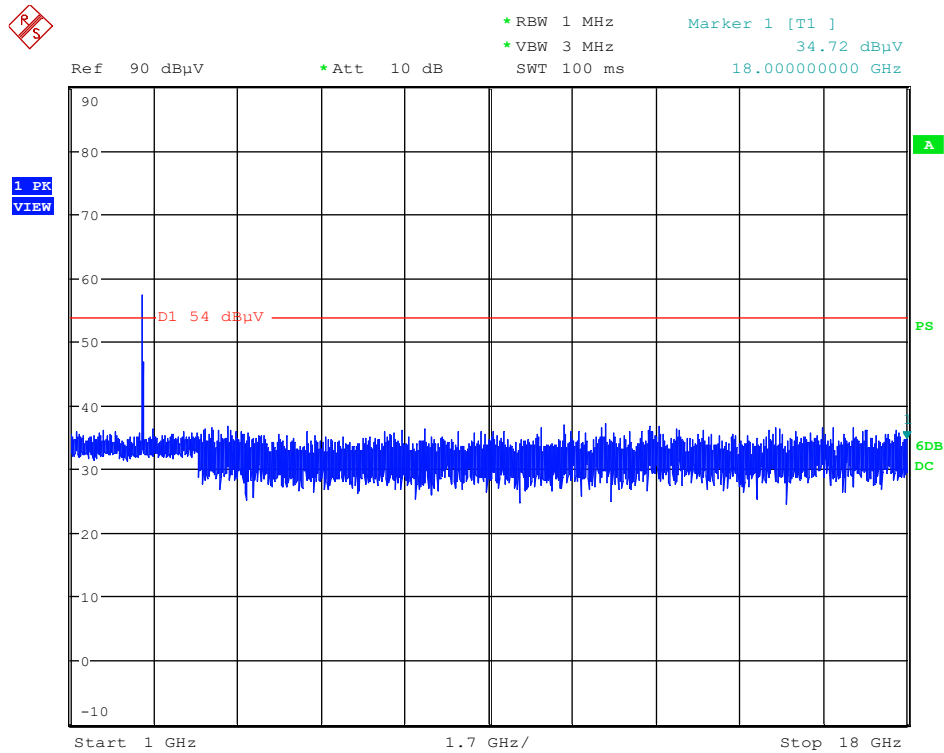


Mid Channel, 18 GHz to 26 GHz, Horizontal



Date: 22.OCT.2018 15:00:06

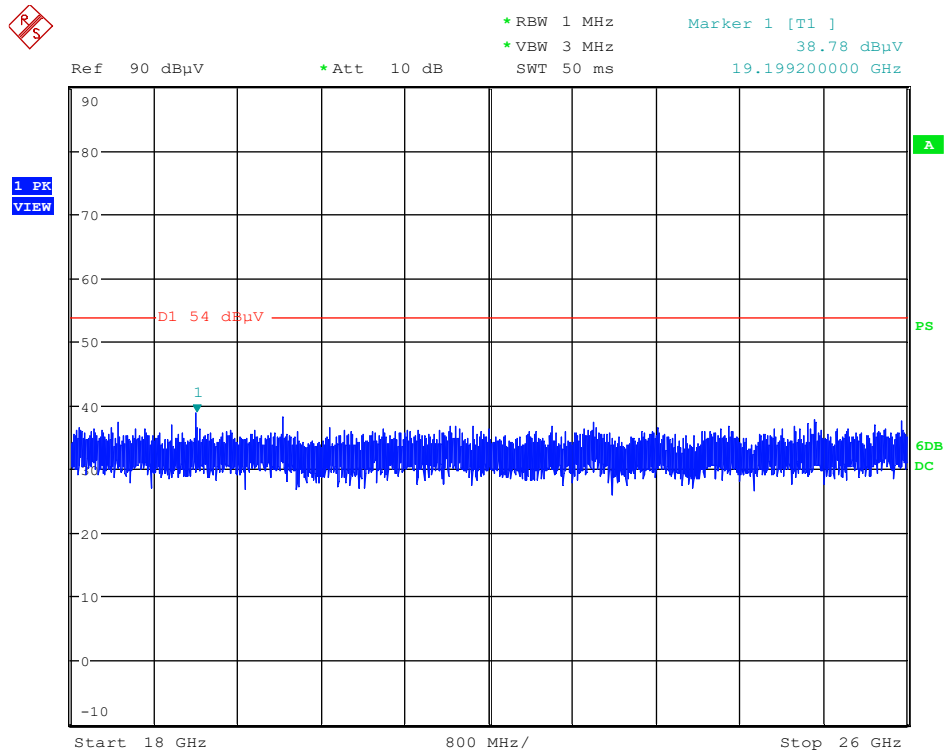
High Channel, 1 GHz to 18 GHz, Vertical



Date: 22.OCT.2018 16:51:03



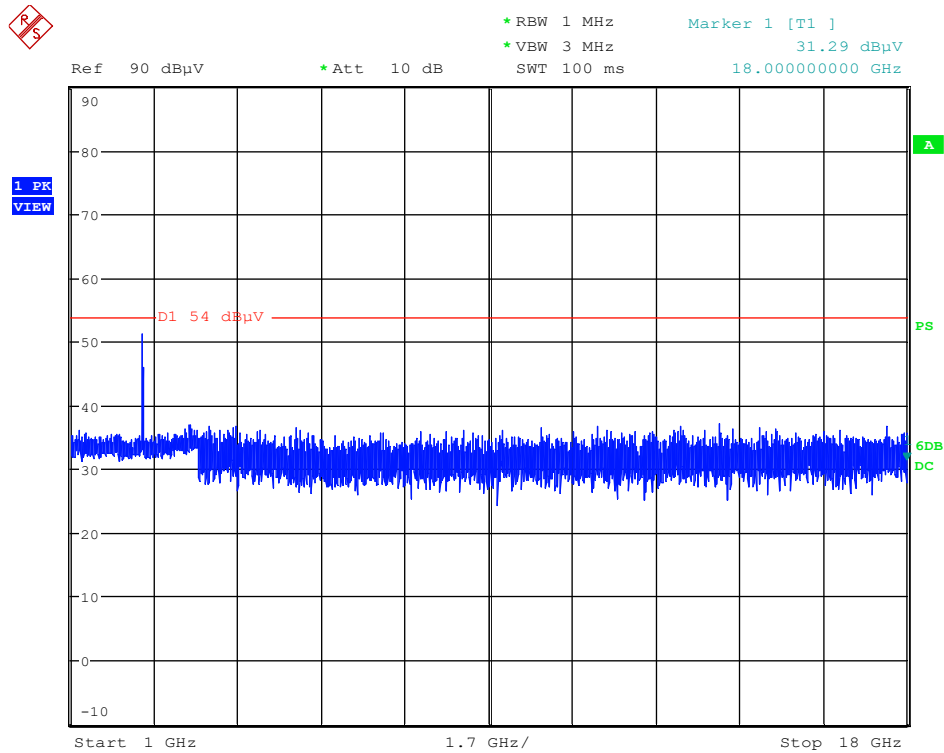
High Channel, 18 GHz to 26 GHz, Vertical



Date: 22.OCT.2018 14:58:56



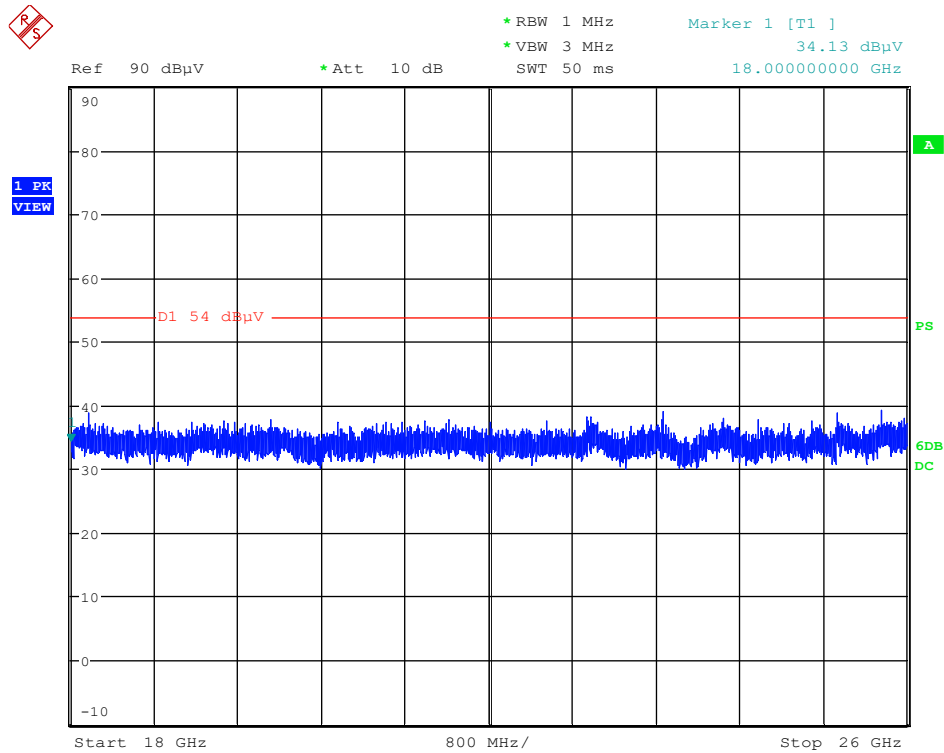
High Channel, 1 GHz to 18 GHz, Horizontal



Date: 22.OCT.2018 16:52:39

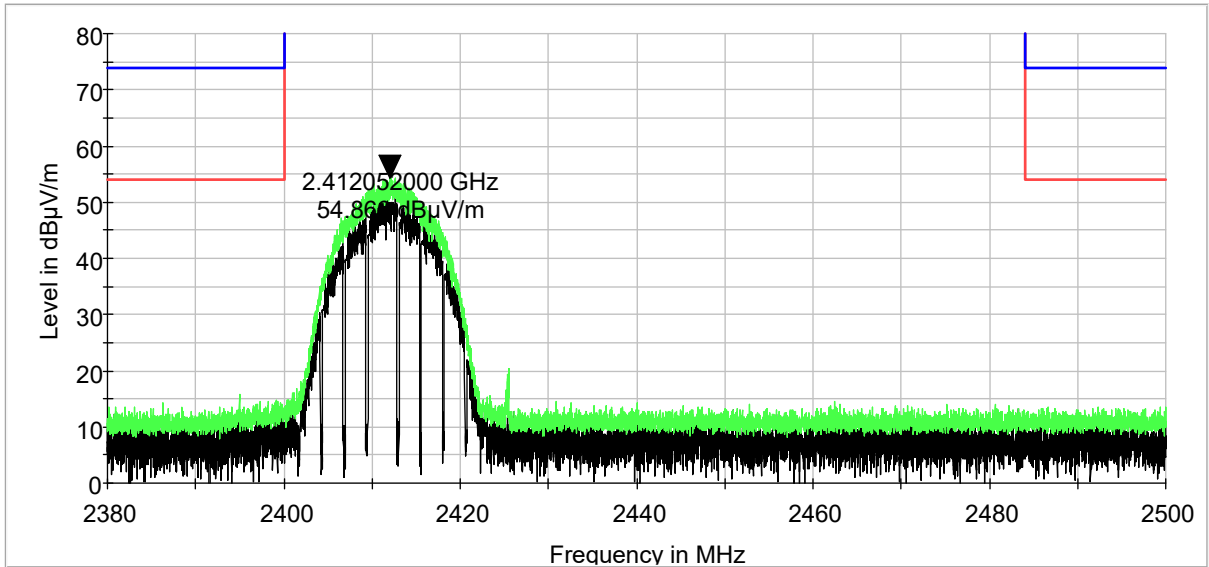


High Channel, 18 GHz to 26 GHz, Horizontal

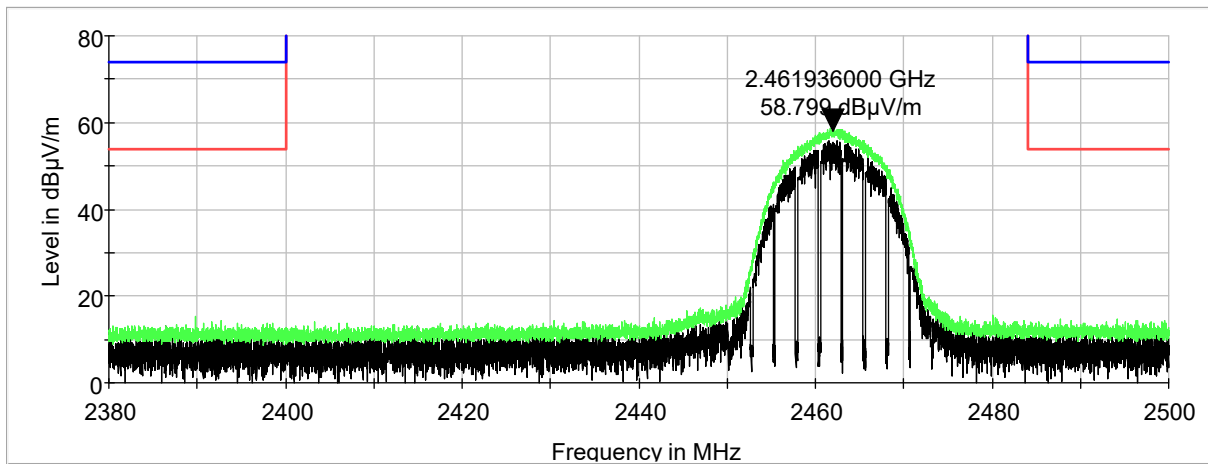




CCK 802.11b: Lower Band Edge



CCK: Upper Band Edge





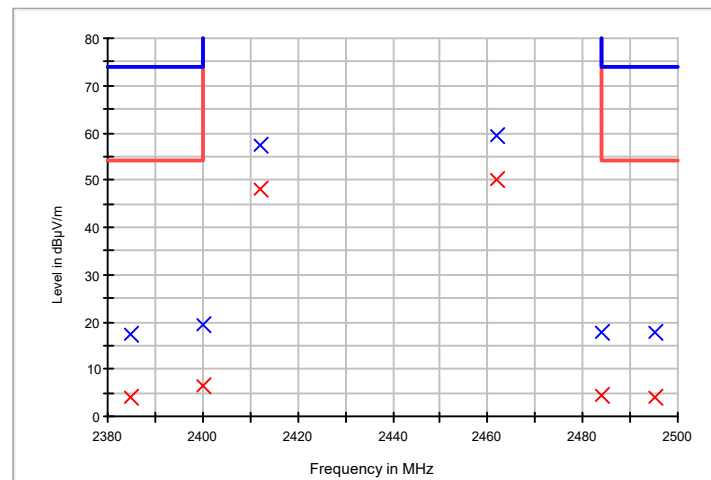
CCK 802.11b: Band Edge Measurements

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2385.00	H	150.00	34.00	36.6	-19.1	17.50	74.0	-56.5
2400.00	H	150.00	34.00	38.9	-19.4	19.50	74.0	-54.5
2412.00	H	150.00	34.00	76.6	-19.3	57.30	--	--
2462.00	H	150.00	43.00	78.6	-19.2	59.40	--	--
2483.50	H	150.00	43.00	36.9	-19.0	17.90	74.0	-56.1
2495.00	H	150.00	43.00	36.5	-18.9	17.60	74.0	-56.4

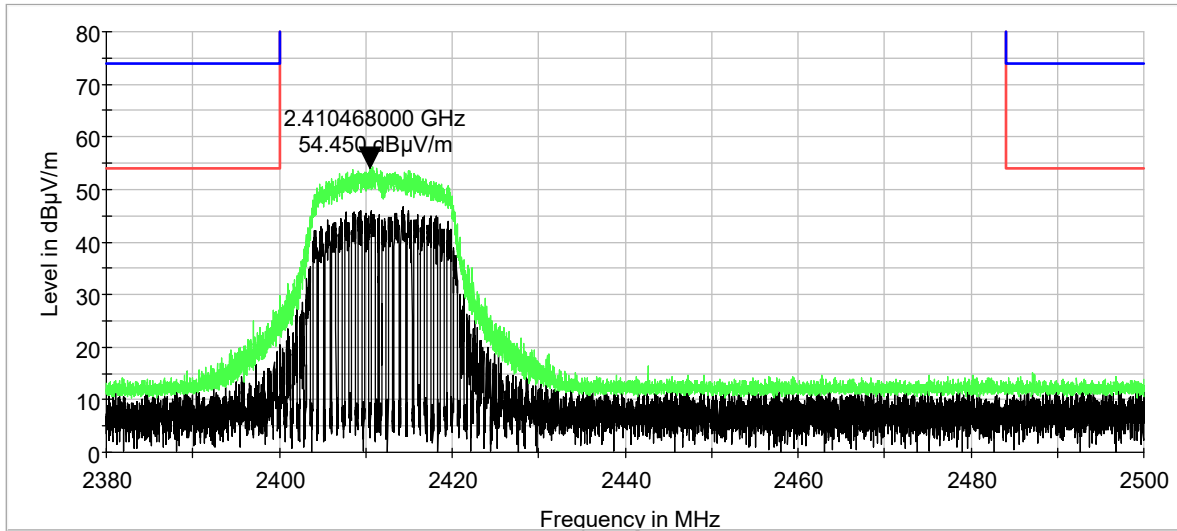
AVG

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2385.00	H	150.00	34.00	22.9	-19.1	3.80	54.0	-50.2
2400.00	H	150.00	34.00	25.9	-19.4	6.50	54.0	-47.5
2412.00	H	150.00	34.00	67.2	-19.3	47.90	--	--
2462.00	H	150.00	43.00	69.3	-19.2	50.10	--	--
2483.50	H	150.00	43.00	23.4	-19.0	4.40	54.0	-49.6
2495.00	H	150.00	43.00	23.1	-18.9	4.20	54.0	-49.8

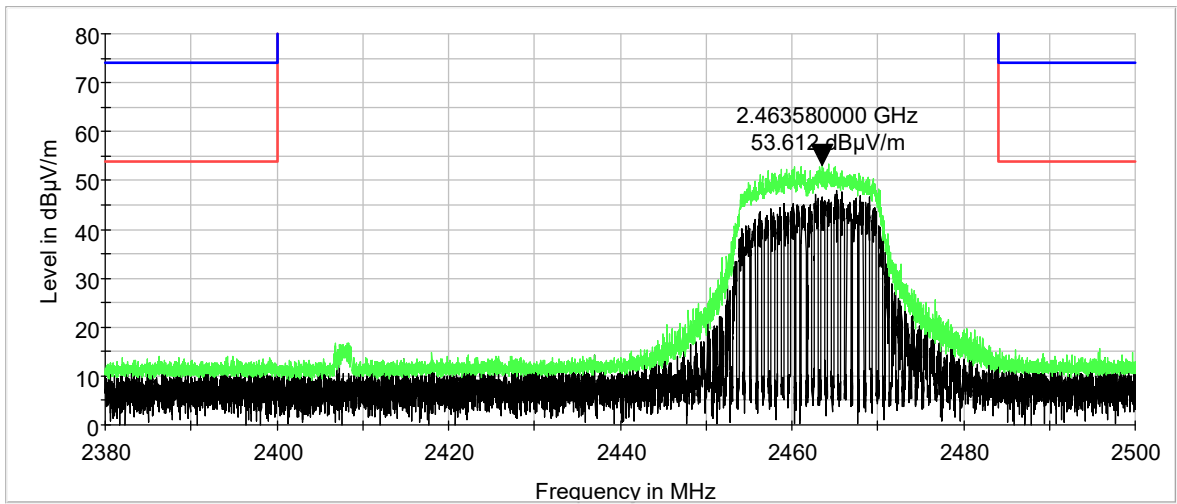




OFDM 802.11g: Lower Band Edge



OFDM 802.11g: Upper Band Edge





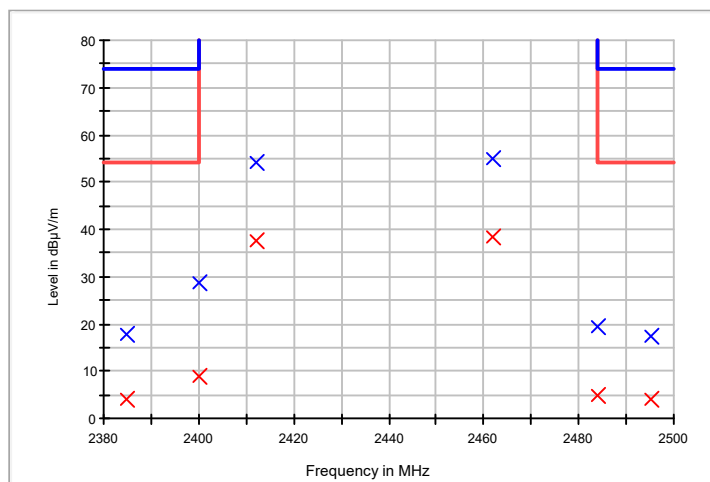
OFDM 802.11g: Band Edge Measurements

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2385.00	V	150.00	280.00	36.7	-19.1	17.60	74.0	-56.4
2400.00	V	150.00	280.00	47.9	-19.4	28.50	74.0	-45.5
2412.00	V	150.00	280.00	73.5	-19.3	54.20	--	--
2462.00	V	150.00	272.00	74.2	-19.2	55.00	--	--
2483.50	V	150.00	272.00	38.3	-19.0	19.30	74.0	-54.7
2495.00	V	150.00	272.00	36.2	-18.9	17.30	74.0	-56.7

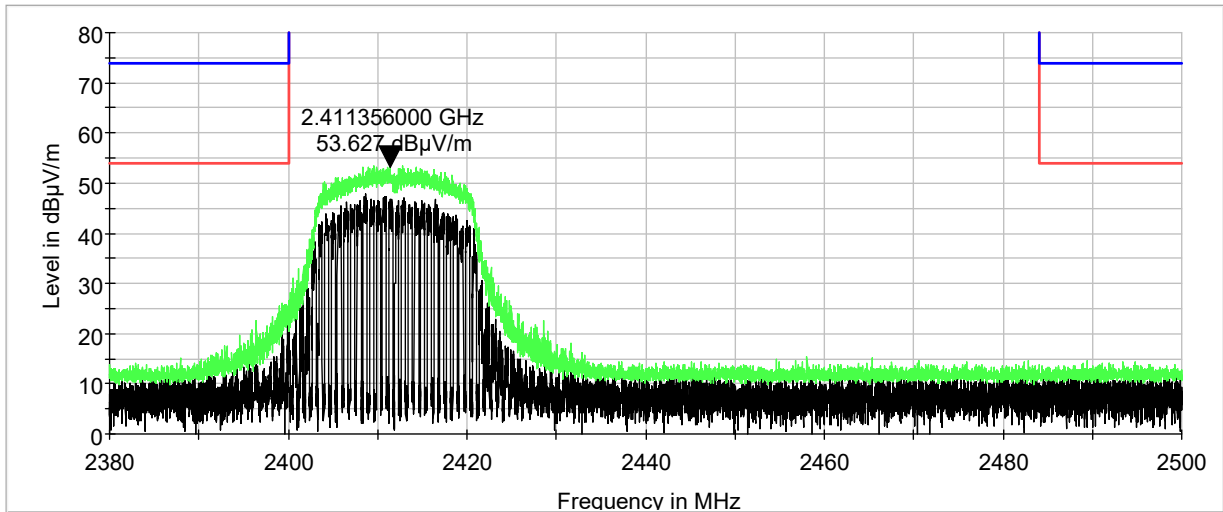
AVG

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2385.00	V	150.00	280.00	23.0	-19.1	3.90	54.0	-50.1
2400.00	V	150.00	280.00	28.2	-19.4	8.80	54.0	-45.2
2412.00	V	150.00	280.00	57.0	-19.3	37.70	--	--
2462.00	V	150.00	272.00	57.4	-19.2	38.20	--	--
2483.50	V	150.00	272.00	23.8	-19.0	4.80	54.0	-49.2
2495.00	V	150.00	272.00	23.1	-18.9	4.20	54.0	-49.8

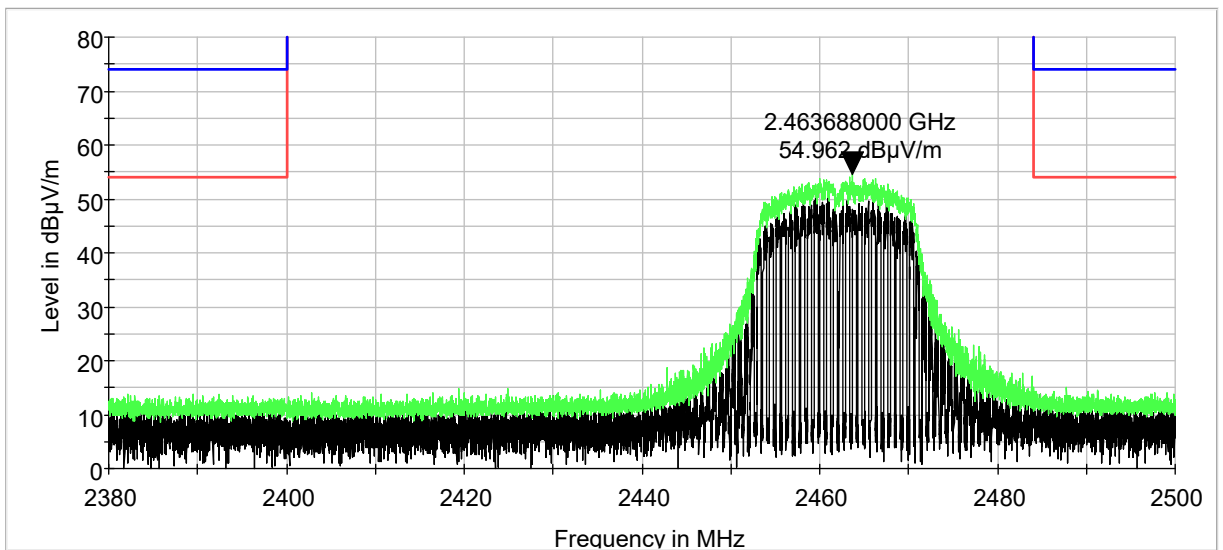




HT20 (MCS7): Lower Band Edge



HT20 (MCS7): Upper Band Edge





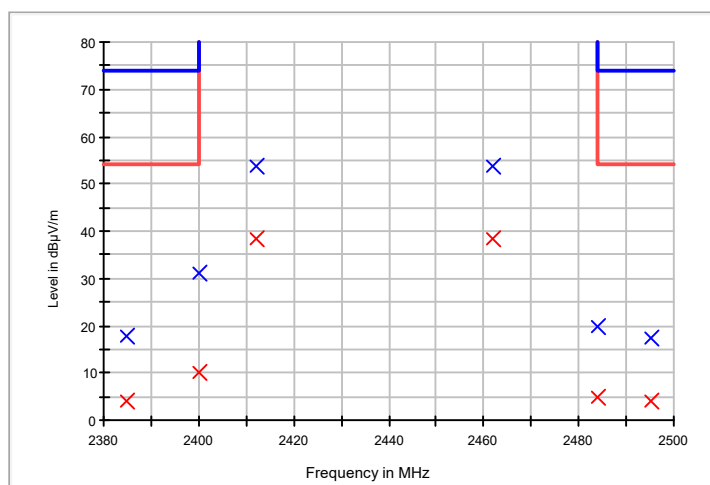
HT20 (MCS7): Band Edge Measurements

MaxPeak

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2385.00	H	150.00	309.00	36.9	-19.1	17.80	74.0	-56.2
2400.00	H	150.00	309.00	50.4	-19.4	31.00	74.0	-43.0
2412.00	H	150.00	309.00	73.0	-19.3	53.70	--	--
2462.00	H	150.00	317.00	73.0	-19.2	53.80	--	--
2483.50	H	150.00	17.00	38.7	-19.0	19.70	74.0	-54.3
2495.00	H	150.00	317.00	36.3	-18.9	17.40	74.0	-56.6

AVG

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (deg)	Reading (dBμV)	Cable Loss & Antenna Factor (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2385.00	H	150.00	309.00	23.2	-19.1	4.10	54.0	-49.9
2400.00	H	150.00	309.00	29.5	-19.4	10.10	54.0	-43.9
2412.00	H	150.00	309.00	57.6	-19.3	38.30	--	--
2462.00	H	150.00	317.00	57.8	-19.2	38.60	--	--
2483.50	H	150.00	17.00	23.7	-19.0	4.70	54.0	-49.3
2495.00	H	150.00	317.00	23.0	-18.9	4.10	54.0	-49.9





12 FCC PART 15.247(e) – PEAK POWER SPECTRAL DENSITY (PSD)

Peak power spectral density measurements were performed.

12.1 Requirements:

The peak power spectral density shall not exceed +8dBm in any 3 kHz band during any time interval of continuous transmission.

Power spectral density measurements were performed at a resolution bandwidth of 3 kHz (video bandwidth set at 10 KHz). The peak spectral densities were measured at the low, mid, and upper channels.

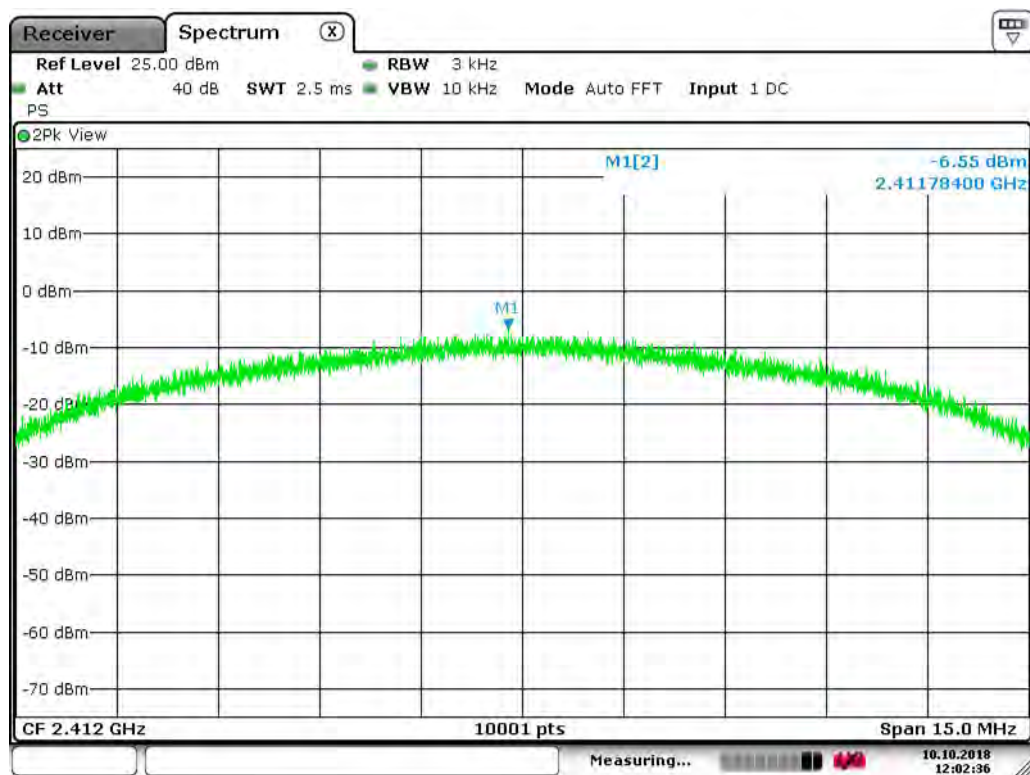


12.2 Peak Power Spectral Density Test Data

Test Date(s):	2018-10-10*	Test Engineer:	J. Chiller
Standards:	CFR 47 Part 15.247(e); KDB558074	Air Temperature:	20.6°C
		Relative Humidity:	46%

*2020-04-29: The EUT was scanned to confirm the data from the previous testing had not changed.

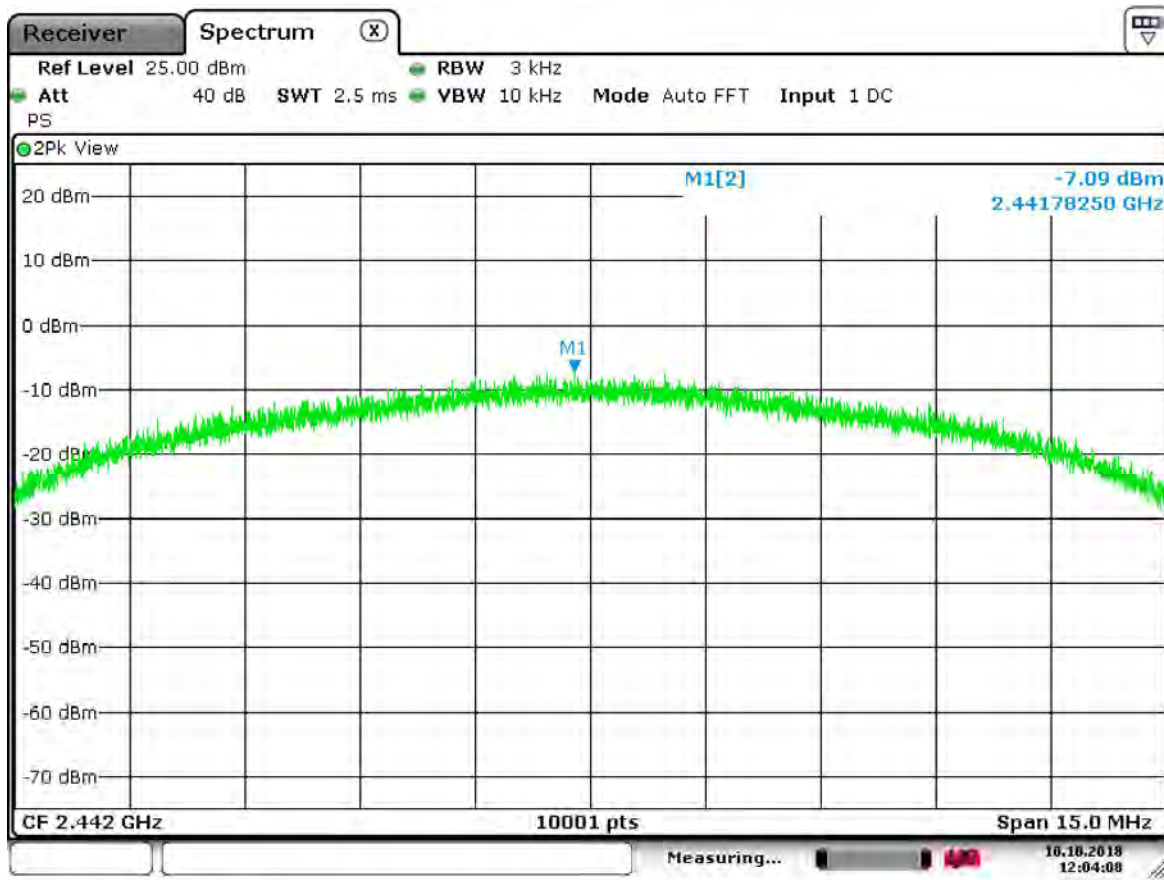
CCK 802.11b, Low Channel



Date: 10.OCT.2018 12:02:36



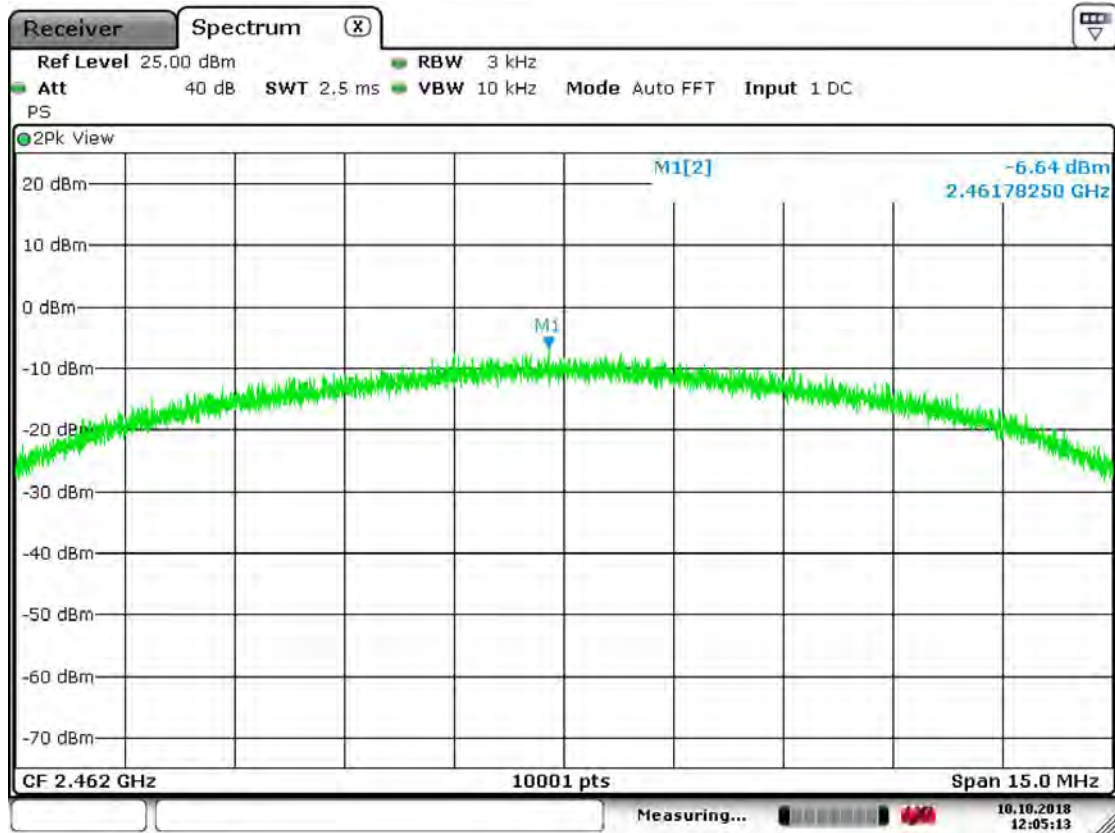
CCK 802.11b, Mid Channel



Date: 10.OCT.2018 12:04:08



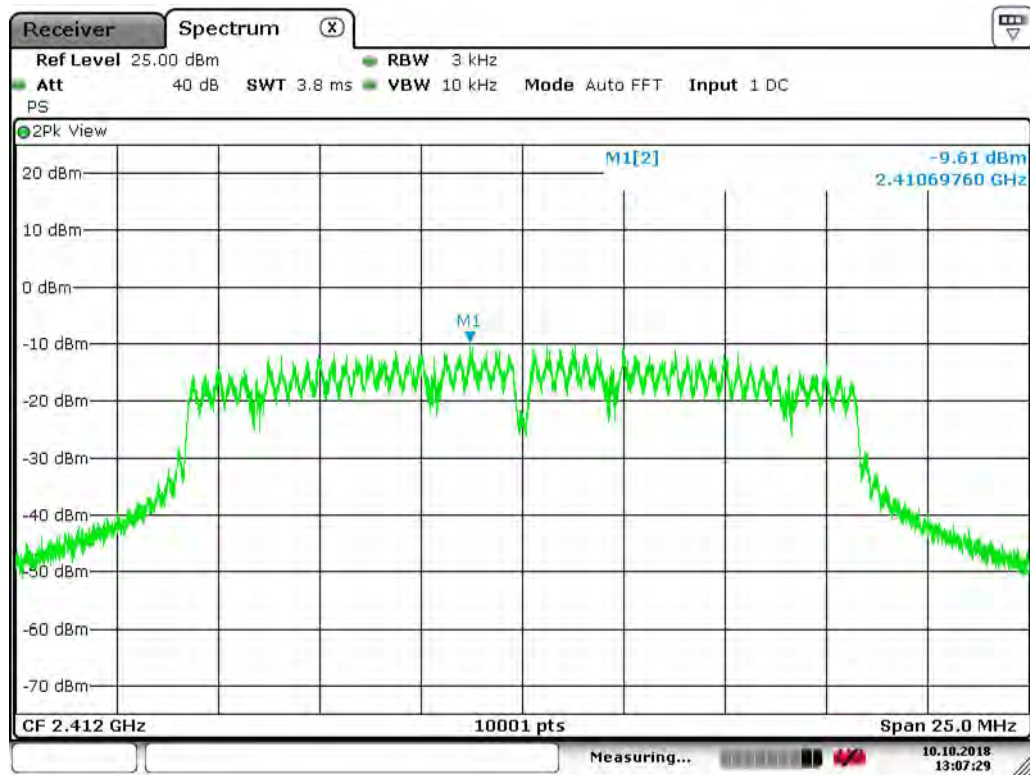
CCK 802.11b, High Channel



Date: 10.OCT.2018 12:05:13



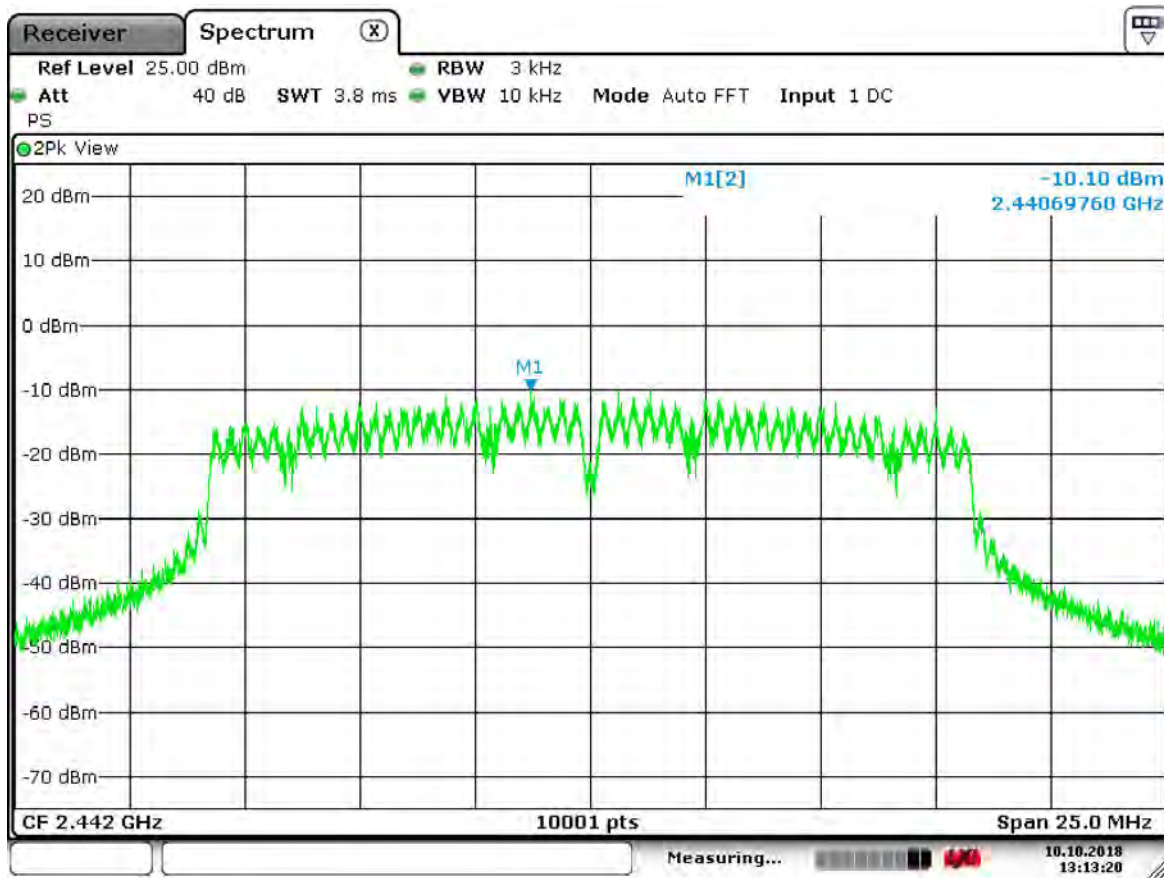
OFDM 802.11g, Low Channel



Date: 10.OCT.2018 13:07:29



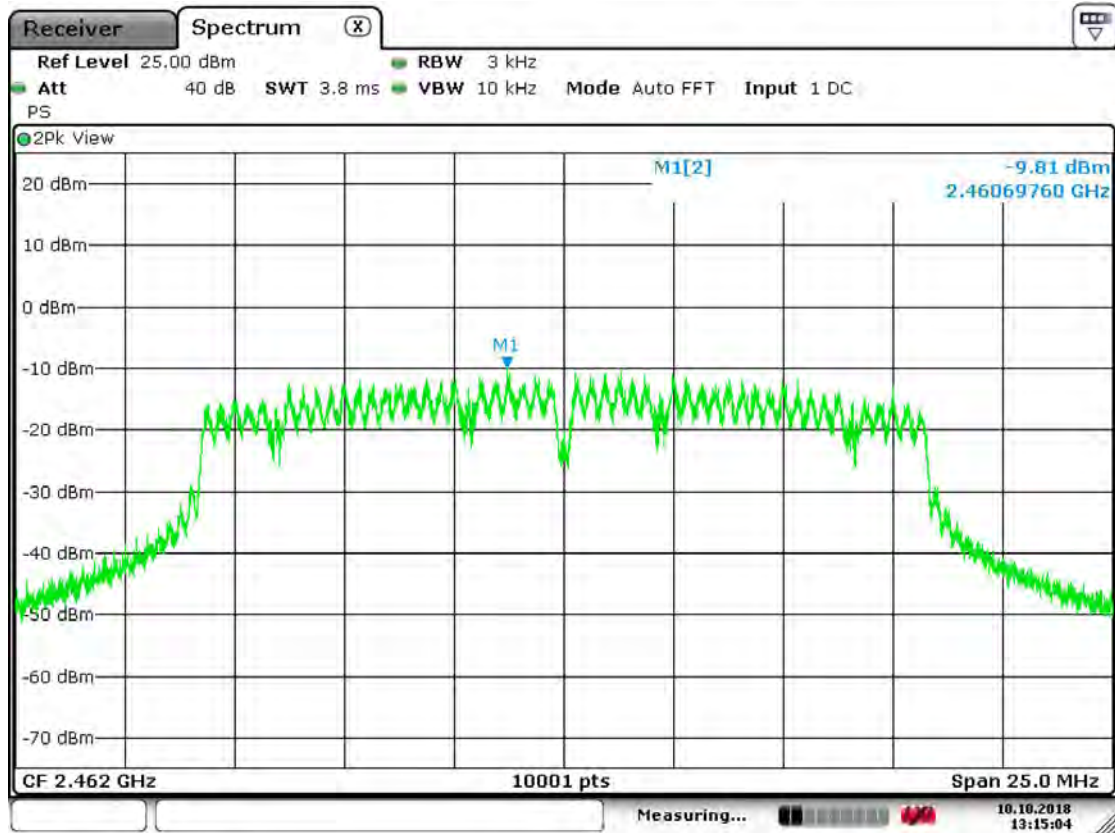
OFDM 802.11g, Mid Channel



Date: 10.OCT.2018 13:13:20



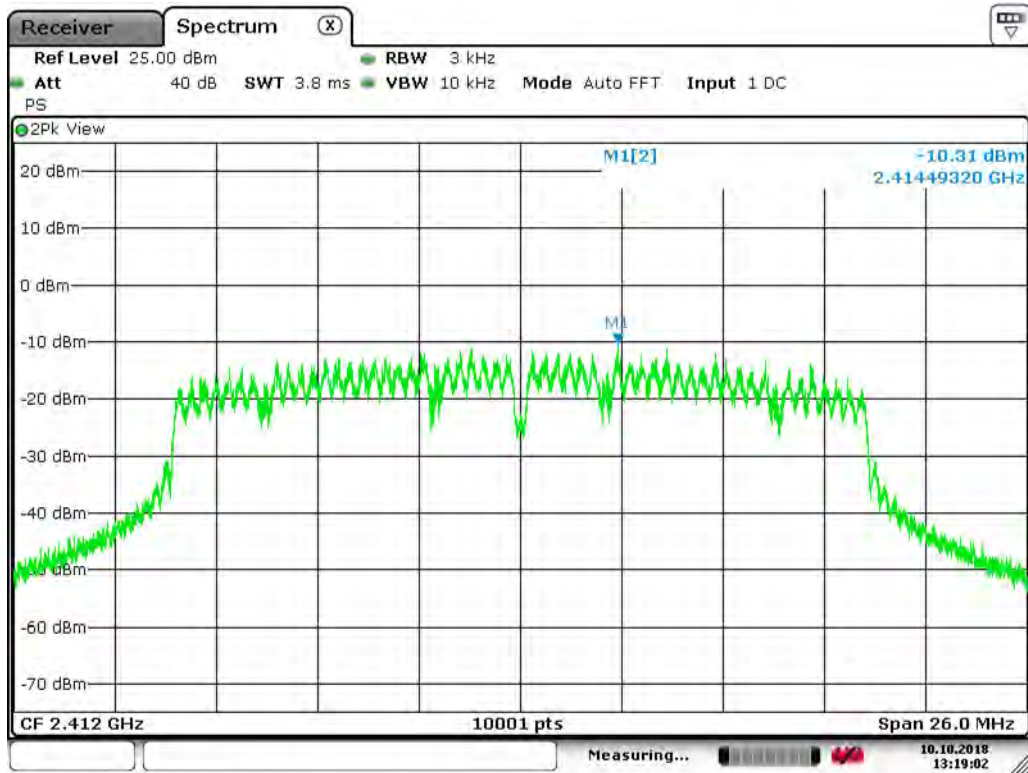
OFDM 802.11g, High Channel



Date: 10.OCT.2018 13:15:04



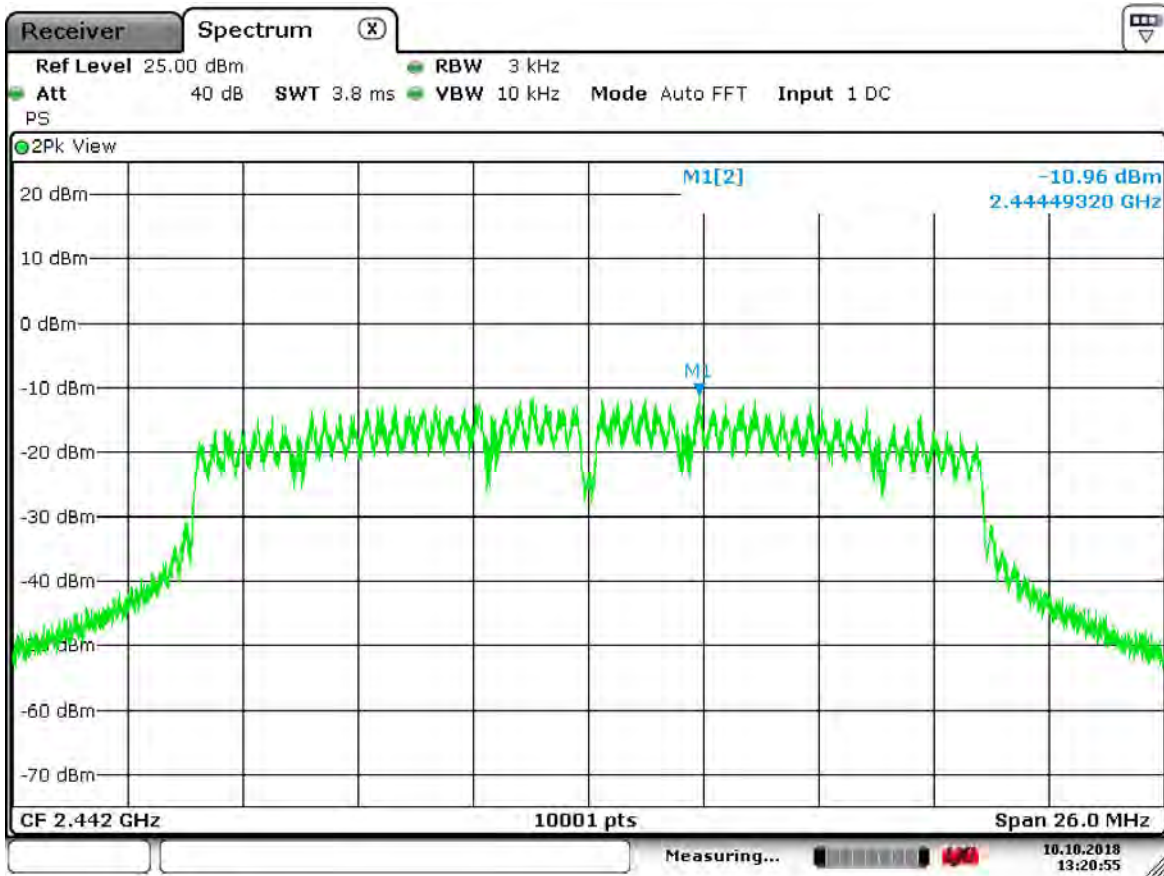
HT20 (MCS7), Low Channel



Date: 10.OCT.2018 13:19:02



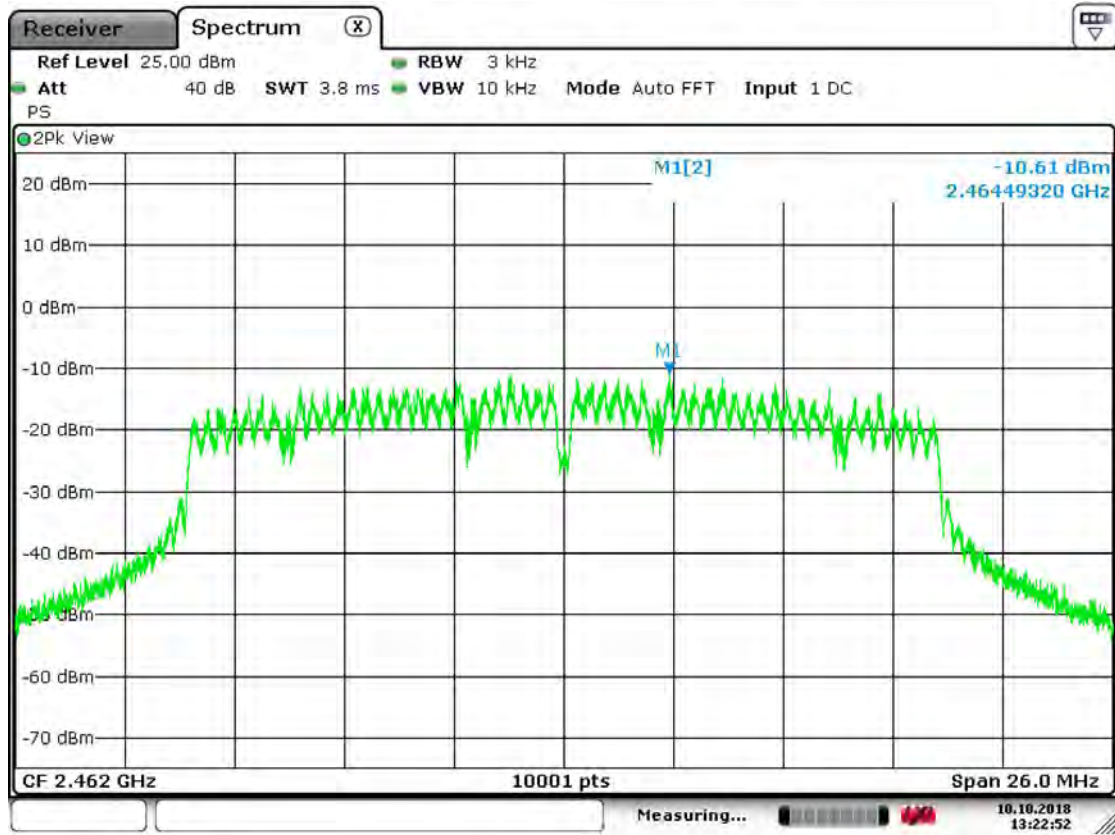
HT20 (MCS7), Mid Channel



Date: 10.OCT.2018 13:20:55



HT20 (MCS7), High Channel



Date: 10.OCT.2018 13:22:53



13 CONDUCTED EMISSIONS

13.1 Requirements

In accordance with FCC CFR 47 Part 15.207(a), "Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that 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 the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

13.2 Procedure

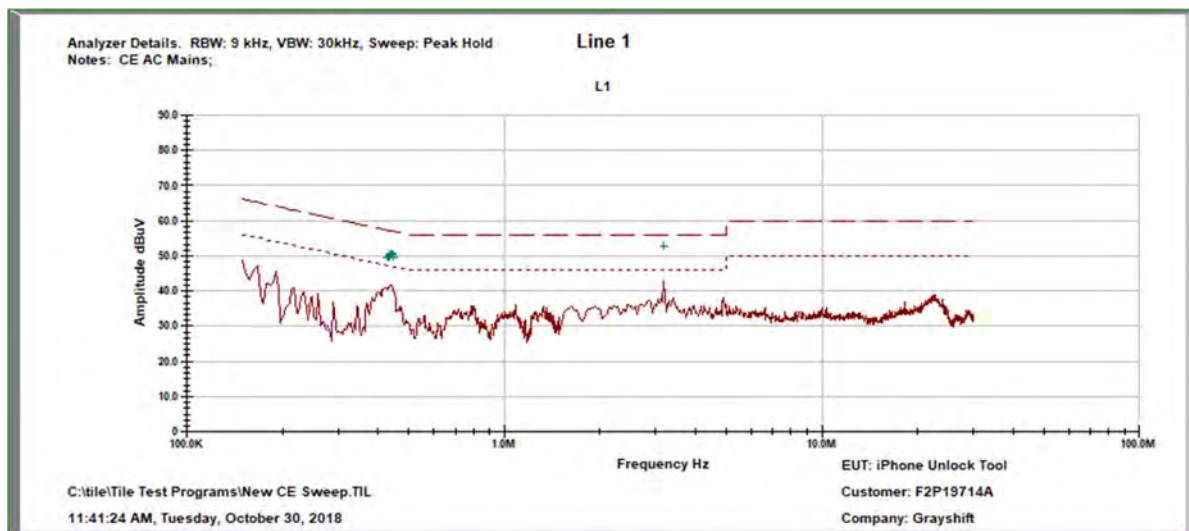
The EUT was placed on a 1.0 x 1.5 meter non-conductive table, 0.8 meter above a horizontal ground plane and 0.4 meter from a vertical ground plane. Power was provided to the EUT through a LISN bonded to a 3 x 2 meter ground plane. The LISN and peripherals were supplied power through a filtered AC power source. The output of the LISN was connected to the input of the receiver via a transient limiter, and emissions in the range 150 kHz to 30 MHz were measured. The measurements were recorded using the quasi-peak and average detectors as directed by the standard, and the resolution bandwidth during testing was 9 kHz. The raw measurements were corrected to allow for attenuation from the LISN, transient limiter and cables.



13.3 Conducted Emissions Test Data

Test Date:	2018-10-10	Test Engineer:	J. Chiller
Rule:	15.207	Air Temperature:	22.1° C
Test Results:	Pass	Relative Humidity:	43%

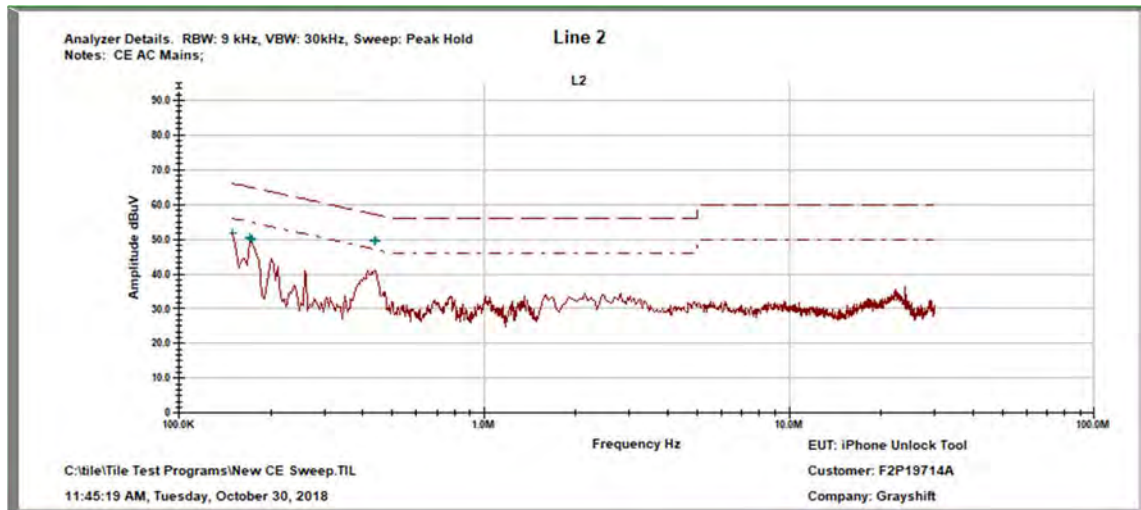
Line 1: 0.15 MHz to 30 MHz



Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBμV)	Adjustment (dB)	Results (dBμV)	Limit (dBμV)	Margin (dB)
1	Line 1	0.42675	Quasi-Peak	29.385	10.457	39.842	57.316	-17.474
		0.42675	Average	25.269	10.457	35.726	47.316	-11.590
2	Line 1	0.4335	Quasi-Peak	30.559	10.452	41.011	57.186	-16.175
		0.4335	Average	23.301	10.452	33.753	57.186	-23.433
3	Line 1	0.435	Quasi-Peak	30.650	10.451	41.101	57.157	-16.056
		0.435	Average	21.353	10.451	31.804	47.157	-15.353
4	Line 1	0.436875	Quasi-Peak	30.474	10.450	40.924	57.121	-16.197
		0.436875	Average	23.086	10.450	33.536	57.121	-23.585
5	Line 1	0.44	Quasi-Peak	30.062	10.448	40.510	57.062	-16.55
		0.44	Average	24.075	10.448	34.523	47.062	-12.539
6	Line 1	0.44025	Quasi-Peak	30.163	10.448	40.611	57.057	-16.446
		0.44025	Average	26.241	10.448	36.689	47.057	-10.368
7	Line 1	0.443625	Quasi-Peak	29.004	10.446	39.450	56.994	-17.544
		0.443625	Average	23.006	10.446	33.452	46.994	-13.542
8	Line 1	0.445	Quasi-Peak	28.806	10.445	39.251	56.968	-17.717
		0.445	Average	23.209	10.445	33.654	46.968	-13.314
9	Line 1	0.447	Quasi-Peak	27.483	10.444	37.927	56.931	-19.004
		0.447	Average	20.920	10.444	31.364	46.931	-15.567
10	Line 1	3.1875	Quasi-Peak	22.032	10.287	32.319	56.0	-23.681
		3.1875	Average	13.569	10.287	23.856	46.0	-22.144



Conducted Test – Line 2: 0.15 MHz to 30 MHz

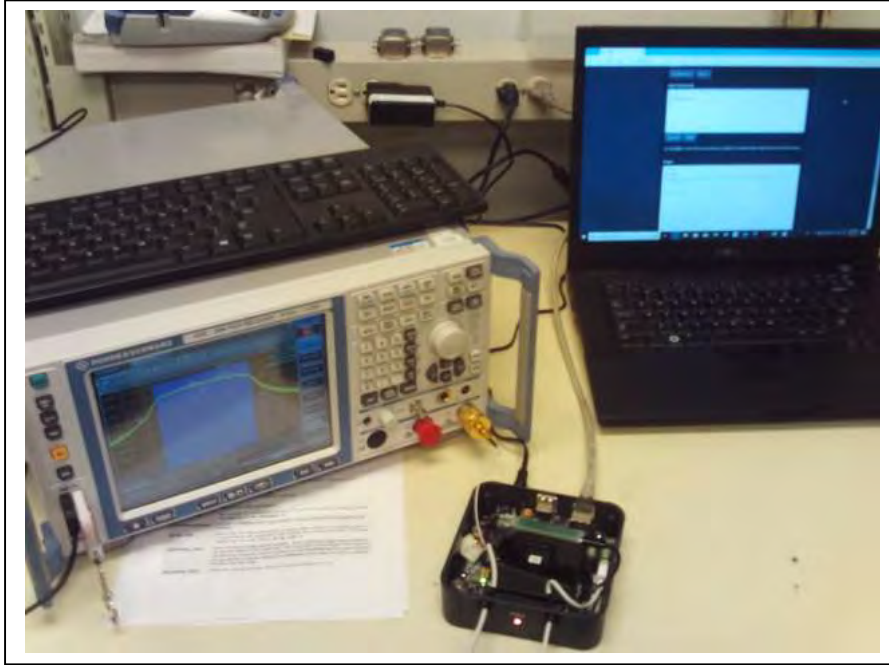


Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBμV)	Adjustment (dB)	Results (dBμV)	Limit (dBμV)	Margin (dB)
1	Line 2	0.15	Quasi-Peak	34.520	11.555	46.075	66.0	-19.925
		0.15	Average	18.326	11.555	29.881	56.0	-26.119
2	Line 2	0.17	Quasi-Peak	31.516	11.290	42.806	64.961	-22.155
		0.17	Average	20.788	11.290	32.078	54.961	-22.883
3	Line 2	0.17025	Quasi-Peak	31.499	11.287	42.786	64.949	-22.163
		0.17025	Average	17.739	11.287	29.026	54.949	-25.923
4	Line 2	0.172749	Quasi-Peak	30.964	11.259	42.223	64.828	-22.605
		0.172749	Average	16.866	11.259	28.125	54.828	-26.703
5	Line 2	0.173625	Quasi-Peak	31.065	11.252	42.317	64.786	-22.47
		0.173625	Average	15.374	11.252	26.626	54.786	-28.160
6	Line 2	0.435	Quasi-Peak	28.630	10.451	39.081	57.157	-18.076
		0.435	Average	22.339	10.451	32.790	47.157	-14.367
7	Line 2	0.436875	Quasi-Peak	28.452	10.450	38.902	57.121	-18.219
		0.436875	Average	23.097	10.450	33.547	47.121	-13.574
8	Line 2	0.44	Quasi-Peak	27.917	10.448	38.365	57.062	-18.697
		0.44	Average	21.999	10.448	32.447	47.062	-14.615
9	Line 2	0.44025	Quasi-Peak	27.942	10.448	38.390	57.057	-18.667
		0.44025	Average	23.135	10.448	33.583	47.057	-13.474
10	Line 2	0.443625	Quasi-Peak	26.620	10.446	37.066	56.994	-19.928
		0.443625	Average	21.291	10.446	31.737	46.994	-15.257



14 PHOTOGRAPHS

**Conducted Output Power, Peak Power Spectral Density,
Occupied Bandwidth, and Conducted Spurious Emissions**



Voltage Variations

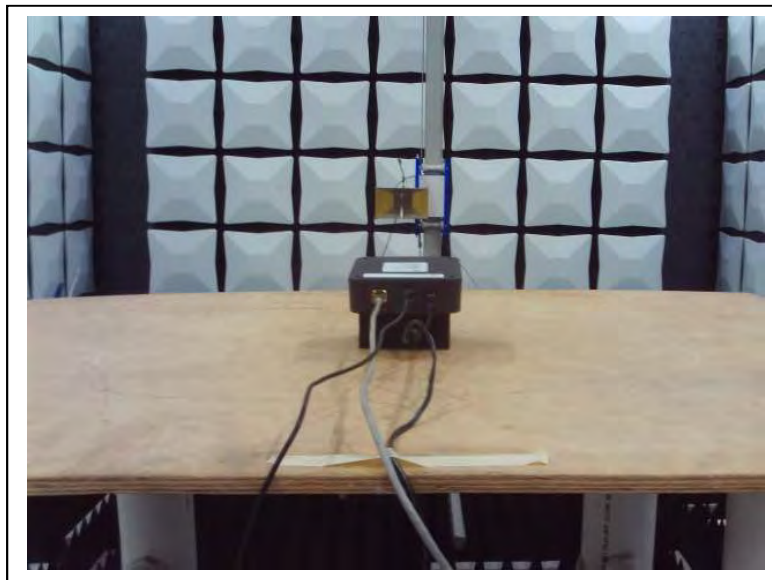




Radiated Spurious Emissions, 30 MHz to 1000 MHz

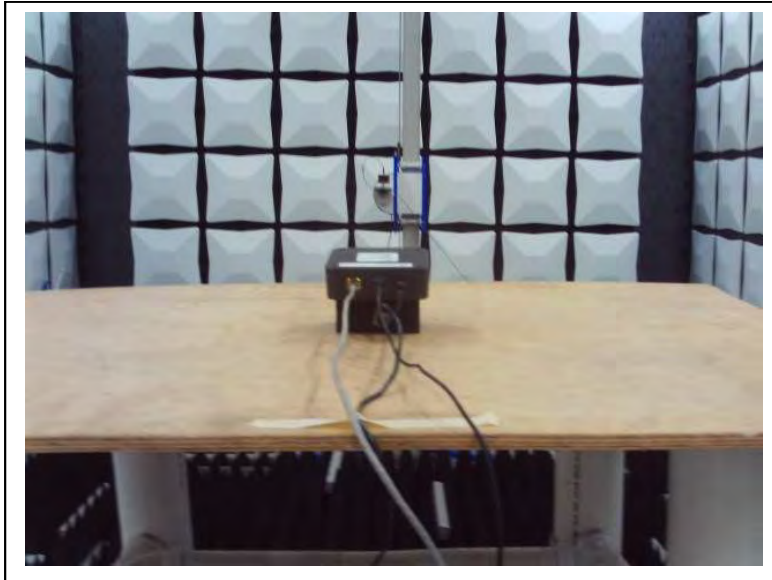


Radiated Spurious Emissions, 1 GHz to 18 GHz





Radiated Spurious Emissions, 18 GHz to 26 GHz



Conducted Emissions

