HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO: FCC 47 CFR part 15 section 15.255;
RSS-210 issue 10 Annex J, RSS-Gen issue 5

FOR:

Radwin Ltd.
PtP/PtMP 60 GHz Radio Transceiver
Models:
RADWIN 6000 TerraWIN™ 625G
RADWIN 6000 TerraWIN™ 601G
FCC ID:Q3K-TRWN600G
IC:5100A-TRWN600G

Table of contents

1 Applicant information

Client name:	Radwin Ltd.
Address:	27 HaBarzel St., Ramat Hahayal, Tel Aviv, 6971039, Israel
Telephone:	+972 (3) 766 2900
Fax:	+972 (3) 766 2902
E-mail:	slava_la@radwin.com
Contact name:	Mr. Slava Lagaev

2 Equipment under test attributes

Product name:	PtP/PtMP 60 GHz Radio Transceiver
Trade Mark:	TerraWIN™
Model(s):	RADWIN 6000 TerraWIN™ 625G
Serial number:	Sample
Hardware version:	1.1
Software release:	1.0.0.0
Receipt date	21-Feb-20

3 Manufacturer information

Manufacturer name:	Radwin Ltd.
Address:	27 HaBarzel St., Ramat Hahayal, Tel Aviv, 6971039, Israel
Telephone:	+972 (3) 766 2900
Fax:	+972 (3) 766 2902
E-Mail:	slava_la@radwin.com
Contact name:	Mr. Slava Lagaev

4 Test details

Project ID:	36870
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	21-Feb-20
Test completed:	17-Mar-20
Test specification(s):	FCC 47 CFR part 15 section 15.255; RSS-210 issue 10 Annex J; RSS-Gen issue 5 with Am.1

5 Tests summary

Test	Status
Transmitter characteristics	
FCC section 15.255(c)(1) (ii),(d)(1) / RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density	Pass
FCC section 15.215(c)/ RSS-210 section J.4(c), RSS-Gen, Section 6.7, Occupied bandwidth	Pass
FCC section 15.255(d)(2)/ RSS-210 section J.3, Radiated spurious emissions below 40 GHz	Pass
FCC section 15. 255(d)(3)/ RSS-210 section J.3, Radiated emissions outside assigned band and above 40 GHz up to 200 GHz	Pass
FCC section 15.255(f)/ RSS-210 section J.6, Frequency stability	Pass
FCC Section 15.207(a)/ RSS-Gen, section 8.8, Conducted emission	Pass
FCC section 15.255(g)/ RSS-Gen, section 3.4, RF exposure	Pass, exhibit included in Application for certification
RSS-Gen section 7.3, Receiver spurious emission	Pass*

*Note: tested during the transmitter radiated spurious emissions below 40 GHz.

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.
The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mrs. E. Pitt, test engineer Mr. A. Morozov, test engineer	March 17, 2020	
Reviewed by:	Mrs. M. Cherniavsky, certification engineer	May 13, 2020	
Approved by:	Mr. S. Samokha, Technical Manager, EMC and Radio	May 27, 2020	

6 EUT description

Note: The following data in this clause is provided by the customer and represents his sole responsibility

6.1 General information

The EUTs are outdoor radio transceivers, operating in 60 GHz frequency band that come in two different software configurations depending on installation purpose.

1. RADWIN 6000 TerraWIN 625G (named also as DN – distribution node) is a Point to Point or/and MultiPoint radio distribution unit operating in a wireless mesh network architecture. It is installed in point of presents sites (POP) or in mesh sites as interconnecting wireless nodes to extent coverage and service availability.

2. RADWIN 6000 TerraWIN 601G (named also as CN – customer node) is a Point to Point and/or MultiPoint customer premises distribution unit, installed either in enterprises or residential customer's sites.

Both radio models can provide aggregate capacity up to 3.9 Gbps while guarantying minimum level of capacity in case of traffic overload over the air, operating in 57-66 GHz frequency band and @2.16 GHz channel bandwidth, using a beamforming single polarized antenna.

The EUT was powered from 55 VDC obtained via auxiliary PoE.

According to manufacturer's declaration provided in Appendig G of the test report, the model RADWIN 6000 TerraWIN™ 601G is a variant of the model RADWIN 6000 TerraWIN™ 625G and is electronically / electrically / mechanically identical. That is why only the model RADWIN 6000 TerraWIN™ 625G was tested as the worst case configuration.

6.2 Ports and lines

Port type	Port description	Connected		Qty.	Cable type	Cable length	Indoor / outdoor
		From	To				
Telecom and power	PoE	EUT	PoE	1	FTP	10 m*	Outdoor
GND	GND	EUT	GND	1	Unshielded	2 m	Outdoor

* May be up to 100 m long.

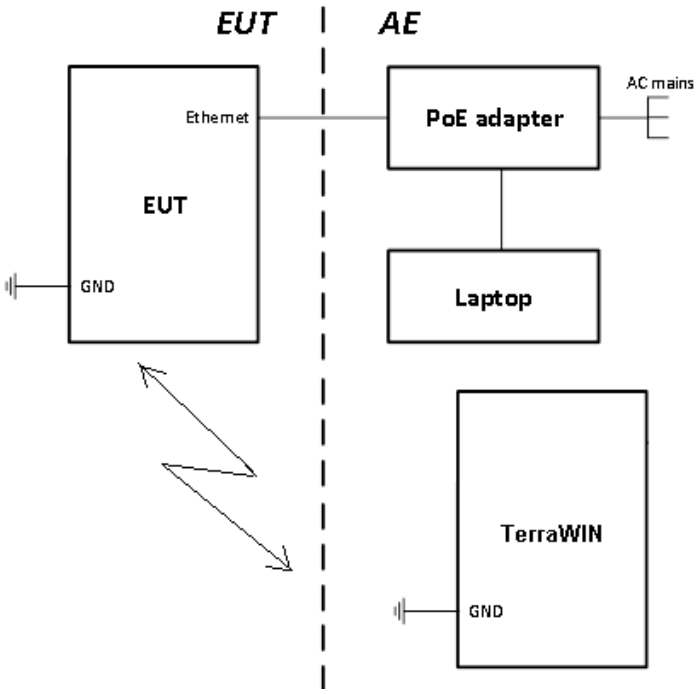
6.3 Auxiliary equipment

Description	Manufacturer	Model number
Laptop	Dell	Latitude E7250
Laptop	Dell	Latitude E7270
PoE	SinPro	CPU55A 270-1

6.4 Changes made in the EUT

No changes were performed in the EUT during testing.

6.5 Test configuration



6.6 Transmitter characteristics

Type of equipment	
V	Stand-alone (Equipment with or without its own control provisions)
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)
	Plug-in card (Equipment intended for a variety of host systems)

Intended use		Condition of use
V	fixed	Always at a distance more than 2 m from all people
	mobile	Always at a distance more than 20 cm from all people
	portable	May operate at a distance closer than 20 cm to human body

Assigned frequency range	57.0 GHz – 66.0 GHz
Operating frequency range	57240 -65880 MHz
Test frequencies	58320 MHz, 60480 MHz, 64800 MHz

Maximum rated output power	EIRP		42.32 dBm
Is transmitter output power variable?	V	No	
		Yes	continuous variable
			stepped variable with stepsize: dB
			minimum RF power: dBm
			maximum RF power:

Antenna connection				
unique coupling	standard connector	V	Integral	with temporary RF connector
				without temporary RF connector

Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
Integrated 4 antenna modules	Murata	LBKA0ZZ1SV-391	27 dBi

Transmitter 99% power bandwidth, MHz	Transmitter aggregate data rate/s, Mbps	Type of modulation
2160	600, 800, 900, 1000	BPSK
2160	1300, 1600, 1900, 2100	QPSK
2160	2600, 3200, 3900	16QAM

Type of multiplexing	TDD

Transmitter power source					
		Nominal rated voltage		Battery type	
V	DC	**Nominal rated voltage**	55 V via POE		
		Voltage range			
	AC mains	**Nominal rated voltage**	120 V	Frequency	60 Hz

Common power source for transmitter and receiver	**V**	yes	no

Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

7 Transmitter tests

7.1 Transmitter power test

7.1.1 General

This test was performed to measure the peak output power. Specification test limits are given in Table 7.1.1.

Table 7.1.1 Output power limits

Assigned frequency range, MHz	Maximum output power			
	Peak conducted output power		EIRP, dBm	
	mW	dBm	Peak	Average
57000 – 66000	500	27.0	43	40

7.1.2 Test procedure

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

7.1.2.2 The EUT was adjusted to produce maximum available for end user RF output power.

7.1.2.3 The average and peak voltage was measured at the low and high frequency channels with oscilloscope connected to RF detector and provided in the associated plots.

7.1.2.4 The unmodulated signal was applied to Zero-Biased Detector via variable attenuator as shown in Figure 7.1.2.

7.1.2.5 The variable attenuator was adjusted such that the oscilloscope indicated a voltage equal to the peak voltage recorded in the step 7.1.2.3.

7.1.2.6 The variable attenuator was disconnected from the Zero-Biased Detector.

7.1.2.7 Without changing any settings, the variable attenuator was connected to a power meter as shown in Figure 7.1.3.

7.1.2.8 The power was measured and result was recorded in Table 7.1.2 and Table 7.1.3.

7.1.2.9 The steps 7.1.2.4 through 7.1.2.8 were repeated for the average voltage recorded in the step 7.1.2.3 and 7.1.2.4.

Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

Figure 7.1.1 Peak output power test setup

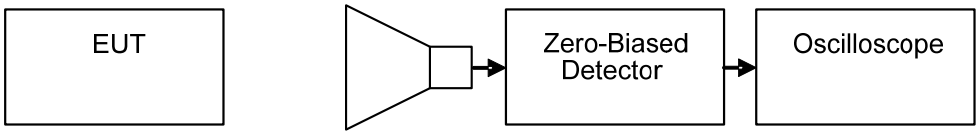


Figure 7.1.2 Peak output power test setup

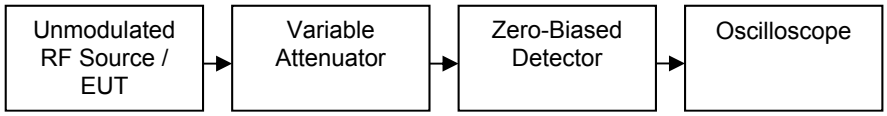
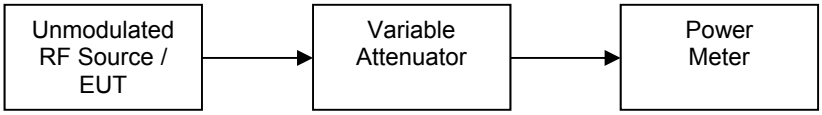


Figure 7.1.3 Peak output power test setup



Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

Table 7.1.2 Peak output power test results

OPERATING FREQUENCY RANGE: 57.0 – 71.0 GHz
DETECTOR USED: Peak
MEASUREMENTS DISTANCE: 6 m
VIDEO BANDWIDTH: >10 MHz
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
MODULATION: BPSK

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
58320	0.005144	-8.33	1.44	27.0	150.01	40.88	43.0	-2.12	Pass
60480	0.004960	-10.98	1.00	27.0	149.89	40.75	43.0	-2.25	Pass
64800	0.004630	-12.62	0.81	27.0	150.30	41.16	43.0	-1.84	Pass

MODULATION: QPSK

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
58320	0.005144	-8.04	1.44	27.0	150.01	40.88	43.0	-2.12	Pass
60480	0.004960	-13.13	1.42	27.0	150.31	41.17	43.0	-1.83	Pass
64800	0.004630	-12.67	0.81	27.0	150.30	41.16	43.0	-1.84	Pass

MODULATION: 16QAM

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
58320	0.005144	-11.07	2.88	27.0	151.45	42.32	43.0	-0.68	Pass
60480	0.004960	-11.71	1.01	27.0	149.90	40.76	43.0	-2.24	Pass
64800	0.004630	-13.94	1.30	27.0	150.79	41.65	43.0	-1.35	Pass

* - λ = 300/Frequency(MHz)
** - E_{meas}= 126.8 – 20log(λ) + Power measured – Measurement Antenna Gain
*** - EIRP= E_{meas} + 20log(Measurements distance) – 104.7
**** - Margin = EIRP – Limit

Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

Table 7.1.3 Average output power test results

OPERATING FREQUENCY RANGE: 57.0 – 71.0 GHz
DETECTOR USED: Average
MEASUREMENTS DISTANCE: 6 m
VIDEO BANDWIDTH: >10 MHz
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
MODULATION: BPSK

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
58320	0.005144	4.49	-1.00	27.0	147.57	38.44	40.0	-1.56	Pass
60480	0.004960	9.18	0.04	27.0	148.93	39.79	40.0	-0.21	Pass
64800	0.004630	10.03	-0.82	27.0	148.67	39.53	40.0	-0.47	Pass

MODULATION: QPSK

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
58320	0.005144	4.32	-1.00	27.0	147.57	38.44	40.0	-1.56	Pass
60480	0.004960	9.94	0.20	27.0	149.09	39.95	40.0	-0.05	Pass
64800	0.004630	9.92	-0.82	27.0	148.67	39.53	40.0	-0.47	Pass

MODULATION: 16QAM

Frequency, MHz	λ*, m	DSO, mV	Power measured, dBm	Antenna Gain, dBi	E_{meas}**, dBuV/m	EIRP***, dBm	Limit, dBm	Margin****, dB	Verdict
58320	0.005144	5.26	-0.48	27.0	148.09	38.96	40.0	-1.04	Pass
60480	0.004960	7.73	-0.41	27.0	148.48	39.34	40.0	-0.66	Pass
64800	0.004630	9.71	-0.82	27.0	148.67	39.53	40.0	-0.47	Pass

* - λ = 300/Frequency(MHz)
** - E_{meas}= 126.8 – 20log(λ) + Power measured – Measurement Antenna Gain
*** - EIRP= E_{meas} + 20log(Measurements distance) – 104.7
**** - Margin = EIRP – Limit

Reference numbers of test equipment used

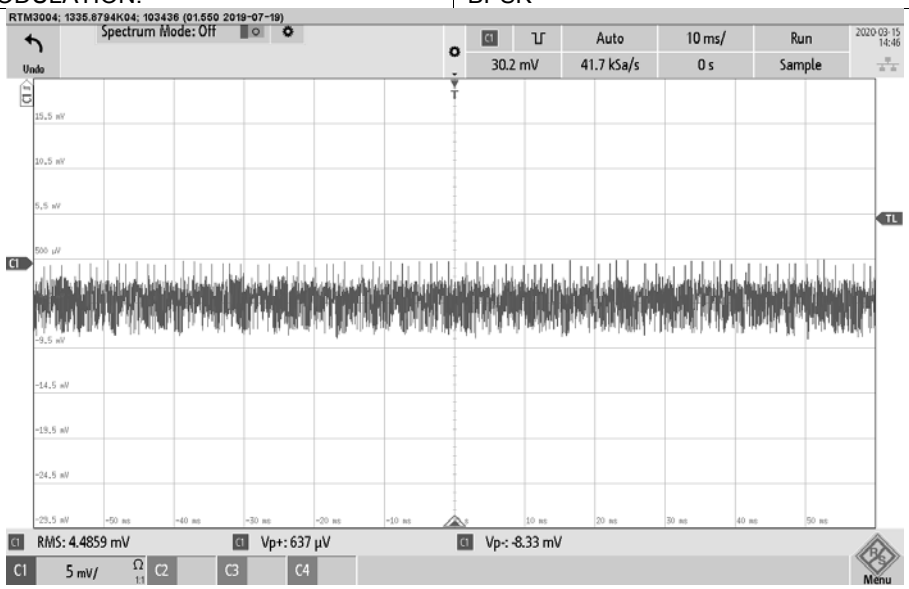
HL 0770	HL 0771	HL 3291	HL 3333	HL 3293	HL 3901	HL 4856	HL 5379

Full description is given in Appendix A.

Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

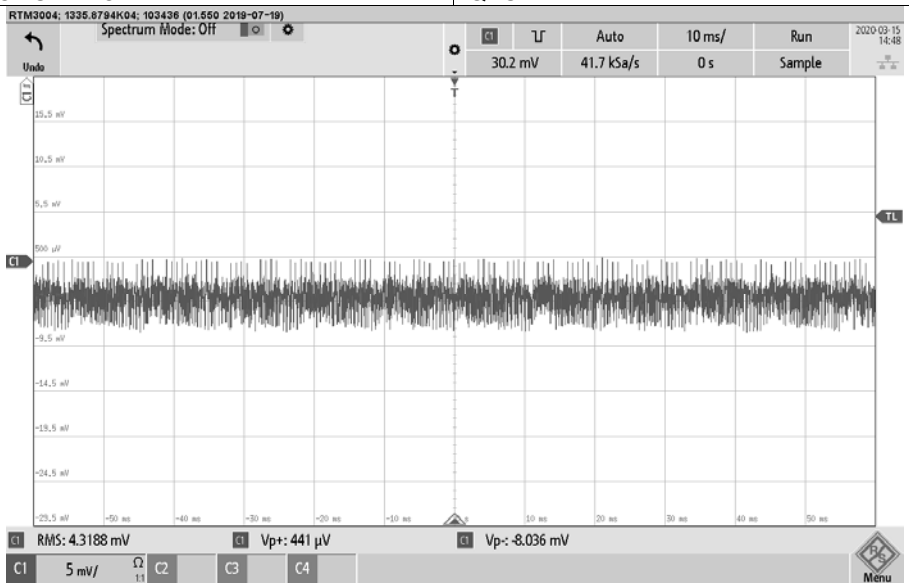
Plot 7.1.1 Output power test result at the 58.32 GHz frequency

DETECTOR:	Peak/Average
MODULATION:	BPSK



Plot 7.1.2 Output power test result at the 58.32 GHz frequency

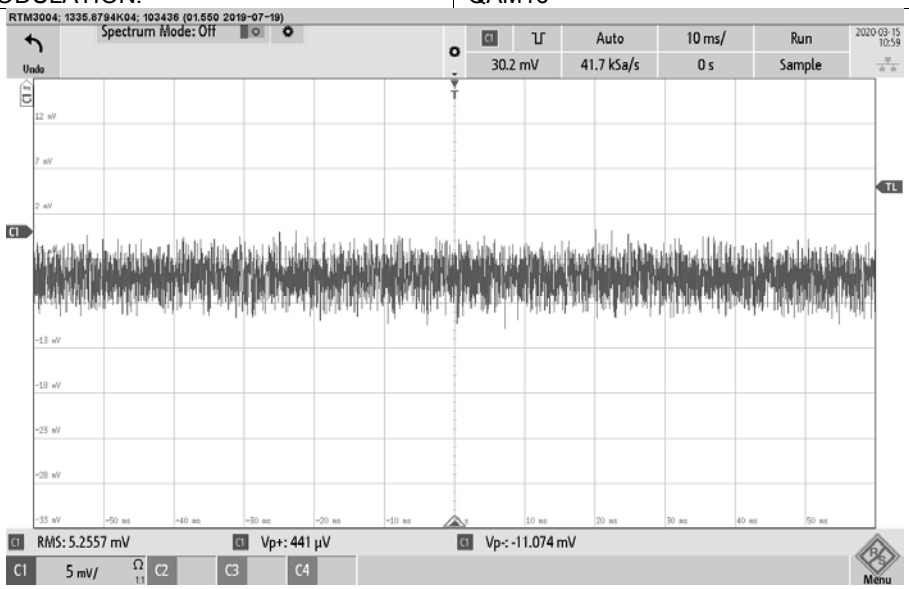
DETECTOR:	Peak/Average
MODULATION:	QPSK



Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

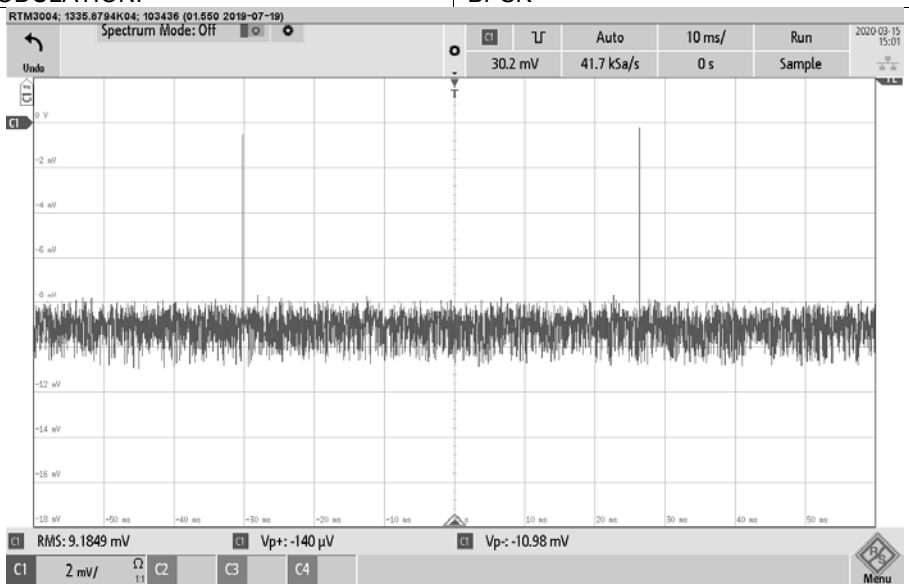
Plot 7.1.3 Output power test result at the 58.32 GHz frequency

DETECTOR:	Peak/Average
MODULATION:	QAM16



Plot 7.1.4 Output power test result at the 60.48 GHz frequency

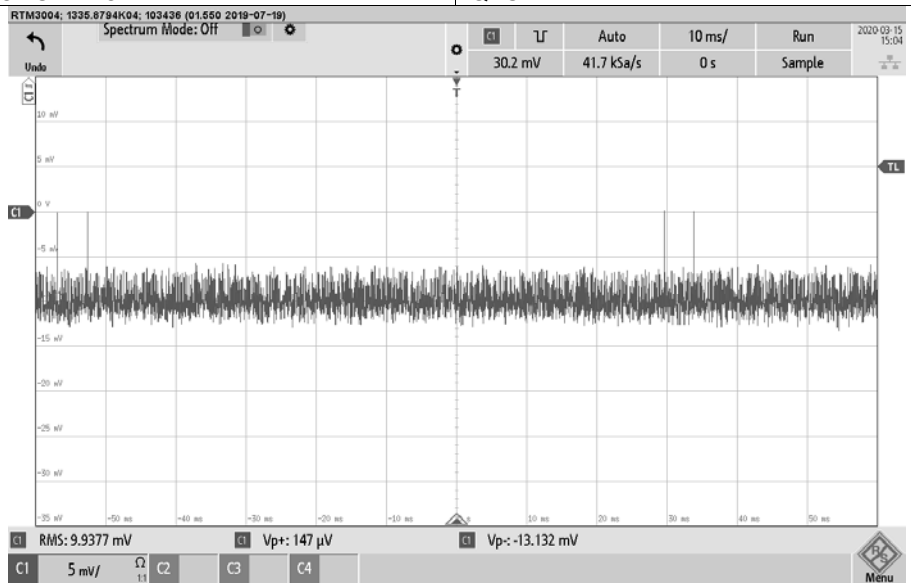
DETECTOR:	Peak/Average
MODULATION:	BPSK



Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

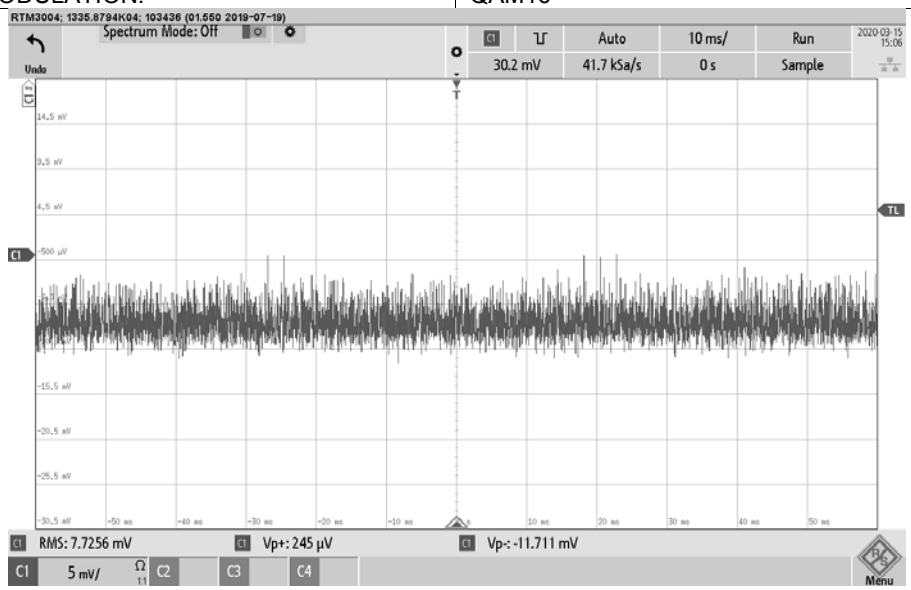
Plot 7.1.5 Output power test result at the 60.48 GHz frequency

DETECTOR:	Peak/Average
MODULATION:	QPSK



Plot 7.1.6 Output power test result at the 60.48 GHz frequency

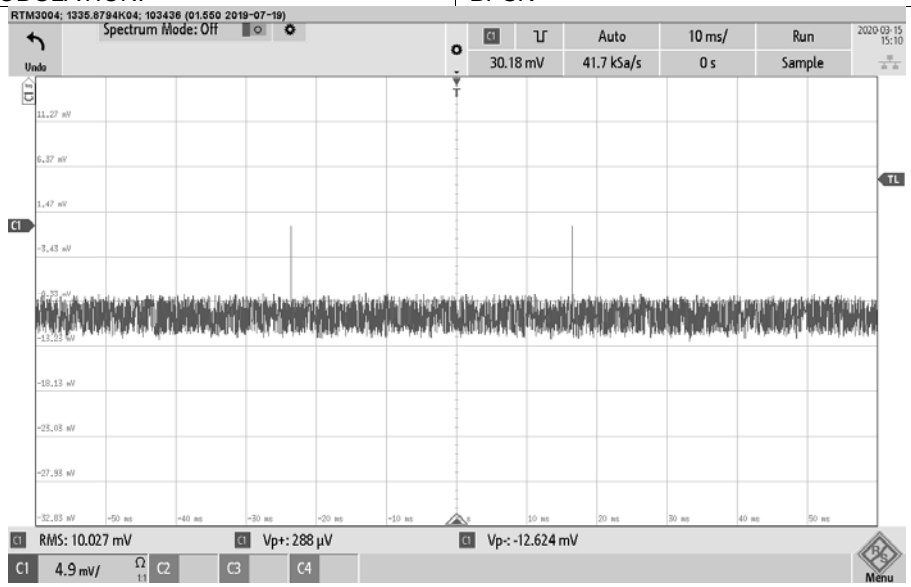
DETECTOR:	Peak/Average
MODULATION:	QAM16



Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

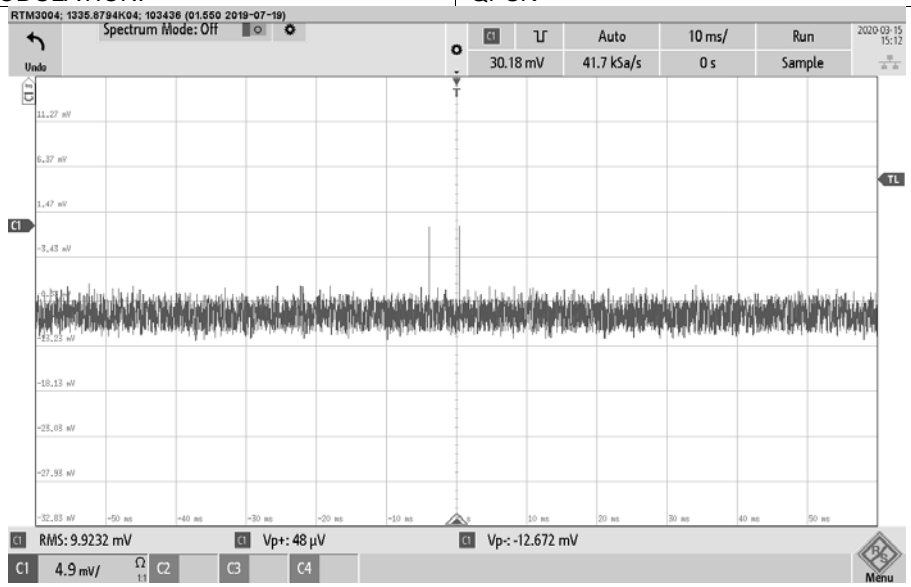
Plot 7.1.7 Output power test result at the 64.80 GHz frequency

DETECTOR:	Peak/Average
MODULATION:	BPSK



Plot 7.1.8 Output power test result at the 64.80 GHz frequency

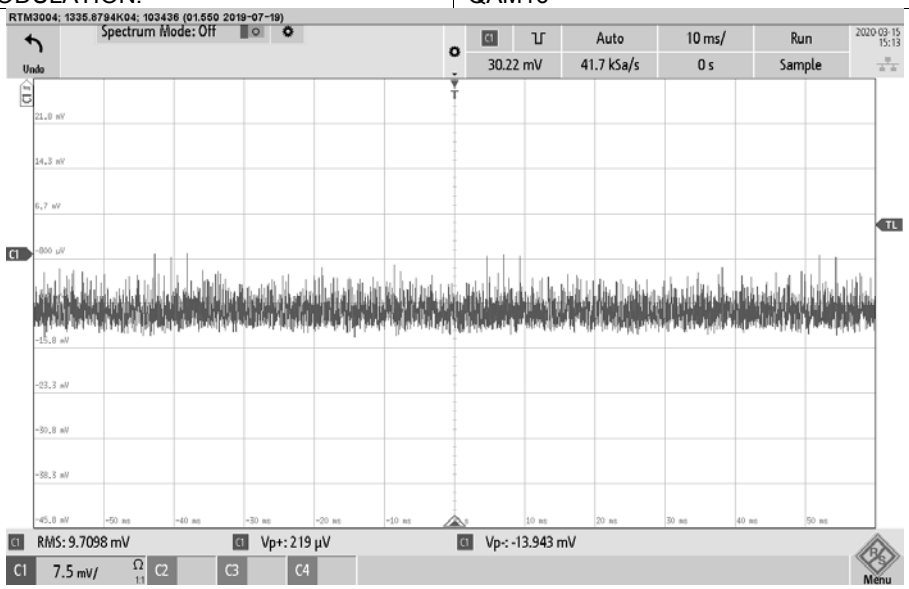
DETECTOR:	Peak/Average
MODULATION:	QPSK



Test specification:	FCC Section 15.255(c)(1)(ii),(d)(1), RSS-210 section J.2.2(b), J.4, Transmitter power and power spectral density		
Test procedure:	47 CFR, Section 2.1046; Section 15.255(b); ANSI C63.10, Sections 9.4, 9.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	17-Mar-20		
Temperature: 24 ºC	Relative Humidity: 49 %	Air Pressure: 1013 hPa	Power: 55 VDC
Remarks:			

Plot 7.1.9 Output power test result at the 64.80 GHz frequency

DETECTOR:	Peak/Average
MODULATION:	QAM16



Test specification:	FCC Section 15.215(c), RSS-210 section J.4(c), RSS-Gen section 6.7, Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Mar-20		
Temperature: 25 ºC	Relative Humidity: 43 %	Air Pressure: 1015 hPa	Power: 55 VDC
Remarks:			

7.2 Occupied bandwidth test

7.2.1 General

This test was performed to measure transmitter occupied bandwidth. Specification test limits are given in Table 7.2.1**Error! Reference source not found.**.

Table 7.2.1 Occupied bandwidth limits

Assigned frequency range, MHz	Modulation envelope reference points	
57000 - 71000	6 dBc	99%

NOTE: Modulation envelope reference points provided in terms of attenuation below unmodulated carrier.

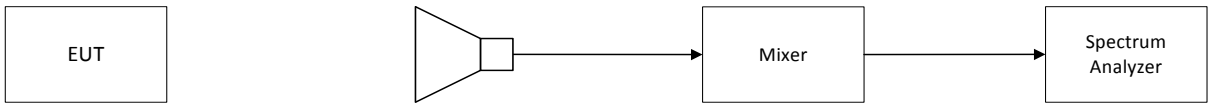
7.2.2 Test procedure

7.2.2.1 The EUT was set up as shown in Figure 7.2.1**Error! Reference source not found.**, energized and its proper operation was checked.

7.2.2.2 The EUT was set to transmit modulated carrier as provided in Table 7.2.2.

7.2.2.3 The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope. The test results are provided in Table 7.2.2 and the associated plots.

Figure 7.2.1 Occupied bandwidth test setup



Test specification:	FCC Section 15.215(c), RSS-210 section J.4(c), RSS-Gen section 6.7, Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Mar-20		
Temperature: 25 ºC	Relative Humidity: 43 %	Air Pressure: 1015 hPa	Power: 55 VDC
Remarks:			

Table 7.2.2 Occupied bandwidth test results

OPERATING FREQUENCY RANGE: 57000 –66000 MHz
DETECTOR USED: Peak

Frequency, GHz	Modulation	Occupied bandwidth 6 dBc, MHz	Occupied bandwidth 99%, MHz	Verdict
58.32	16QAM	1495.0	1933.8	Pass
	QPSK	1522.0	2001.5	Pass
	BPSK	1478.0	1927.6	Pass
60.48	16QAM	1534.0	2000.8	Pass
	QPSK	1596.0	2077.8	Pass
	BPSK	1520.0	1952.3	Pass
64.80	16QAM	1464.0	2034.3	Pass
	QPSK	1512.0	2083.5	Pass
	BPSK	1428.0	1945.4	Pass

Reference numbers of test equipment used

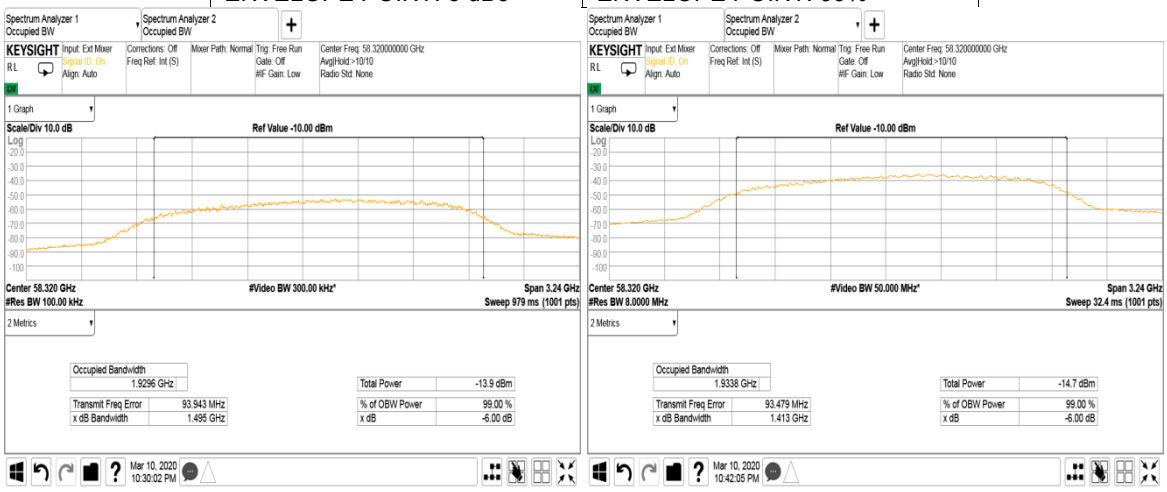
HL 0771	HL 5376	HL 5380					

Full description is given in Appendix A.

Test specification:	FCC Section 15.215(c), RSS-210 section J.4(c), RSS-Gen section 6.7, Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Mar-20		
Temperature: 25 ºC	Relative Humidity: 43 %	Air Pressure: 1015 hPa	Power: 55 VDC
Remarks:			

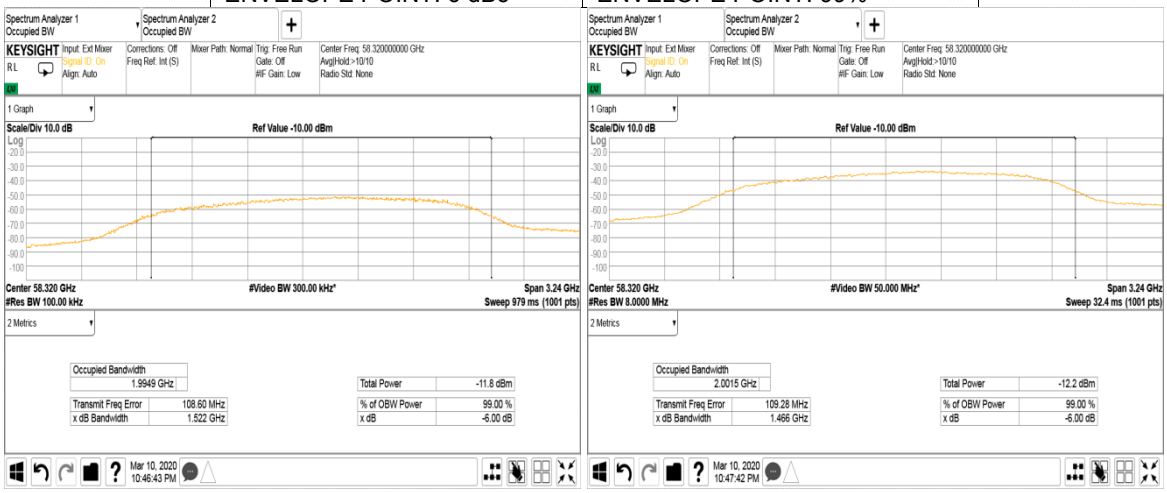
Plot 7.2.1 The 6dBc and 99% occupied bandwidth

FREQUENCY:	58.32 GHz
MODULATION:	16QAM
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Plot 7.2.2 The 6dBc and 99% occupied bandwidth

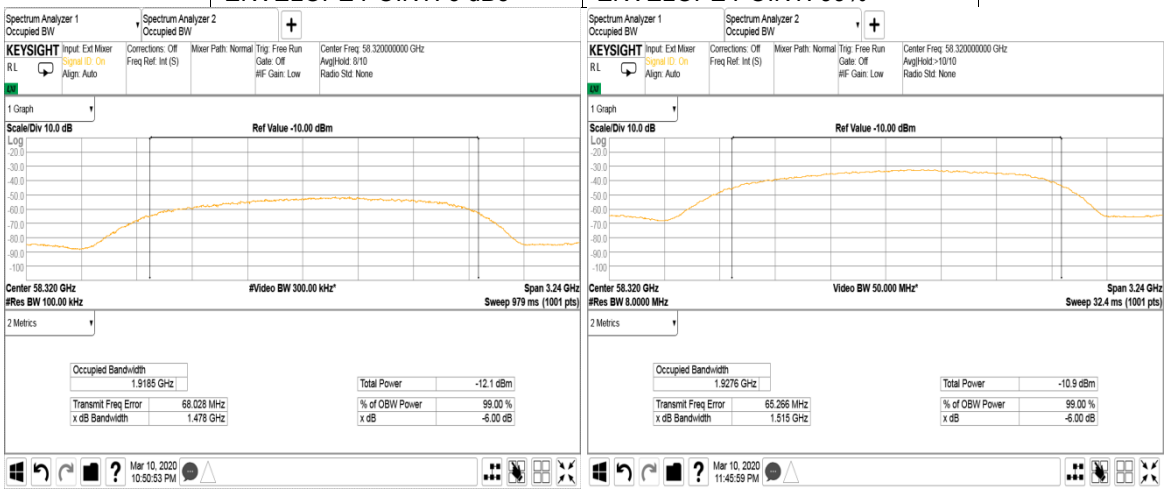
FREQUENCY:	58.32 GHz
MODULATION:	QPSK
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Test specification:	FCC Section 15.215(c), RSS-210 section J.4(c), RSS-Gen section 6.7, Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Mar-20		
Temperature: 25 ºC	Relative Humidity: 43 %	Air Pressure: 1015 hPa	Power: 55 VDC
Remarks:			

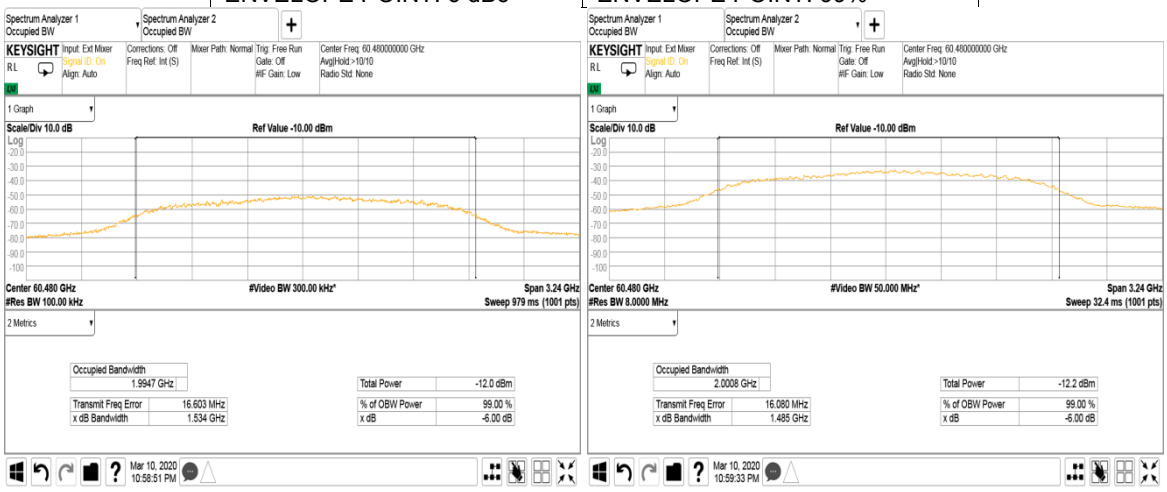
Plot 7.2.3 The 6dBc and 99% occupied bandwidth

FREQUENCY:	58.32 GHz
MODULATION:	BPSK
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Plot 7.2.4 The 6dBc and 99% occupied bandwidth

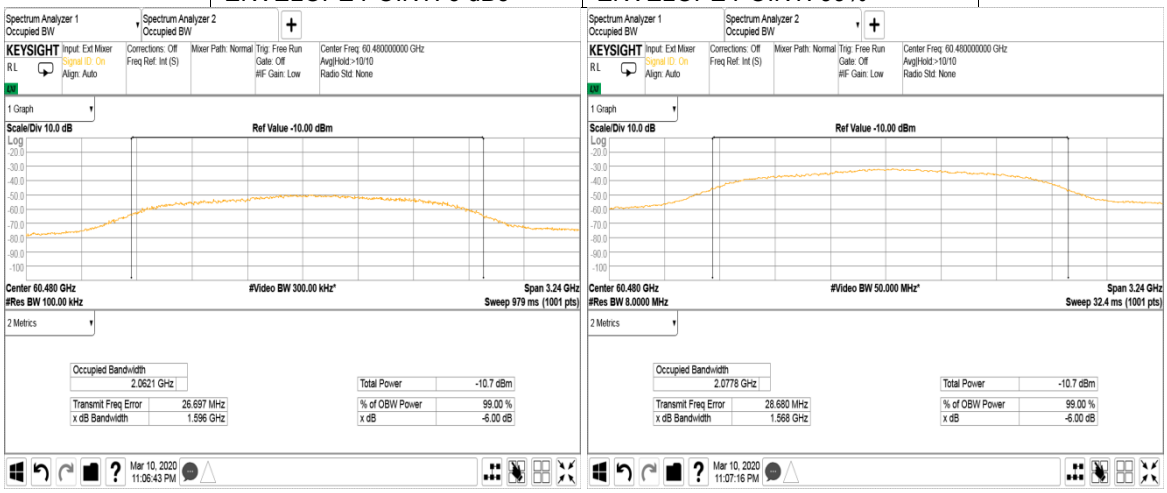
FREQUENCY:	60.48 GHz
MODULATION:	16QAM
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Test specification:	FCC Section 15.215(c), RSS-210 section J.4(c), RSS-Gen section 6.7, Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Mar-20		
Temperature: 25 ºC	Relative Humidity: 43 %	Air Pressure: 1015 hPa	Power: 55 VDC
Remarks:			

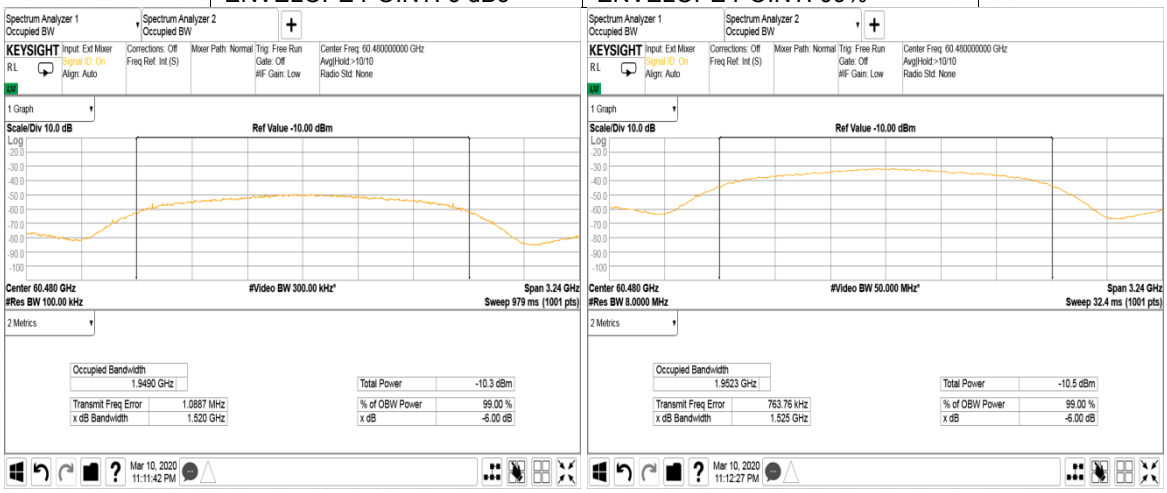
Plot 7.2.5 The 6dBc and 99% occupied bandwidth

FREQUENCY:	60.48 GHz
MODULATION:	QPSK
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Plot 7.2.6 The 6dBc and 99% occupied bandwidth

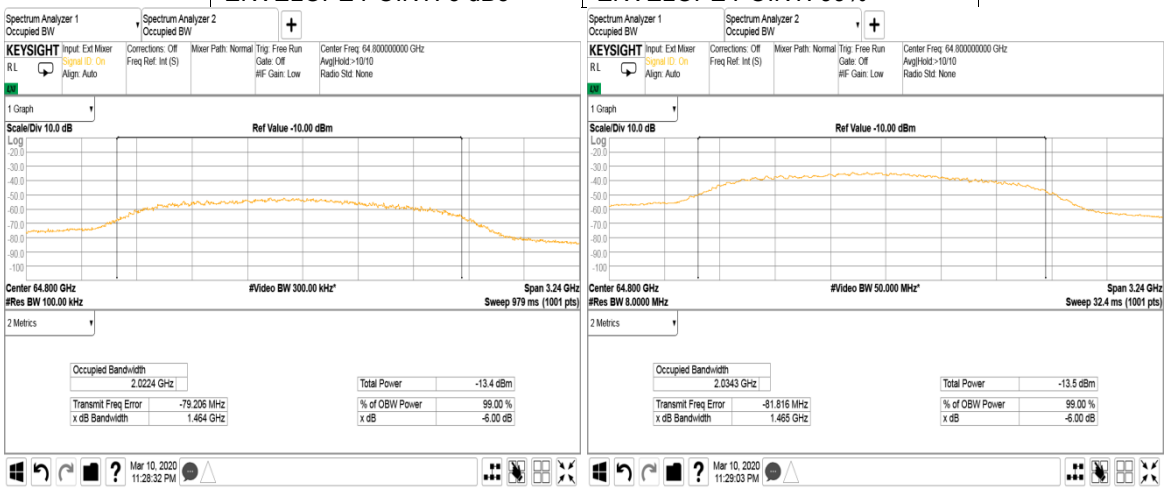
FREQUENCY:	60.48 GHz
MODULATION:	BPSK
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Test specification:	FCC Section 15.215(c), RSS-210 section J.4(c), RSS-Gen section 6.7, Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Mar-20		
Temperature: 25 ºC	Relative Humidity: 43 %	Air Pressure: 1015 hPa	Power: 55 VDC
Remarks:			

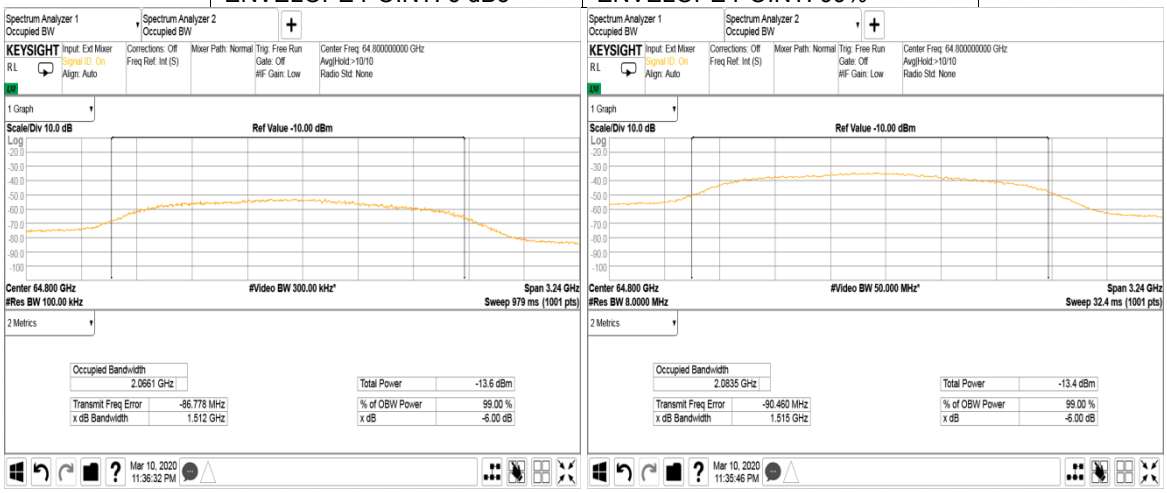
Plot 7.2.7 The 6dBc and 99% occupied bandwidth

FREQUENCY:	64.80 GHz
MODULATION:	16QAM
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Plot 7.2.8 The 6dBc and 99% occupied bandwidth

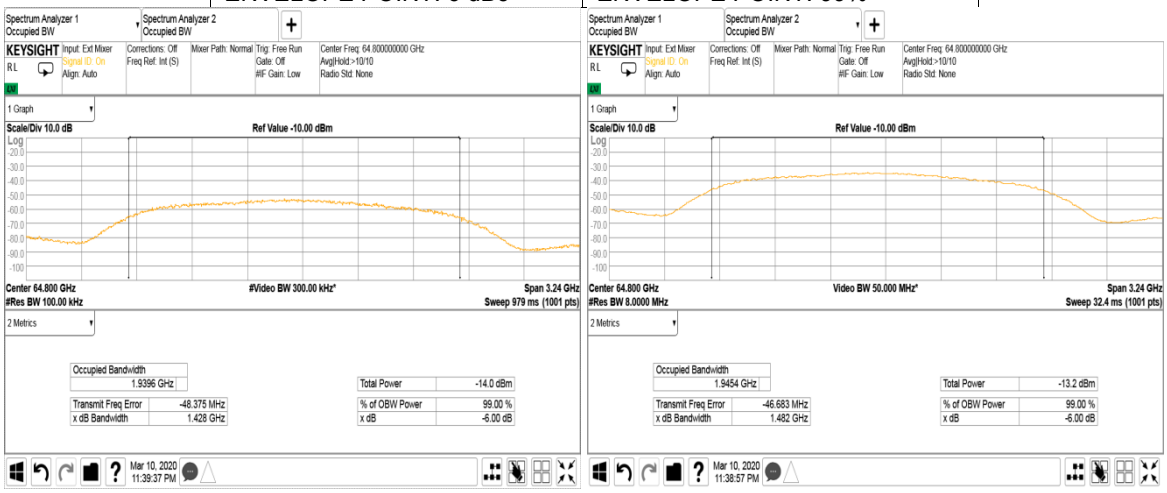
FREQUENCY:	64.80 GHz
MODULATION:	QPSK
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Test specification:	FCC Section 15.215(c), RSS-210 section J.4(c), RSS-Gen section 6.7, Occupied bandwidth		
Test procedure:	47 CFR, Section 2.1049, ANSI C63.10, Section 9.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	11-Mar-20		
Temperature: 25 ºC	Relative Humidity: 43 %	Air Pressure: 1015 hPa	Power: 55 VDC
Remarks:			

Plot 7.2.9 The 6dBc and 99% occupied bandwidth

FREQUENCY:	64.80 GHz
MODULATION:	BPSK
ENVELOPE POINT: 6 dBc	ENVELOPE POINT: 99%



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

7.3 Field strength of emissions

7.3.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Radiated spurious emissions limits

Frequency range, MHz	Field strength at 3 m, dB(μV/m)*		
	Within restricted bands		
	Peak	Quasi Peak	Average
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**
0.090 – 0.110	NA	108.5 – 106.8**	NA
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**
0.490 – 1.705	NA	73.8 – 63.0**	NA
1.705 – 30.0*		69.5	
30 – 88		40.0	
88 – 216		43.5	
216 – 960		46.0	
960 - 1000		54.0	
1000 – 40000	74.0	NA	54.0

*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$Lim_{S2} = Lim_{S1} + 40 \log (S_1/S_2),$$

where S_1 and S_2 – standard defined and test distance respectively in meters.

**- The limit decreases linearly with the logarithm of frequency.

Note: The above field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency but not exceeding 40 Ghz for intentional radiators operated below 10 GHz and up to the fifth harmonic of the highest fundamental frequency but not exceeding 100 Ghz for intentional radiators operated above 10 GHz.

Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

7.3.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.3.2.1 The EUT was set up as shown in Figure 7.2.1, energized and the performance check was conducted.

7.3.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna was rotated around its vertical axis.

7.3.2.3 The worst test results (the lowest margins) were recorded in Table 7.3.3 and shown in the associated plots.

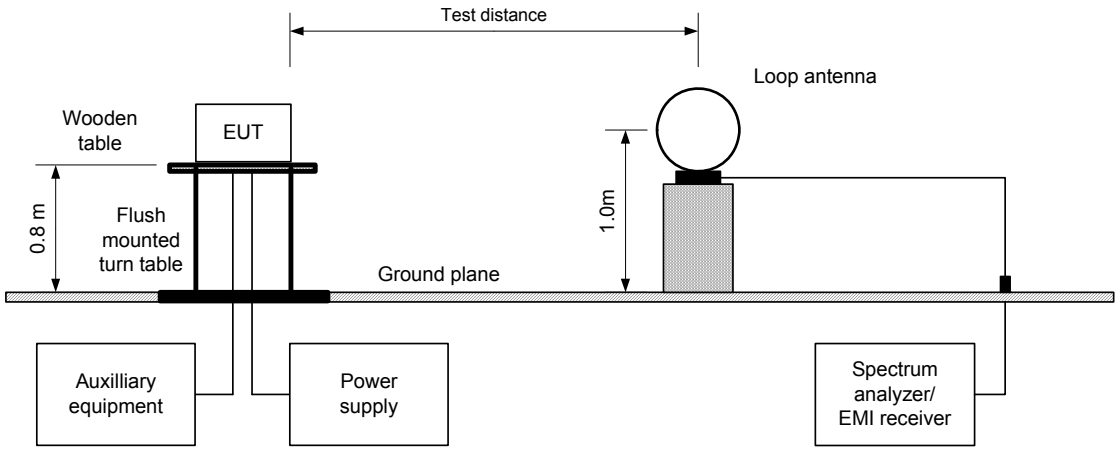
7.3.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.3.3.1 The EUT was set up as shown in Figure 7.2.2, Figure 7.2.3, energized and the performance check was conducted.

7.3.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

7.3.3.3 The worst test results (the lowest margins) were recorded in **Error! Reference source not found.**, Table 7.3.3 and shown in the associated plots.

Figure 7.3.1 Setup for spurious emission field strength measurements below 30 MHz



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

Figure 7.3.2 Setup for spurious emission field strength measurements in 30 – 1000 MHz

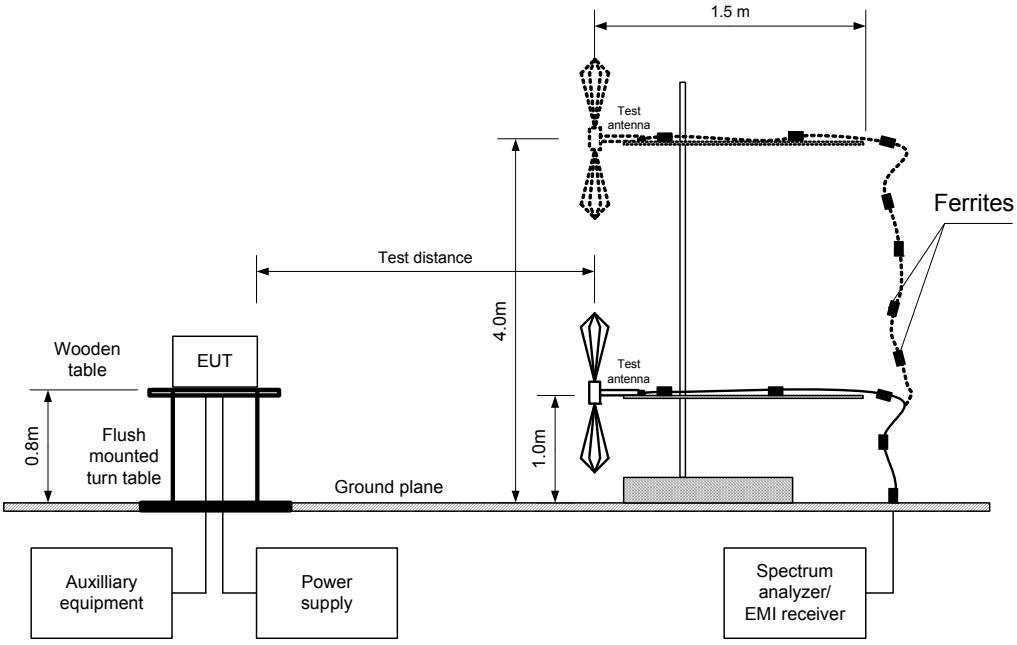
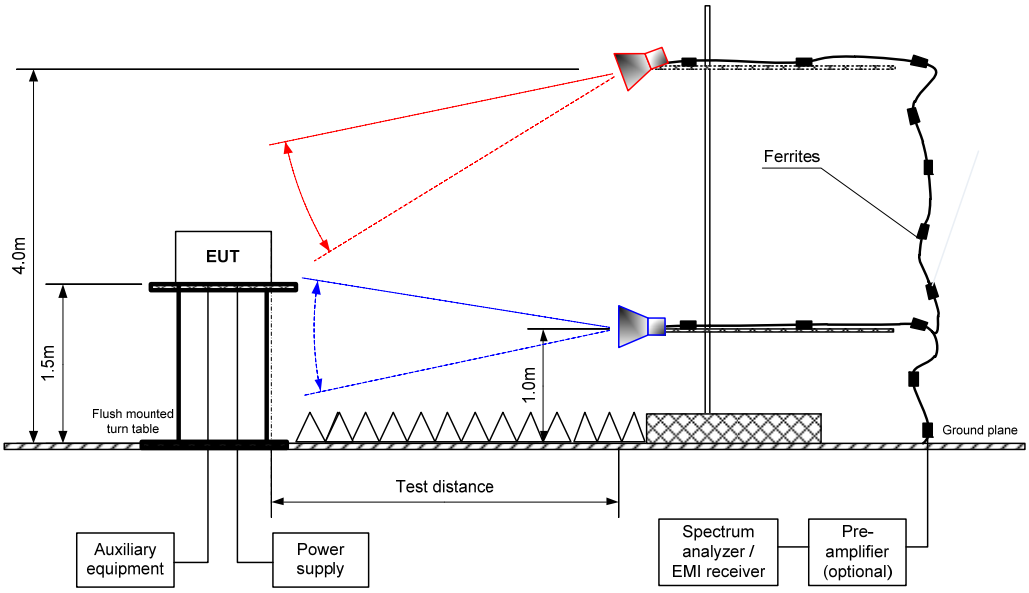


Figure 7.3.3 Setup for spurious emission field strength measurements above1000 MHz



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

Table 7.3.2 Field strength of spurious emissions at frequencies above 1 GHz

TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
MODULATION: QPSK
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
INVESTIGATED FREQUENCY RANGE: 0.009 - 40000 MHz
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 1.0 MHz
VIDEO BANDWIDTH: ≥ Resolution bandwidth
TEST ANTENNA TYPE: Double ridged guide (above 1000 MHz)

F, MHz	Antenna		Azimuth, degrees*	Peak field strength			Avr factor, dB	Average field strength			Verdict
	Pol.	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
Low frequency 58.32 GHz											
1400	V	1.0	30	45.4	74.0	-28.6	NA	40.2	54.0	-13.8	Pass
1600	V	1.3	58	53.1	74.0	-20.9	NA	51.7	54.0	-2.3	
2000	V	2.3	71	54.7	74.0	-19.3	NA	51.2	54.0	-2.8	
3000	V	1.3	31	50.7	74.0	-23.3	NA	48.4	54.0	-5.6	
8000	V	1.4	26	52.4	74.0	-21.6	NA	48.3	54.0	-5.7	
12000	V	1.2	71	50.3	74.0	-23.7	NA	48.2	54.0	-5.8	
38407	H	1.0	-7	64.1	74.0	-9.9	NA	50.4	54.0	-3.6	
Mid frequency 60.80 GHz											Pass
1400.0	V	1.78	184	47.71	74.0	-26.29	NA	43.22	54.0	-10.78	
1600.0	V	1.54	208	46.95	74.0	-27.05	NA	43.99	54.0	-10.01	
2000.1	V	2.06	188	57.23	74.0	-16.77	NA	53.53	54.0	-0.47	
2600.2	V	1.36	156	51.71	74.0	-22.29	NA	49.46	54.0	-4.54	
2799.7	V	1.00	163	55.71	74.0	-18.29	NA	52.22	54.0	-1.78	
2999.7	V	2.67	160	52.50	74.0	-21.50	NA	46.89	54.0	-7.11	
8000.0	V	1.28	199	54.55	74.0	-19.45	NA	48.52	54.0	-5.48	
38649.6	H	3.17	262	64.12	74.0	-9.88	NA	50.40	54.0	-3.60	
High frequency 64.80 GHz											Pass
1400	V	1.0	18	46.5	74.0	-27.5	NA	40.9	54.0	-13.1	
1600	V	1.0	42	52.9	74.0	-21.1	NA	51.2	54.0	-2.8	
2000	V	2.0	52	56.0	74.0	-18.0	NA	51.6	54.0	-2.4	
2600	V	2.1	94	48.3	74.0	-25.7	NA	45.4	54.0	-8.6	
8000	V	1.3	65	47.3	74.0	-26.7	NA	43.7	54.0	-10.3	
16000	V	1.2	60	51.8	74.0	-22.2	NA	48.8	54.0	-5.2	
38407	H	1.0	-7	64.1	74.0	-9.9	NA	50.4	54.0	-3.6	

*- EUT front panel refers to 0 degrees position of turntable.
**- Margin = dB below (negative if above) specification limit.

Reference numbers of test equipment used

HL 4360	HL 4933	HL 5404	HL 4360	HL 3903	HL 4956		

Full description is given in Appendix A.

Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

Table 7.3.3 Field strength of emissions below 1 GHz

TEST DISTANCE: 3 m
EUT POSITION: Typical (Vertical)
MODULATION: QPSK
INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 0.2 kHz (9 kHz – 150 kHz)
9.0 kHz (150 kHz – 30 MHz)
120 kHz (30 MHz – 1000 MHz)
VIDEO BANDWIDTH: ≥ Resolution bandwidth
TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
Biconilog (30 MHz – 1000 MHz)

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
Low frequency 58.32 GHz								
31.06	35.5	34.0	40.0	-6.0	Vertical	1.0	80	
33.56	37.4	36.1	40.0	-3.9	Vertical	1.0	79	
37.13	36.3	34.8	40.0	-5.2	Vertical	1.0	-54	Pass
49.26	38.7	36.8	40.0	-3.2	Vertical	1.0	-166	
113.9	37.3	36.4	43.5	-7.1	Vertical	1.0	-171	
125.0	39.6	38.4	43.5	-5.1	Vertical	1.3	-76	
Mid frequency 60.80 GHz								
31.06	33.6	31.8	40.0	-8.19	Vertical	1.02	240	
32.09	35.5	34.0	40.0	-5.99	Vertical	1.02	360	
36.88	37.6	36.4	40.0	-3.58	Vertical	1.02	215	
46.11	36.5	33.9	40.0	-6.03	Vertical	1.02	353	Pass
108.24	36.9	34.8	43.5	-8.70	Vertical	1.02	61	
134.54	41.0	39.0	43.5	-4.45	Vertical	1.02	251	
400.02	40.1	37.2	46.0	-8.78	Vertical	1.02	296	
465.57	39.2	36.1	46.0	-9.84	Vertical	1.35	180	
High frequency 64.80 GHz								
31.06	34.3	32.7	40.0	-7.3	Vertical	1.0	80	
33.56	35.3	33.8	40.0	-6.2	Vertical	1.0	79	
37.13	35.5	34.0	40.0	-6.0	Vertical	1.0	71	Pass
49.26	38.8	37.0	40.0	-3.0	Vertical	1.0	-77	
125.0	39.4	37.3	43.5	-6.2	Vertical	1.0	69	
400.0	40.2	36.7	46.0	-9.3	Vertical	1.3	47	

*- Margin = Measured emission - specification limit.
**- EUT front panel refer to 0 degrees position of turntable.

Reference numbers of test equipment used

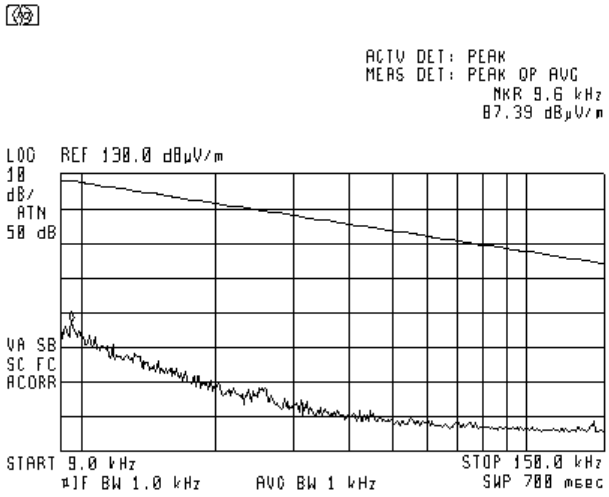
HL 5288	HL 0446	HL 3903	HL 5404	HL 4360			

Full description is given in Appendix A.

Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

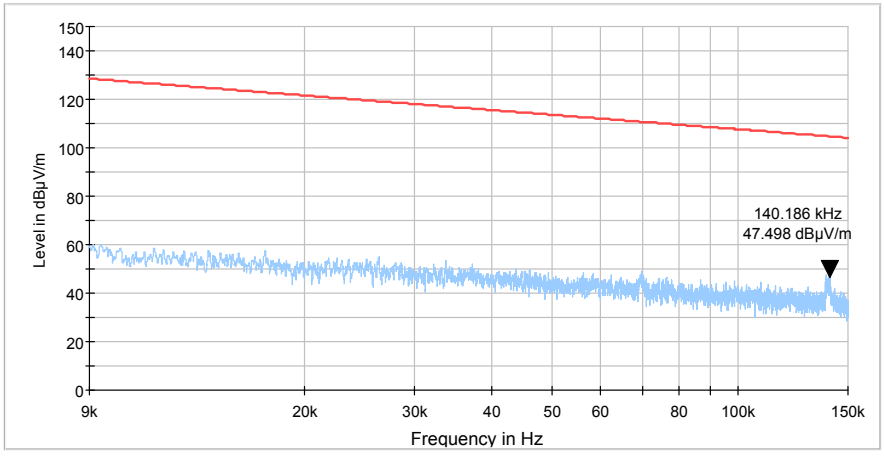
Plot 7.3.1 Radiated emission measurements from 9 to 150 kHz at low frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Plot 7.3.2 Radiated emission measurements from 9 to 150 kHz at mid frequency

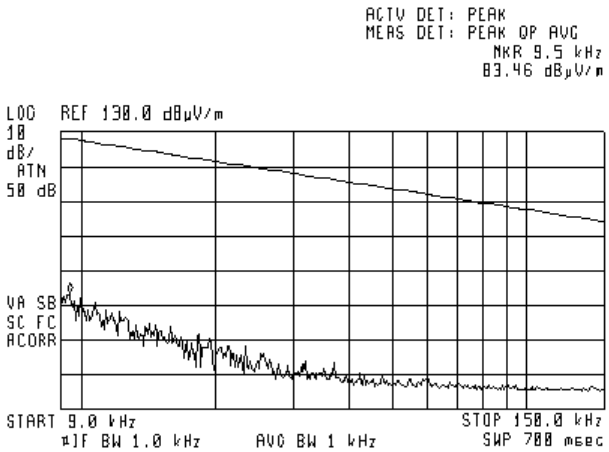
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

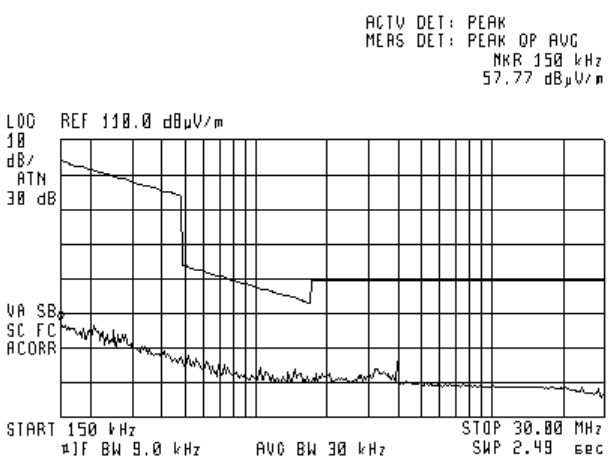
Plot 7.3.3 Radiated emission measurements from 9 to 150 kHz at high frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Plot 7.3.4 Radiated emission measurements from 0.15 to 30 MHz at low frequency

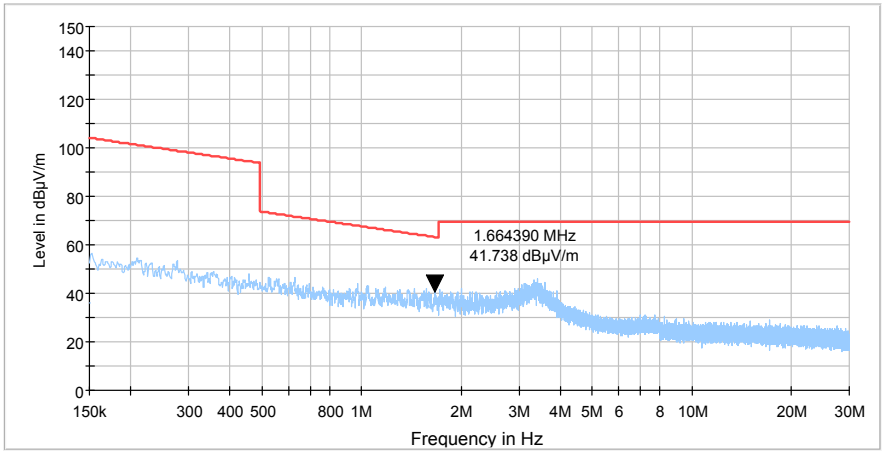
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

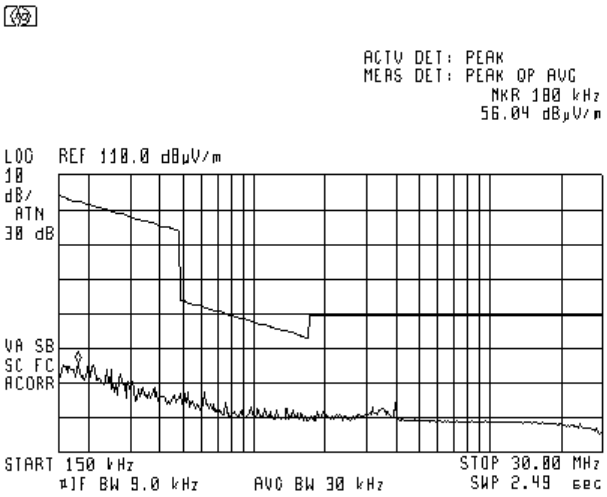
Plot 7.3.5 Radiated emission measurements from 0.15 to 30 MHz at mid frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Plot 7.3.6 Radiated emission measurements from 0.15 to 30 MHz at high frequency

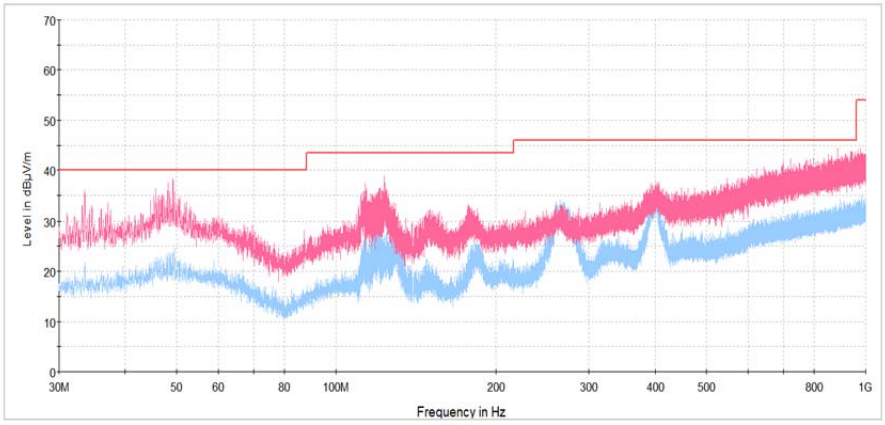
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical
EUT POSITION: Typical (Vertical)



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

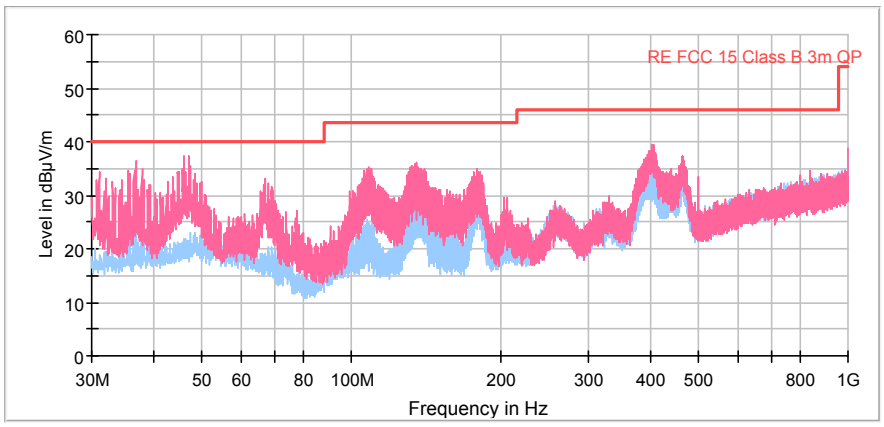
Plot 7.3.7 Radiated emission measurements from 30 to 1000 MHz at low frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.3.8 Radiated emission measurements from 30 to 1000 MHz at mid frequency

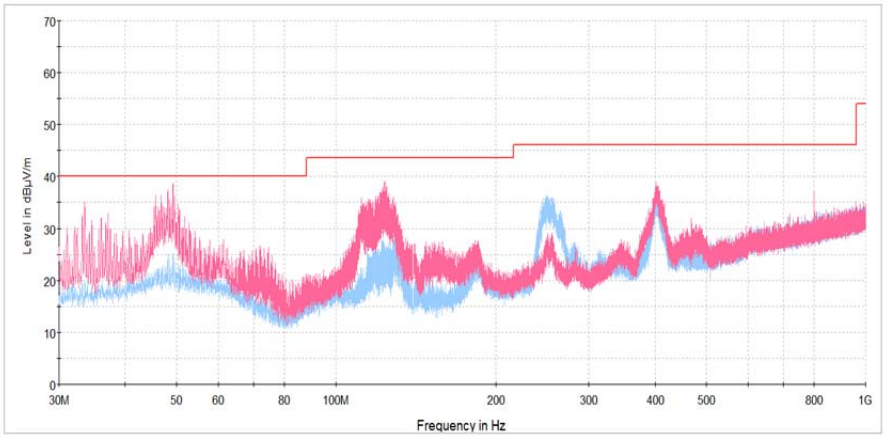
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

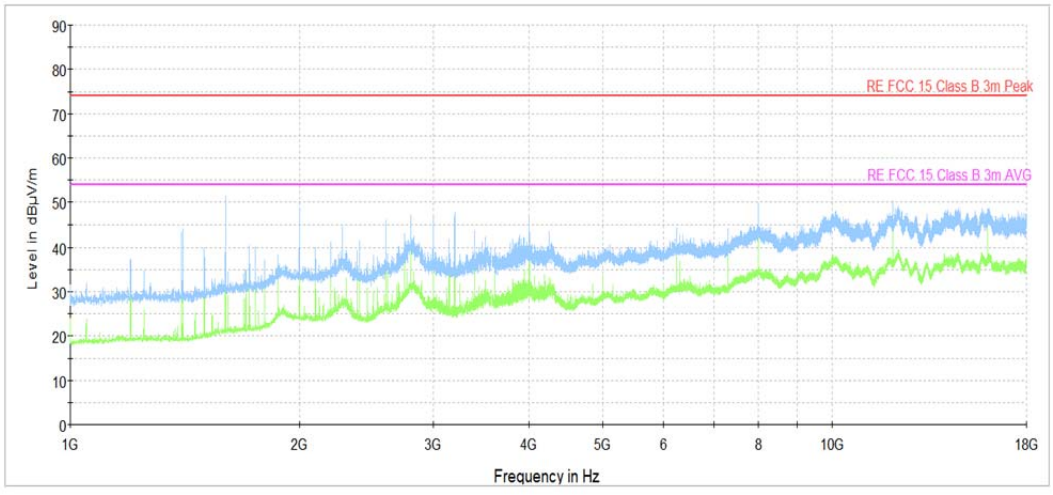
Plot 7.3.9 Radiated emission measurements from 30 to 1000 MHz at high frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.3.10 Radiated emission measurements from 1.0 to 18 MHz at low frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



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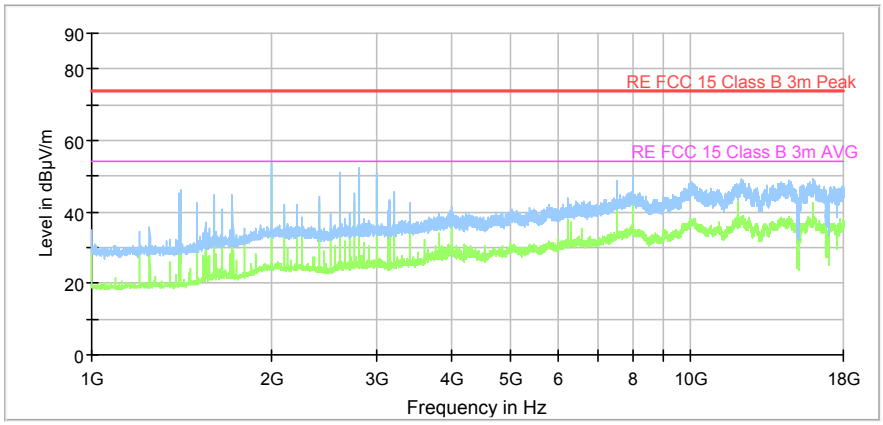
Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

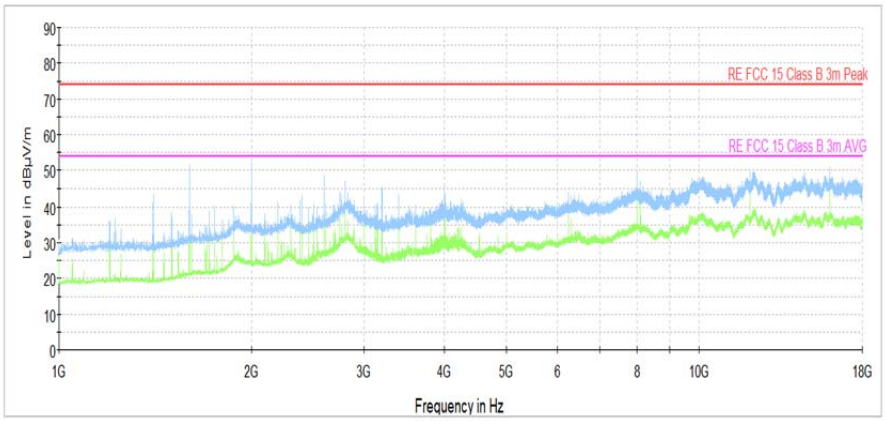
Plot 7.3.11 Radiated emission measurements from 1.0 to 18 MHz at mid frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.3.12 Radiated emission measurements from 1.0 to 18 MHz at high frequency

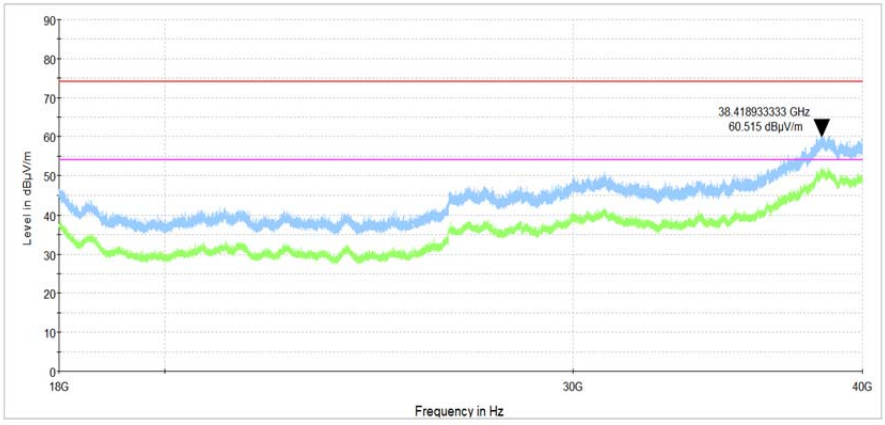
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

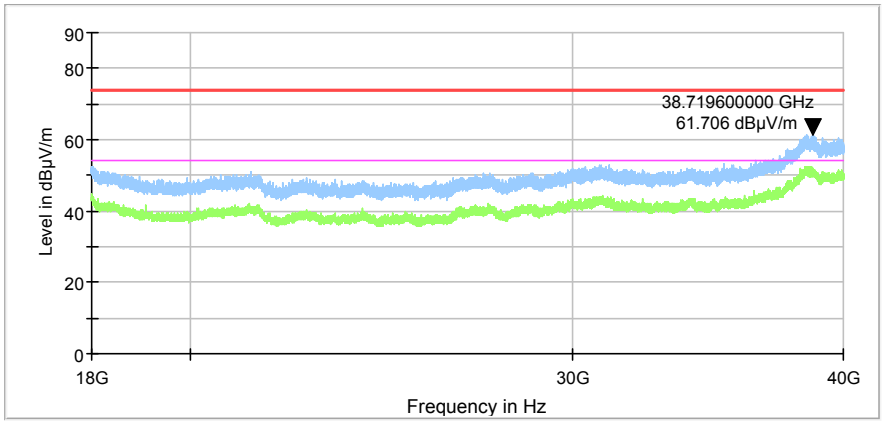
Plot 7.3.13 Radiated emission measurements from 18.0 to 40 GHz at low frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Plot 7.3.14 Radiated emission measurements from 18.0 to 40 GHz at mid frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)



Test specification:	FCC Section 15.255(d)(2), RSS-210 section J.3, Out of band radiated emissions below 40 GHz		
Test procedure:	47 CFR, Section 2.1053; ANSI C63.10, Section 9.13		
Test mode:	Compliance	Verdict:	PASS
Date(s):	06-Mar-20		
Temperature: 23 ºC	Relative Humidity: 58 %	Air Pressure: 1010 hPa	Power: 55 VDC
Remarks:			

Plot 7.3.15 Radiated emission measurements from 18.0 to 40 GHz at high frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
EUT POSITION: Typical (Vertical)