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TEST REPORT

ACCORDING TO:

FCC 47CFR part 15 subpart C §15.247 (DTS) and subpart B,
RSS-247 Issue 2:2017, ICES-003 Issue 6:2016

FOR:

Wireless Systems Solutions LLC
Remote Radio Unit (RRU)
Part Number: ARRU-148-85
FCC ID: 2AWXX-ARRU14885CVT

This report is in conformity with ISO/IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested.
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Table of contents

1	Applicant information.....	3
2	Equipment under test attributes	3
3	Manufacturer information	3
4	Test details.....	3
5	Tests summary.....	4
6	EUT description.....	5
6.1	General information.....	5
6.2	Test configuration.....	6
6.3	Changes made in EUT	6
6.4	Transmitter characteristics	7
7	Transmitter tests according to 47CFR part 15 subpart C requirements	8
7.1	Minimum 6 dB bandwidth	8
7.2	Peak output power	16
7.3	Field strength of spurious emissions	21
7.4	Spurious emissions at RF antenna connector for one beam configuration	33
7.5	Spurious emissions at RF antenna connector for 4 non overlapping beam configuration	181
7.6	Band edge emissions at RF antenna connector for one beam configuration	305
7.7	Band edge emissions at RF antenna connector for 4 non overlapping beam configuration	346
7.8	Peak spectral power density	383
7.9	Conducted emissions for 4 non overlapping beam configuration	436
7.10	Antenna requirements.....	439
8	Emissions tests according to FCC 47CFR part 15 subpart B and ICES-003 requirements.....	440
8.1	Conducted emissions for 4 non overlapping beam configuration	440
8.2	Radiated emission measurements for 4 non overlapping beam configuration	443
9	APPENDIX A Test equipment and ancillaries used for tests	446
10	APPENDIX B Test equipment correction factors.....	448
11	APPENDIX C Test laboratory description	455
12	APPENDIX D Measurement uncertainties	456
13	APPENDIX E Specification references.....	457
14	APPENDIX F Manufacturer’s declaration.....	459
15	APPENDIX F Abbreviations and acronyms.....	461

1 Applicant information

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Telephone: +972-55-9206877
Fax: NA
E-mail: boaz@wireless2.net
Contact name: Mr. Boaz Reuven

2 Equipment under test attributes

Product name: Remote Radio Unit (RRU)
Product type: Transceiver
Part Number: ARRU-148-85
Serial number: NA
Hardware version: C3
Software release: Build 1.4.9-rc1.4
Receipt date 03-Jan-21

3 Manufacturer information

Manufacturer name: MC Assembly*
Manufacturer name*: SMTC Corporation Acquires MC Assembly Holdings, Inc.
Address: 425 North Dr, Melbourne, FL 32934, USA
Telephone: 321-253-0541
Fax: NA
E-Mail: blair.chendler@smtc.com
Contact name: Mr. Blair Chendler

4 Test details

Project ID: 41601
Location: Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started: 05-Apr-20
Test completed: 24-May-20
Test specification(s): FCC 47CFR part 15 subpart C §15.247 (DTS) and subpart B, RSS-247 Issue 2:2017, ICES-003 Issue 6:2016

5 Tests summary

Test	Status
Transmitter characteristics	
FCC section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth	Pass
FCC section 15.247(b)3/ RSS-247 section 5.4(4), Peak output power	Pass*
FCC section 15.247(i) / RSS-102 section 2.5.2, RF exposure	Pass, the exhibit to the application of certification is provided
FCC section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	Pass
FCC section 15.247(d)/ RSS-247 section 5.5, Emissions at band edges	Pass
FCC section 15.247(e) / RSS-247 section 5.2(2), Peak power density	Pass*
FCC section 15.203 / RSS-Gen section 8.3, Antenna requirement	Pass
FCC section 15.207(a) / RSS-Gen section 8.8, Conducted emission	Pass
Unintentional emissions	
FCC section 15.107/ ICES-003, Section 6.1, Class B, Conducted emission	Pass
FCC section 15.109/ RSS-Gen section 7.1.2 /ICES-003, Section 6.2, Class B, Radiated emission	Pass




The original EUT configuration was certified by FCC under FCC ID: 2AWXX-ARRH04885CVT.

*The relevant tests (listed above) were recalculated for the new report to reflect the following changes according to manufacturer's declaration provided in Appendix F.

1. 4 non-overlapping beams (6 dB) with cable loss of 0.15 dB instead of 3 non-overlapping beams (4.77 dB) and cable loss of 1.23 db

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:	Mr. A. Morozov, test engineer, EMC & Radio	05-Apr-20 – 24-May-20	
Reviewed by:	Mrs. S. Peysahov Sheynin, test engineer, EMC & Radio	13-May-21	
Approved by:	Mr. S. Samokha, technical manager, EMC & Radio	03-Jun-21	



6 EUT description

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

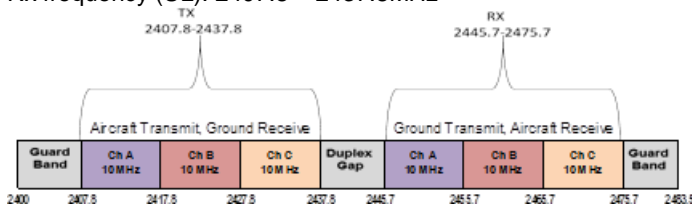
6.1 General information

The System is intended for In-Flight Entertainment (IFE) and does not include any flight-critical data.

The system provides a broadband air to ground connectivity within the network, providing a multi-megabit, bi-directional throughput with low latency.

Tx frequency (DL): 2445.7 – 2475.7MHz

Rx frequency (UL): 2407.8 – 2437.8MHz



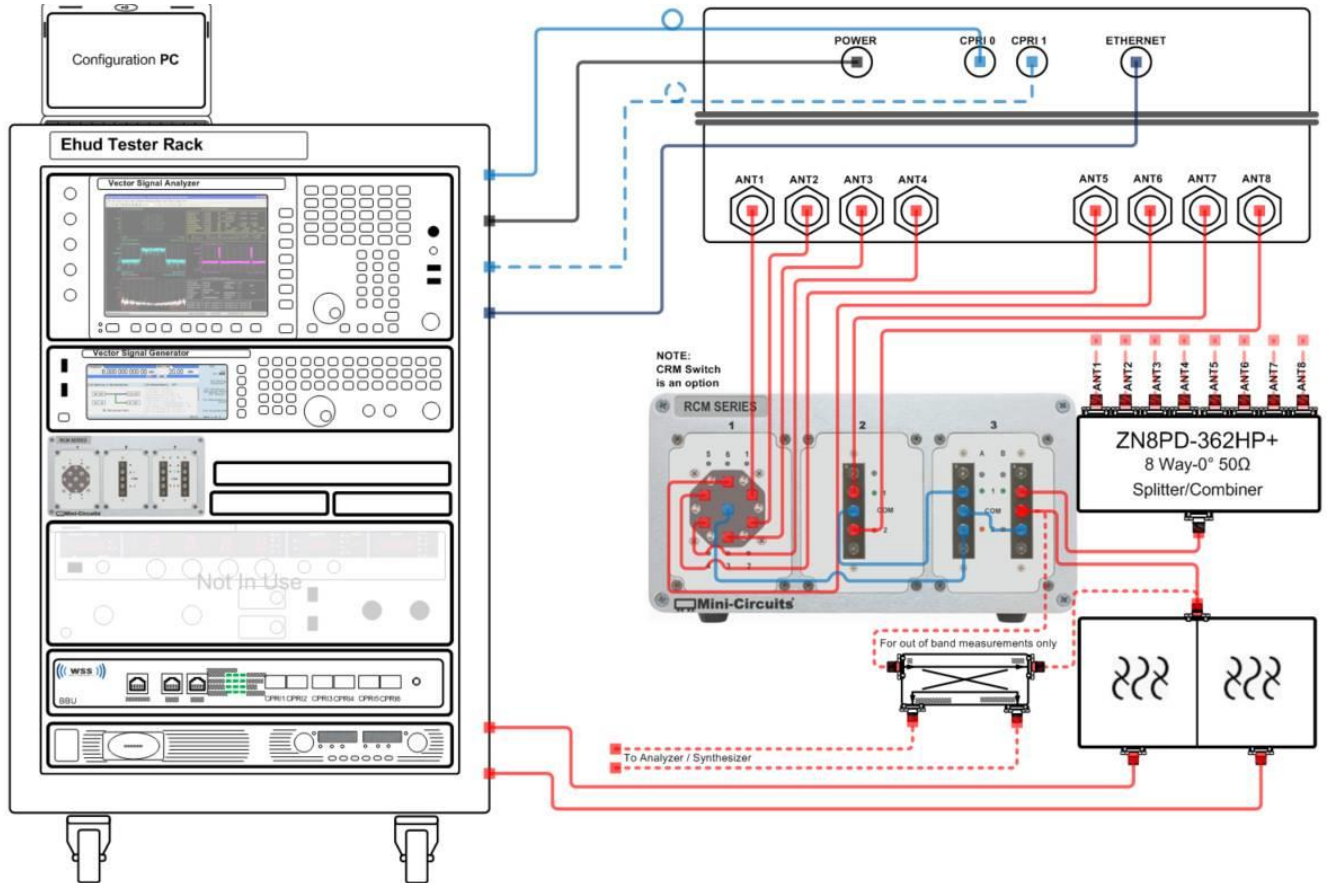
Channel	(UL) AU Transmit QPSK or 16QAM		(DL) RRU Transmit QPSK or 16QAM or 64QA	
	Center Frequency	BW	Center Frequency	BW
A1	2410.3MHz	5MHz	2448.2MHz	5MHz
A2	2415.3MHz	5MHz	2453.2MHz	5MHz
B1	2420.3MHz	5MHz	2458.2MHz	5MHz
B2	2425.3MHz	5MHz	2463.2MHz	5MHz
C1	2430.3MHz	5MHz	2468.2MHz	5MHz
C2	2435.3MHz	5MHz	2473.2MHz	5MHz
A	2412.8MHz	10MHz	2450.7MHz	10MHz
B	2422.8MHz	10MHz	2460.7MHz	10MHz
C	2432.8MHz	10MHz	2470.7MHz	10MHz

The system generates the LTE signal(s) in two modes, loopback and streamed data.

In loopback mode, the IQ data from the Rx port loops back (inside the FPGA) to the Tx while the other mode takes the streamed IQ (inside the FPGA).

Tx unit can transmit up to 34dBm at its Tx port.

6.2 Test configuration



6.3 Changes made in EUT

No changes were implemented in the EUT during testing.



6.4 Transmitter characteristics

Type of equipment			
X	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	
X	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		2400-2483.5 MHz	
Operating frequency		2448.2-2473.2 MHz	
Maximum rated output power		Peak output power 28.72 dBm	
Is transmitter output power variable?		X	No
			Yes
			continuous variable
			stepped variable with stepsize
	minimum RF power	dBm	
	maximum RF power	dBm	
Antenna connection			
unique coupling	standard connector	X	integral
			with temporary RF connector
			without temporary RF connector
Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
External	CCI	BFA8F-A5A	17.3 dBi
Modulation		QPSK / 16QAM / 64QAM	
Transmitter aggregate data rate/s		22.15Mbps	
Modulating test signal (baseband)		OFDM	
Transmitter power source			
	Battery	Nominal rated voltage	VDC
X	DC	Nominal rated voltage	48 VDC
	AC mains	Nominal rated voltage	Frequency
Spread spectrum technique used			Frequency hopping (FHSS)
		X	Digital transmission system (DTS)
			Hybrid



Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 24.1 °C	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 48 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C requirements

7.1 Minimum 6 dB bandwidth

7.1.1 General

This test was performed to measure 6 dB bandwidth of the EUT carrier frequency. Specification test limits are given in Table 7.1.1.

Table 7.1.1 6 dB bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Minimum bandwidth, kHz
902.0 – 928.0	6.0	500.0
2400.0 – 2483.5		
5725.0 – 5850.0		

* - Modulation envelope reference points provided in terms of attenuation below the peak of modulated carrier.

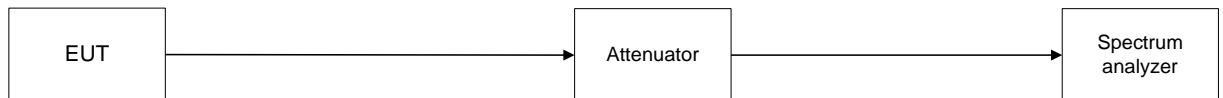
7.1.2 Test procedure

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 set to transmit modulated carrier.

7.1.2.3 The transmitter minimum 6 dB bandwidth was measured with spectrum analyzer RBW=100 kHz as frequency delta between reference points on modulation envelope and provided in Table 7.1.2 and associated plot.

Figure 7.1.1 6 dB bandwidth test setup





Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 24.1 °C	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 48 VDC
Remarks:			

Table 7.1.2 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 2400.0 - 2483.5 MHz
 DETECTOR USED: Peak
 SWEEP MODE: Max hold
 SWEEP TIME: Auto
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 MODULATION ENVELOPE REFERENCE POINTS: 6.0 dBc

EMISSION BANDWIDTH: 5MHz

Carrier frequency, MHz	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz*	Verdict
QPSK				
2448.2	4548	500	4048	Pass
2458.2	4533	500	4033	Pass
2473.2	4514	500	4014	Pass
16QAM				
2448.2	4534	500	4034	Pass
2458.2	4538	500	4038	Pass
2473.2	4507	500	4007	Pass
64QAM				
2448.2	4497	500	3997	Pass
2458.2	4533	500	4033	Pass
2473.2	4472	500	3972	Pass

EMISSION BANDWIDTH: 10MHz

Carrier frequency, MHz	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz*	Verdict
QPSK				
2450.7	9023	500	8523	Pass
2460.7	9031	500	8531	Pass
2470.7	9022	500	8522	Pass
16QAM				
2450.7	8994	500	8494	Pass
2460.7	9021	500	8521	Pass
2470.7	9009	500	8509	Pass
64QAM				
2450.7	8972	500	8472	Pass
2460.7	9026	500	8526	Pass
2470.7	9030	500	8530	Pass

* - Margin = 6 dB bandwidth – Specification limit

Reference numbers of test equipment used

HL 5175	HL 5376	HL 5409						
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Full description is given in Appendix A.



HERMON LABORATORIES

Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 24.1 °C	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 48 VDC
Remarks:			

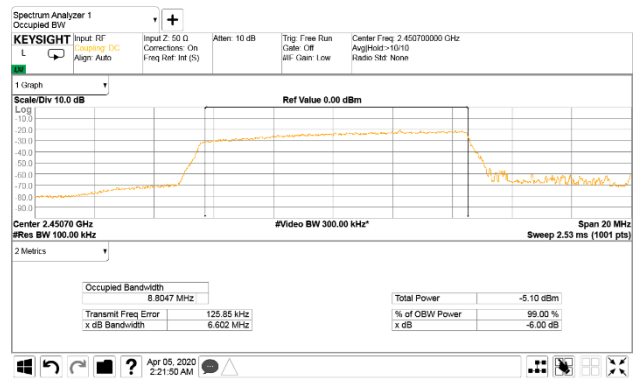
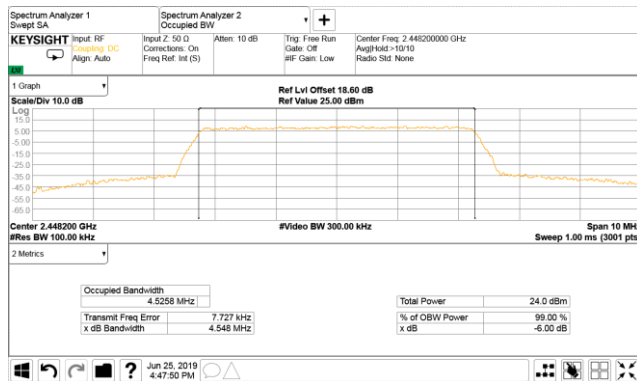
Plot 7.1.1 6 dB bandwidth test result at low frequency, antenna chain # 1

CHANNEL BANDWIDTH:

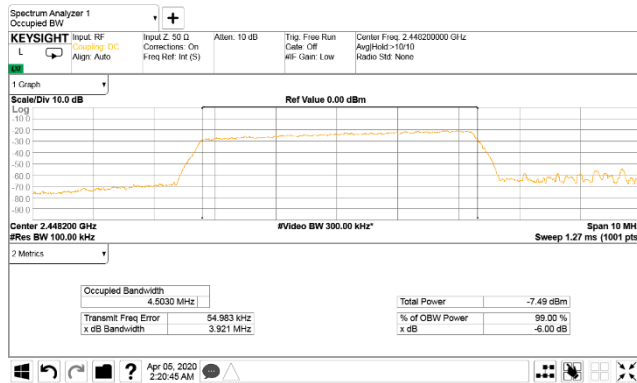
5 MHz

MODULATION: QPSK

MODULATION: 64 QAM



MODULATION: 16 QAM





HERMON LABORATORIES

Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 24.1 °C	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 48 VDC
Remarks:			

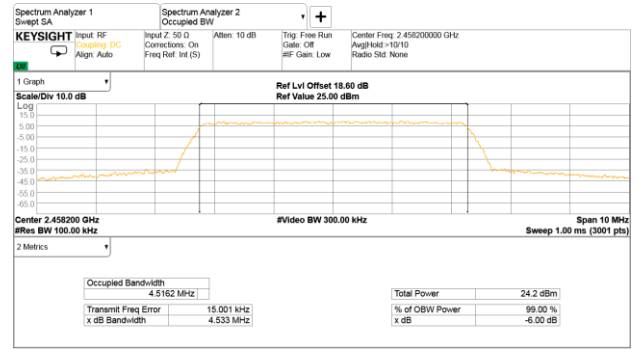
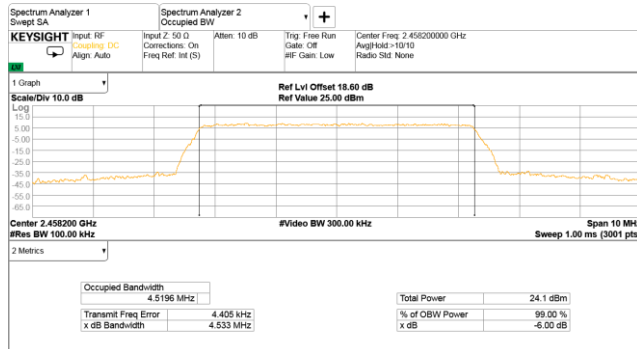
Plot 7.1.2 6 dB bandwidth test result at mid frequency, antenna chain # 1

CHANNEL BANDWIDTH:

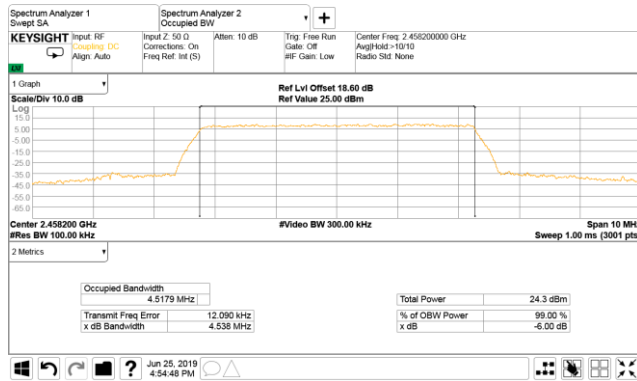
5 MHz

MODULATION: QPSK

MODULATION: 64 QAM



MODULATION: 16 QAM





HERMON LABORATORIES

Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 24.1 °C	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 48 VDC
Remarks:			

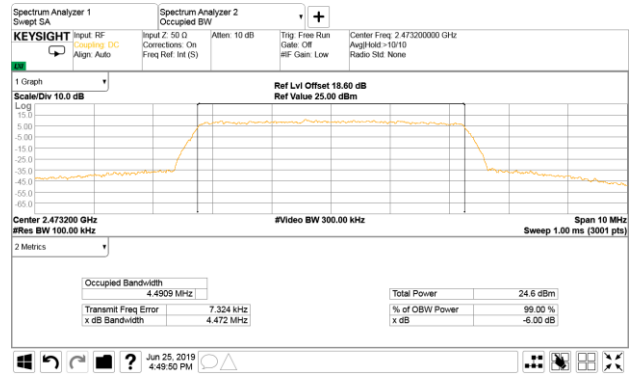
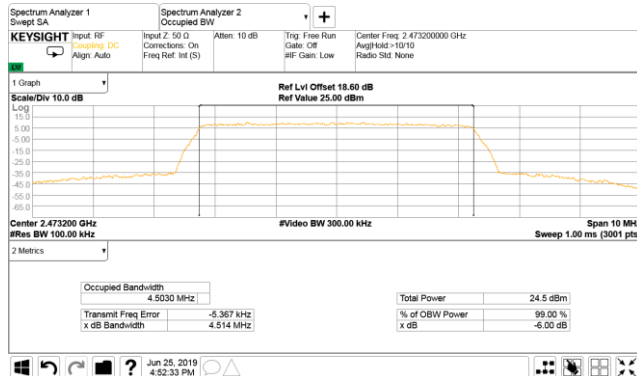
Plot 7.1.3 6 dB bandwidth test result at high frequency, antenna chain # 1

CHANNEL BANDWIDTH:

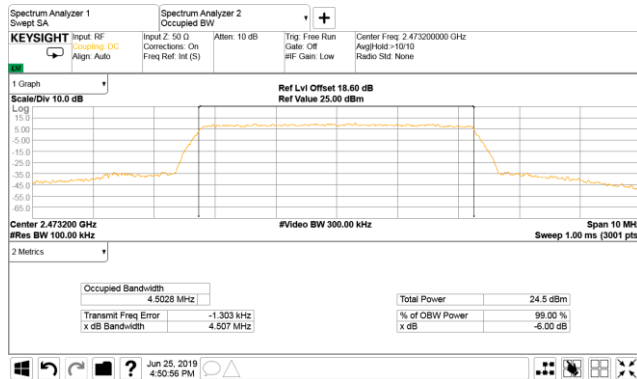
5 MHz

MODULATION: QPSK

MODULATION: 64 QAM



MODULATION: 16 QAM





HERMON LABORATORIES

Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 24.1 °C	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 48 VDC
Remarks:			

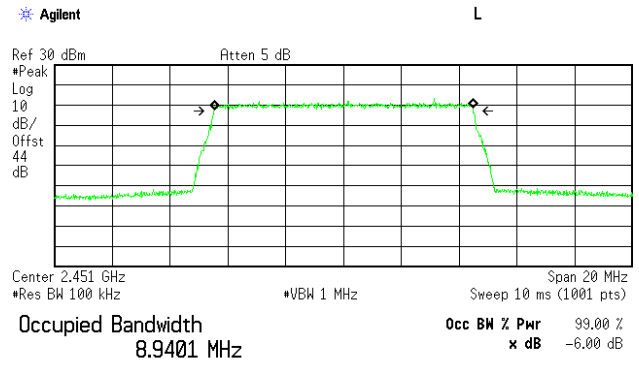
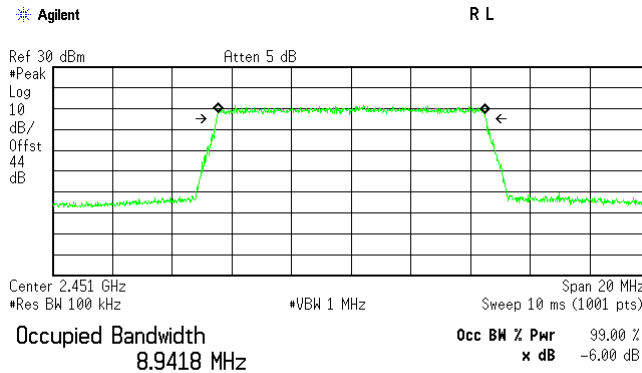
Plot 7.1.4 6 dB bandwidth test result at low frequency, antenna chain # 1

CHANNEL BANDWIDTH:

10 MHz

MODULATION: QPSK

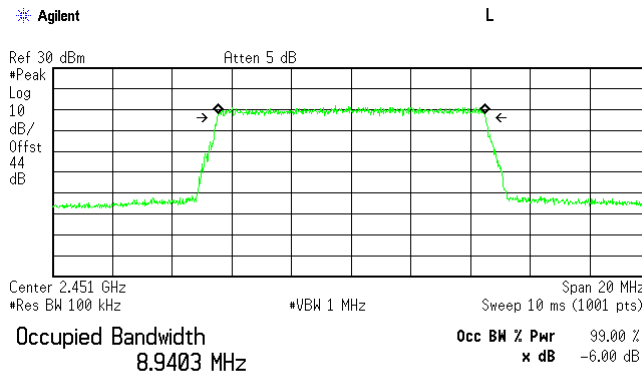
MODULATION: 64 QAM



Transmit Freq Error 5.706 kHz
x dB Bandwidth 9.023 MHz

Transmit Freq Error 8.096 kHz
x dB Bandwidth 8.972 MHz

MODULATION: 16 QAM



Transmit Freq Error 14.777 kHz
x dB Bandwidth 8.994 MHz



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Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 24.1 °C	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 48 VDC
Remarks:			

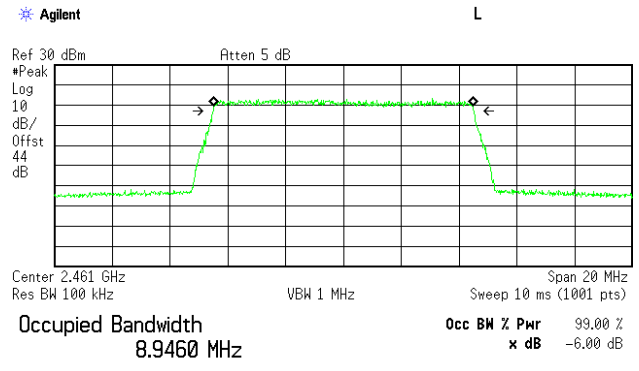
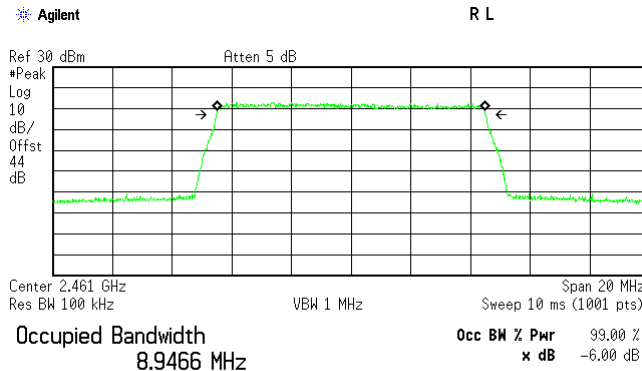
Plot 7.1.5 6 dB bandwidth test result at mid frequency, antenna chain # 1

CHANNEL BANDWIDTH:

10 MHz

MODULATION: QPSK

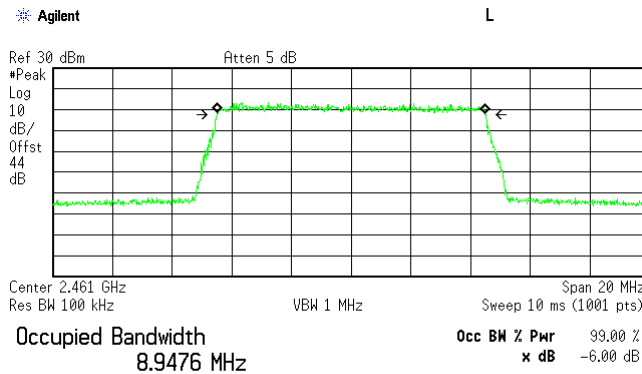
MODULATION: 64 QAM



Transmit Freq Error 944,155 Hz
x dB Bandwidth 9.031 MHz

Transmit Freq Error -321,973 Hz
x dB Bandwidth 9.026 MHz

MODULATION: 16 QAM



Transmit Freq Error 1,397 kHz
x dB Bandwidth 9.021 MHz



HERMON LABORATORIES

Test specification: Section 15.247(a)2 / RSS-247 section 5.2(1), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 13-Jun-19			
Temperature: 24.1 °C	Relative Humidity: 46 %	Air Pressure: 1008 hPa	Power: 48 VDC
Remarks:			

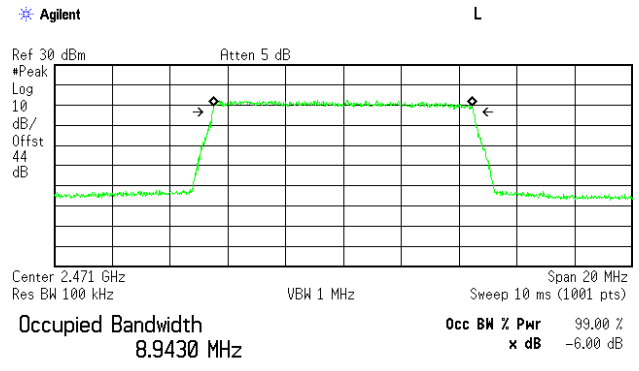
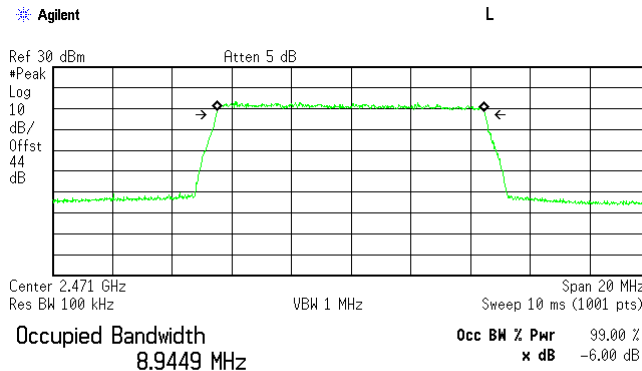
Plot 7.1.6 6 dB bandwidth test result at high frequency, antenna chain # 1

CHANNEL BANDWIDTH:

10 MHz

MODULATION: QPSK

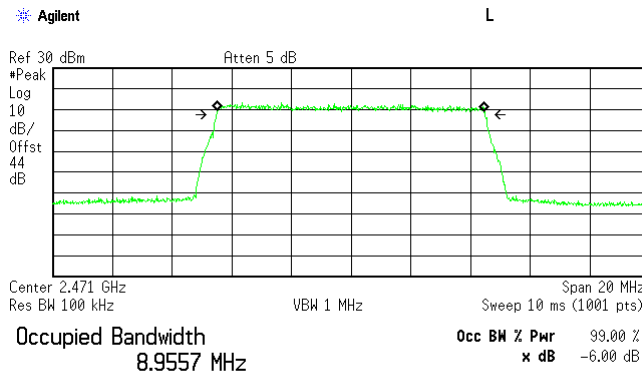
MODULATION: 64 QAM



Transmit Freq Error -11.871 kHz
x dB Bandwidth 9.022 MHz

Transmit Freq Error -12.375 kHz
x dB Bandwidth 9.030 MHz

MODULATION: 16 QAM



Transmit Freq Error -10.895 kHz
x dB Bandwidth 9.009 MHz



Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Peak output power			
Test procedure: ANSI C63.10 section 11.9			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

7.2 Peak output power

7.2.1 General

This test was performed to measure the maximum peak output power at the transmitter RF antenna connector. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Peak output power limits

Assigned frequency range, MHz	Maximum antenna gain, dBi	Peak output power*	
		W	dBm
902.0 – 928.0	6.0	1.0	30.0
2400.0 – 2483.5			
5725.0 – 5850.0			

*- If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

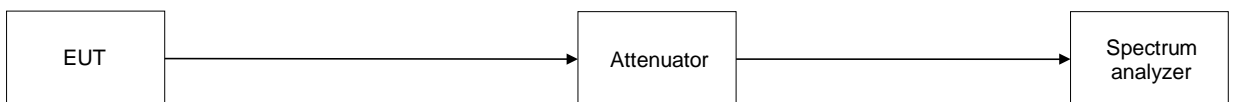
7.2.2 Test procedure

7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and its proper operation was checked.

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

7.2.2.3 The worst test results (the lowest margins) were recorded in Table 7.2.2 and Table 7.2.3.

Figure 7.2.1 Peak output power test setup





Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Peak output power			
Test procedure: ANSI C63.10 section 11.9			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

Table 7.2.2 Peak output power test results for one beam

ASSIGNED FREQUENCY: 2400.0 - 2483.5 MHz
 MODULATING SIGNAL: PRBS
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 DETECTOR USED: Average

EUT 6 dB BANDWIDTH: 5 MHz

Carrier frequency, MHz	Chain, #1, dBm	Chain, #2, dBm	Chain, #3, dBm	Chain, #4, dBm	Chain, #5, dBm	Chain, #6, dBm	Chain, #7, dBm	Chain, #8, dBm	Sum power, dBm
Modulation QPSK									
2448.2	15.68	14.50	14.95	14.23	13.85	14.02	15.10	14.90	23.69
2458.2	15.14	14.12	14.77	14.15	13.80	14.06	14.87	15.15	23.54
2473.2	15.92	14.50	15.22	14.35	14.17	14.00	15.12	15.08	23.84
Modulation 16QAM									
2448.2	15.70	14.40	14.95	14.23	13.85	14.05	15.00	14.77	23.66
2458.2	15.54	14.13	14.76	14.16	13.80	14.05	14.87	15.16	23.60
2473.2	15.93	14.6	15.23	14.35	14.20	14.00	15.15	15.20	23.88
Modulation 64QAM									
2448.2	14.77	14.43	14.96	14.24	13.85	14.02	15.05	14.77	23.53
2458.2	15.59	14.14	14.78	14.15	13.80	14.05	14.85	15.20	23.61
2473.2	15.92	14.50	15.25	14.35	14.18	14.00	15.09	15.12	23.85

Carrier frequency, MHz	Sum power, dBm	External attenuation, dB	Cable loss, dB	Total power, dBm	Limit, dBm	Margin*, dB	Verdict
Modulation QPSK							
2448.2	23.69	Included	0.15	23.54	24.00	-0.46	Pass
2458.2	23.54	Included	0.15	23.39	24.00	-0.61	Pass
2473.2	23.84	Included	0.15	23.69	24.00	-0.31	Pass
Modulation 16QAM							
2448.2	23.66	Included	0.15	23.51	24.00	-0.49	Pass
2458.2	23.60	Included	0.15	23.45	24.00	-0.55	Pass
2473.2	23.88	Included	0.15	23.73	24.00	-0.27	Pass
Modulation 64QAM							
2448.2	23.53	Included	0.15	23.38	24.00	-0.62	Pass
2458.2	23.61	Included	0.15	23.46	24.00	-0.54	Pass
2473.2	23.85	Included	0.15	23.70	24.00	-0.30	Pass

* - Margin = Total output power – specification limit.

** - Total power = Sum power + External attenuation – Cable loss

*** - Sum output power = $\sum 10\log(\text{Output power per Chain } \#x/10)$, where #x = 1,2,...,8 number of chain



Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Peak output power			
Test procedure: ANSI C63.10 section 11.9			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

EUT 6 dB BANDWIDTH: 10 MHz

Carrier frequency, MHz	Chain, #1, dBm	Chain, #2, dBm	Chain, #3, dBm	Chain, #4, dBm	Chain, #5, dBm	Chain, #6, dBm	Chain, #7, dBm	Chain, #8, dBm	Sum power, dBm
Modulation QPSK									
2450.7	15.65	14.40	15.05	14.27	13.82	13.91	15.10	15.01	23.69
2460.7	15.45	13.96	14.60	13.90	13.52	13.61	14.60	14.85	23.36
2470.7	16.10	14.81	15.48	14.65	14.42	14.10	15.42	15.40	24.09
Modulation 16QAM									
2450.7	15.74	14.46	15.13	14.35	13.92	14.02	15.16	15.08	23.77
2460.7	15.45	13.95	14.61	13.92	13.60	13.62	14.62	14.92	23.38
2470.7	16.14	14.85	15.20	14.70	14.50	14.15	15.45	15.43	24.09
Modulation 64QAM									
2450.7	15.78	14.50	15.20	14.38	13.95	14.05	15.18	15.10	23.81
2460.7	15.47	13.98	14.61	13.96	13.60	13.62	14.65	14.93	23.40
2470.7	16.17	14.86	15.30	14.70	14.30	14.20	15.45	15.43	24.10

Carrier frequency, MHz	Sum power, dBm	External attenuation, dB	Cable loss, dB	Total power, dBm	Limit, dBm	Margin*, dB	Verdict
Modulation QPSK							
2450.7	23.69	Included	0.15	23.54	24.00	-0.46	Pass
2460.7	23.36	Included	0.15	23.21	24.00	-0.79	Pass
2470.7	24.09	Included	0.15	23.94	24.00	-0.06	Pass
Modulation 16QAM							
2450.7	23.77	Included	0.15	23.62	24.00	-0.38	Pass
2460.7	23.38	Included	0.15	23.23	24.00	-0.77	Pass
2470.7	24.09	Included	0.15	23.94	24.00	-0.06	Pass
Modulation 64QAM							
2450.7	23.81	Included	0.15	23.66	24.00	-0.34	Pass
2460.7	23.40	Included	0.15	23.25	24.00	-0.75	Pass
2470.7	24.10	Included	0.15	23.95	24.00	-0.05	Pass

* - Margin = Total output power – specification limit.

** - Total power = Sum power + External attenuation – Cable loss

*** - Sum output power = $\sum 10\log(\text{Output power per Chain } \#x/10)$, where #x = 1,2,...,8 number of chain



Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Peak output power			
Test procedure: ANSI C63.10 section 11.9			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

Table 7.2.3 Peak output power test results for 4 non-overlapping beams

ASSIGNED FREQUENCY: 2400.0 - 2483.5 MHz
 MODULATING SIGNAL: PRBS
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 DETECTOR USED: Average

CONFIGURATION: Multi-beams
 EUT 6 dB BANDWIDTH: 5 MHz

Carrier frequency, MHz	Chain, #1, dBm	Chain, #2, dBm	Chain, #3, dBm	Chain, #4, dBm	Chain, #5, dBm	Chain, #6, dBm	Chain, #7, dBm	Chain, #8, dBm	Sum power, dBm
Modulation QPSK									
2448.2	19.32	19.45	19.37	19.23	18.49	19.22	19.08	19.46	28.21
2458.2	19.37	19.47	19.52	19.37	18.54	19.33	19.13	19.42	28.28
2473.2	19.71	19.77	19.72	19.64	18.89	19.67	19.49	19.77	28.59
Modulation 16QAM									
2448.2	19.25	19.51	19.47	19.28	18.49	19.21	19.09	19.45	28.23
2458.2	19.45	19.49	19.56	19.39	18.57	19.37	19.22	19.5	28.33
2473.2	19.69	19.83	19.76	19.69	18.85	19.72	19.47	19.78	28.61
Modulation 64QAM									
2448.2	19.24	19.49	19.46	19.3	18.47	19.19	19.07	19.47	28.22
2458.2	19.33	19.53	19.57	19.32	18.50	19.38	19.27	19.45	28.31
2473.2	19.65	19.88	19.78	19.64	18.88	19.71	19.48	19.72	28.60

Carrier frequency, MHz	Sum power, dBm	External attenuation, dB	Cable loss, dB	Total power, dBm	Limit, dBm	Margin*, dB	Verdict
Modulation QPSK							
2448.2	28.21	Included	0.15	28.06	30.00	-1.94	Pass
2458.2	28.28	Included	0.15	28.13	30.00	-1.87	Pass
2473.2	28.59	Included	0.15	28.44	30.00	-1.56	Pass
Modulation 16QAM							
2448.2	28.23	Included	0.15	28.08	30.00	-1.92	Pass
2458.2	28.33	Included	0.15	28.18	30.00	-1.82	Pass
2473.2	28.61	Included	0.15	28.46	30.00	-1.54	Pass
Modulation 64QAM							
2448.2	28.22	Included	0.15	28.07	30.00	-1.93	Pass
2458.2	28.31	Included	0.15	28.16	30.00	-1.84	Pass
2473.2	28.60	Included	0.15	28.45	30.00	-1.55	Pass

* - Margin = Total output power – specification limit.
 ** - Total power = Sum power + External attenuation – Cable loss
 *** - Sum output power = $\sum 10\log(\text{Output power per Chain } \#x/10)$, where #x = 1,2,...,8 number of chain



Test specification: Section 15.247(b)3 / RSS-247 section 5.4(4), Peak output power			
Test procedure: ANSI C63.10 section 11.9			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

EUT 6 dB BANDWIDTH: 10 MHz

Carrier frequency, MHz	Chain, #1, dBm	Chain, #2, dBm	Chain, #3, dBm	Chain, #4, dBm	Chain, #5, dBm	Chain, #6, dBm	Chain, #7, dBm	Chain, #8, dBm	Sum power, dBm
Modulation QPSK									
2450.7	19.93	19.99	20.09	19.93	19.26	19.87	19.86	20.01	28.87
2460.7	19.86	19.99	20.02	19.82	20.06	19.80	19.84	19.44	28.86
2470.7	19.84	20.01	20.14	19.78	19.22	19.86	19.88	19.99	28.85
Modulation 16QAM									
2450.7	19.85	20.01	20.06	19.92	19.22	19.81	19.91	20.04	28.86
2460.7	19.67	19.79	19.92	19.59	20.02	19.70	19.60	19.80	28.76
2470.7	19.81	19.97	20.05	19.75	19.09	19.83	19.85	19.94	28.80
Modulation 64QAM									
2450.7	19.91	20.03	20.06	19.84	19.19	19.86	19.93	20.03	28.86
2460.7	19.69	19.73	19.87	19.58	19.93	19.65	19.64	19.80	28.74
2470.7	19.91	19.96	20.10	19.76	19.51	19.71	19.85	20.06	28.86

Carrier frequency, MHz	Sum power, dBm	External attenuation, dB	Cable loss, dB	Total power, dBm	Limit, dBm	Margin*, dB	Verdict
Modulation QPSK							
2450.7	28.87	Included	0.15	28.72	30.00	-1.28	Pass
2460.7	28.86	Included	0.15	28.71	30.00	-1.29	Pass
2470.7	28.85	Included	0.15	28.70	30.00	-1.30	Pass
Modulation 16QAM							
2450.7	28.86	Included	0.15	28.71	30.00	-1.29	Pass
2460.7	28.76	Included	0.15	28.61	30.00	-1.39	Pass
2470.7	28.80	Included	0.15	28.65	30.00	-1.35	Pass
Modulation 64QAM							
2450.7	28.86	Included	0.15	28.71	30.00	-1.29	Pass
2460.7	28.74	Included	0.15	28.59	30.00	-1.41	Pass
2470.7	28.86	Included	0.15	28.71	30.00	-1.29	Pass

* - Margin = Total output power – specification limit.

** - Total power = Sum power + External attenuation – Cable loss

*** - Sum output power = $\sum 10\log(\text{Output power per Chain } \#x/10)$, where #x = 1,2,...,8 number of chain

Reference numbers of test equipment used

HL 3301	HL 3302	HL 4070				
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Full description is given in Appendix A.



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

7.3 Field strength of spurious emissions

7.3.1 General

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

Table 7.3.1 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m within restricted bands, dB(µV/m)*			Attenuation of field strength of spurious versus carrier outside restricted bands, dBc***
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	20.0
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 – 10 th harmonic	74.0	NA	54.0	

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

$$Lims_2 = Lims_1 + 40 \log (S_1/S_2),$$

where S₁ and S₂ – standard defined and test distance respectively in meters.

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

*** - The 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.

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 7.3.1, 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° and the measuring antenna was rotated around its vertical axis.

7.3.2.3 The worst test results (the lowest margins) were recorded 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 7.3.2, Figure 7.3.3, 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°, 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 and shown in the associated plots.



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

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

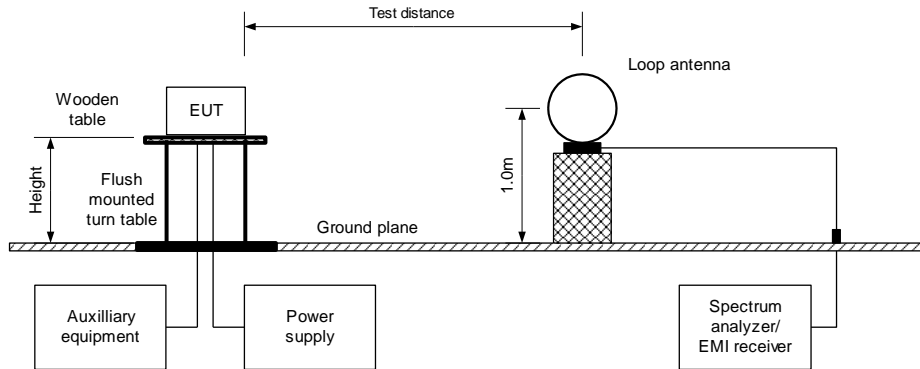
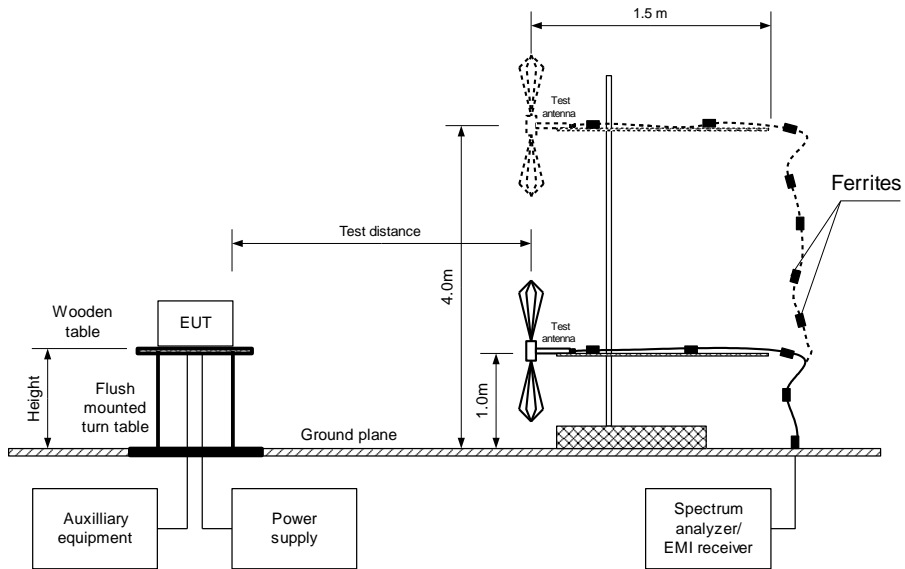


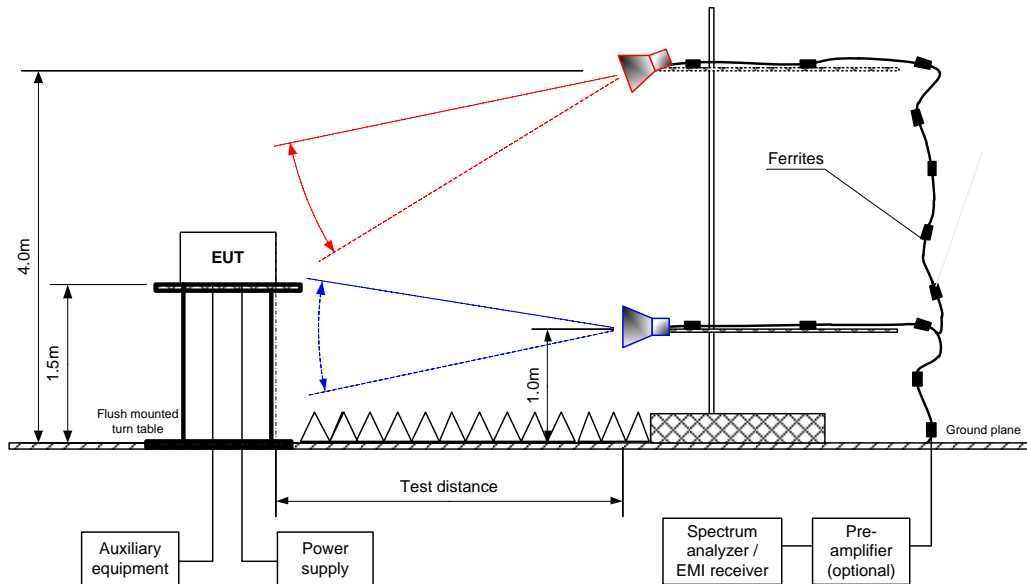
Figure 7.3.2 Setup for spurious emission field strength measurements in 30 – 1000 MHz





Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

Figure 7.3.3 Setup for spurious emission field strength measurements above 1000 MHz





Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

Table 7.3.2 Field strength of spurious emissions above 1 GHz within restricted bands

ASSIGNED FREQUENCY: 2400 – 2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 1000 – 25000 MHz
 TEST DISTANCE: 3 m
 MODULATION: QPSK
 MODULATING SIGNAL: PRBS
 DUTY CYCLE: 100 %
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 1000 kHz
 TEST ANTENNA TYPE: Double ridged guide

Frequency, MHz	Antenna			Peak field strength(VBW=3 MHz)			Average field strength(VBW=10 Hz)				Verdict
	Polarization	Height, m	Azimuth, degrees*	Measured, dB(µV/m)	Limit, dB(µV/m)	Margin, dB**	Measured, dB(µV/m)	Calculated, dB(µV/m)	Limit, dB(µV/m)	Margin, dB***	
Low carrier frequency											
1535.500	V	2.55	-144	43.52	74.0	-30.48	39.55	NA	54.0	-14.45	Pass
Mid carrier frequency											
6881.397	V	1.02	-112	55.00	74.0	-19.00	40.55	NA	54.0	-13.45	Pass
High carrier frequency											
6389.827	V	1.32	115	50.95	74.0	-23.05	42.55	NA	54.0	-11.45	Pass
6881.397	V	1.02	-112	54.67	74.0	-19.33	43.55	NA	54.0	-10.45	

*- EUT front panel refers to 0 degrees position of turntable.
 **- Margin = Measured field strength - specification limit.
 ***- Margin = Calculated field strength - specification limit,
 where Calculated field strength = Measured field strength + average factor.

Table 7.3.3 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
NA	NA	NA	NA	NA	NA

*- Average factor was calculated as follows
 for pulse train shorter than 100 ms: $Average\ factor = 20 \times \log_{10} \left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{Train\ duration} \times Number\ of\ bursts\ within\ pulse\ train \right)$
 for pulse train longer than 100 ms: $Average\ factor = 20 \times \log_{10} \left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{100ms} \times Number\ of\ bursts\ within\ 100ms \right)$



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

Table 7.3.4 Field strength of spurious emissions below 1 GHz within restricted bands

ASSIGNED FREQUENCY: 2400 – 2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
 TEST DISTANCE: 3 m
 MODULATION: QPSK
 MODULATING SIGNAL: PRBS
 DUTY CYCLE: 100 %
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 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)
 Biconical (30 MHz – 200 MHz)
 Log periodic (200 MHz – 1000 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 carrier frequency								
37.644	31.36	28.99	40.0	-11.01	Vertical	1.02	180.0	Pass
73.513	28.80	26.74	40.0	-13.26	Vertical	1.00	102.0	
135.749	29.23	26.70	43.5	-16.80	Vertical	1.00	-96.0	
Mid carrier frequency								
37.632	31.62	29.54	40.0	-10.46	Vertical	1.04	140.0	Pass
73.489	28.76	26.84	40.0	-13.16	Vertical	1.02	102.0	
132.185	29.00	26.23	43.5	-17.27	Vertical	1.04	106.0	
High carrier frequency								
37.616	31.23	28.97	40.0	-11.03	Vertical	1.04	129.0	Pass
73.500	28.49	26.58	40.0	-13.42	Vertical	1.02	111.0	
136.948	29.22	26.56	43.5	-16.94	Vertical	1.02	-106.0	

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



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

Table 7.3.5 Restricted bands according to FCC section 15.205

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.37625 - 8.38675	73 - 74.6	399.9 - 410	2690 - 2900	10.6 - 12.7
0.495 - 0.505	8.41425 - 8.41475	74.8 - 75.2	608 - 614	3260 - 3267	13.25 - 13.4
2.1735 - 2.1905	12.29 - 12.293	108 - 121.94	960 - 1240	3332 - 3339	14.47 - 14.5
4.125 - 4.128	12.51975 - 12.52025	123 - 138	1300 - 1427	3345.8 - 3358	15.35 - 16.2
4.17725 - 4.17775	12.57675 - 12.57725	149.9 - 150.05	1435 - 1626.5	3600 - 4400	17.7 - 21.4
4.20725 - 4.20775	13.36 - 13.41	156.52475 - 156.52525	1645.5 - 1646.5	4500 - 5150	22.01 - 23.12
6.215 - 6.218	16.42 - 16.423	156.7 - 156.9	1660 - 1710	5350 - 5460	23.6 - 24
6.26775 - 6.26825	16.69475 - 16.69525	162.0125 - 167.17	1718.8 - 1722.2	7250 - 7750	31.2 - 31.8
6.31175 - 6.31225	16.80425 - 16.80475	167.72 - 173.2	2200 - 2300	8025 - 8500	36.43 - 36.5
8.291 - 8.294	25.5 - 25.67	240 - 285	2310 - 2390	9000 - 9200	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

Table 7.3.6 Restricted bands according to RSS-Gen

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.291 - 8.294	16.80425 - 16.80475	399.9 - 410	3260 - 3267	10.6 - 12.7
2.1735 - 2.1905	8.362 - 8.366	25.5 - 25.67	608 - 614	3332 - 3339	13.25 - 13.4
3.020 - 3.026	8.37625 - 8.38675	37.5 - 38.25	960 - 1427	3345.8 - 3358	14.47 - 14.5
4.125 - 4.128	8.41425 - 8.41475	73 - 74.6	1435 - 1626.5	3500 - 4400	15.35 - 16.2
4.17725 - 4.17775	12.29 - 12.293	74.8 - 75.2	1645.5 - 1646.5	4500 - 5150	17.7 - 21.4
4.20725 - 4.20775	12.51975 - 12.52025	108 - 138	1660 - 1710	5350 - 5460	22.01 - 23.12
5.677 - 5.683	12.57675 - 12.57725	156.52475 - 156.52525	1718.8 - 1722.2	7250 - 7750	23.6 - 24
6.215 - 6.218	13.36 - 13.41	156.7 - 156.9	2200 - 2300	8025 - 8500	31.2 - 31.8
6.26775 - 6.26825	16.42 - 16.423	240 - 285	2310 - 2390	9000 - 9200	36.43 - 36.5
6.31175 - 6.31225	16.69475 - 16.69525	322 - 335.4	2655 - 2900	9300 - 9500	Above 38.6

Reference numbers of test equipment used

HL1926	HL4360	HL5288	HL4933	HL4956	HL5405	HL3903	HL5111
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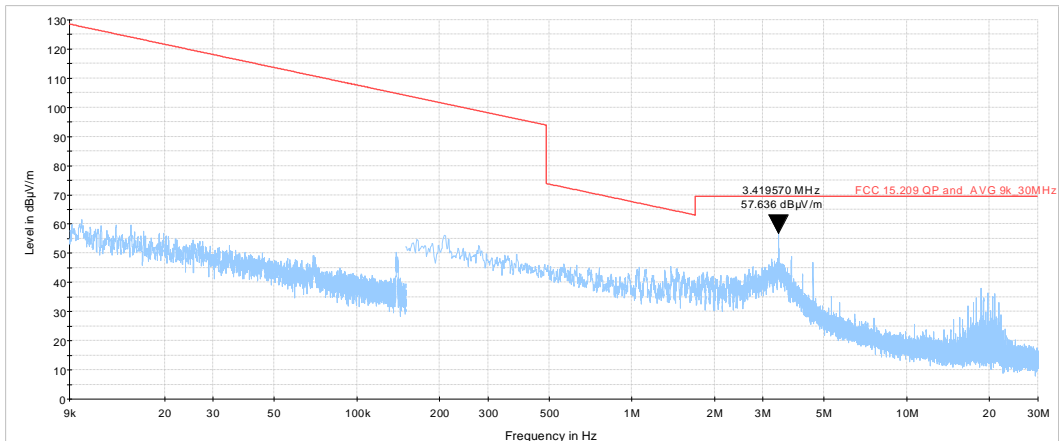
Full description is given in Appendix A.



Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

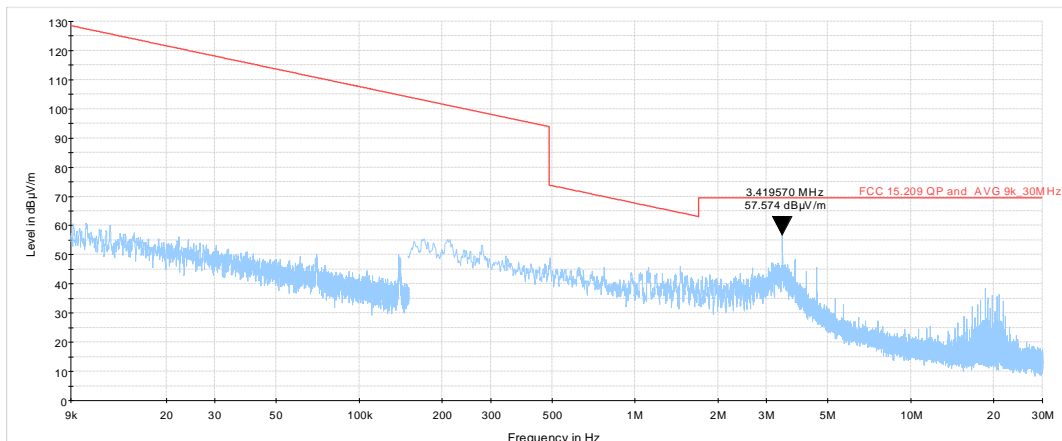
Plot 7.3.1 Radiated emission measurements from 9 KHz to 30 MHz at low carrier frequency

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical/Horizontal



Plot 7.3.2 Radiated emission measurements from 9 KHz to 30MHz at mid carrier frequency

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical/Horizontal



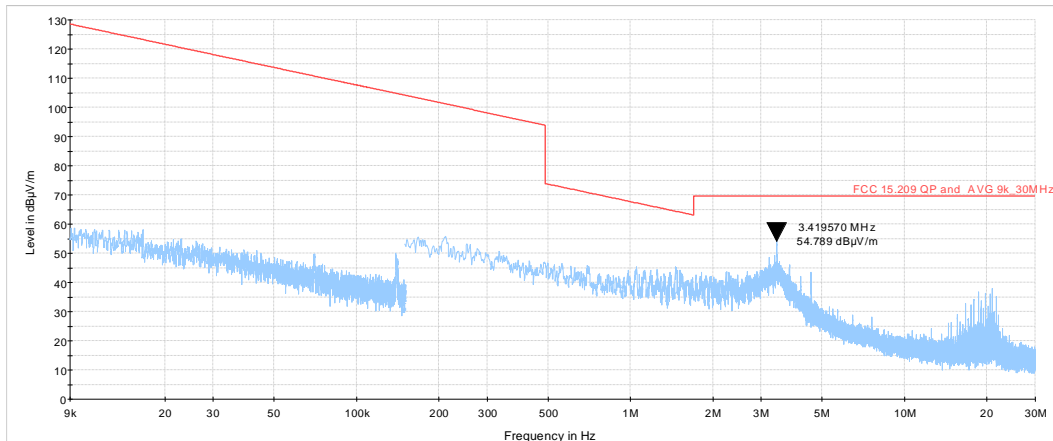


HERMON LABORATORIES

Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

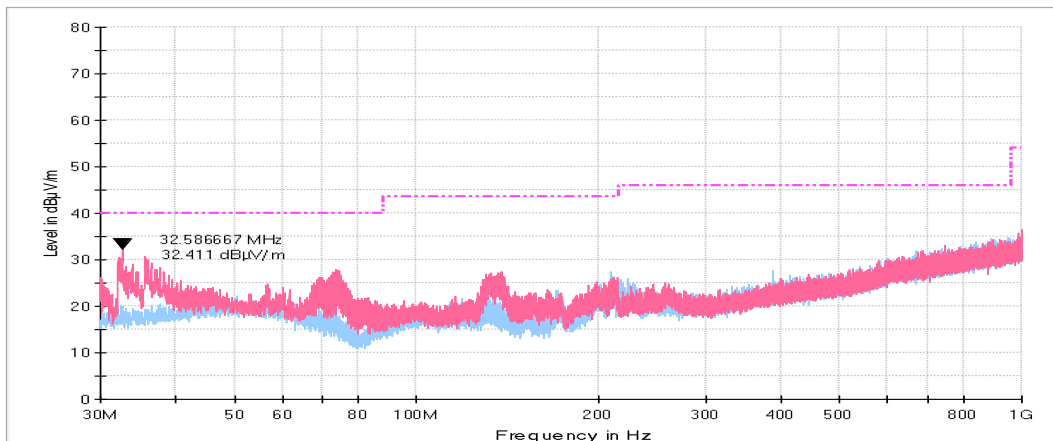
Plot 7.3.3 Radiated emission measurements from 9 KHz to 30MHz high at carrier frequency

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical/Horizontal



Plot 7.3.4 Radiated emission measurements from 30 MHz to 1000 MHz low at carrier frequency

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical/Horizontal

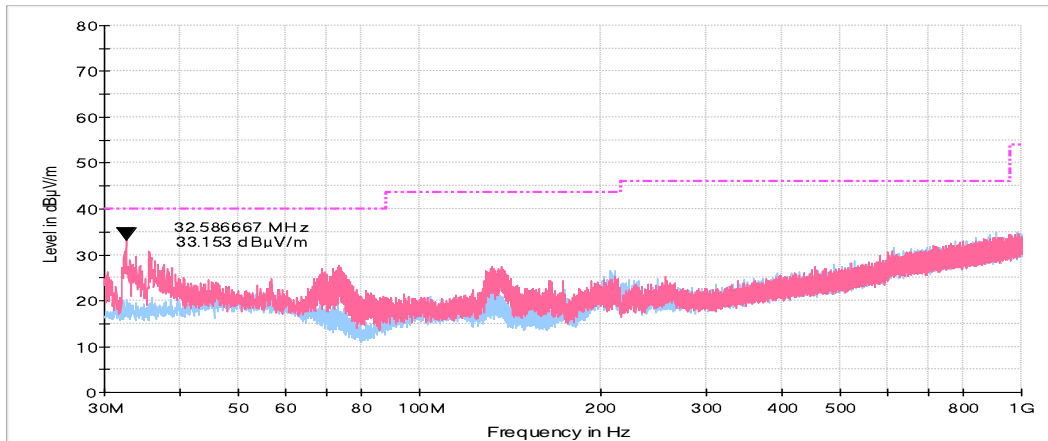




Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

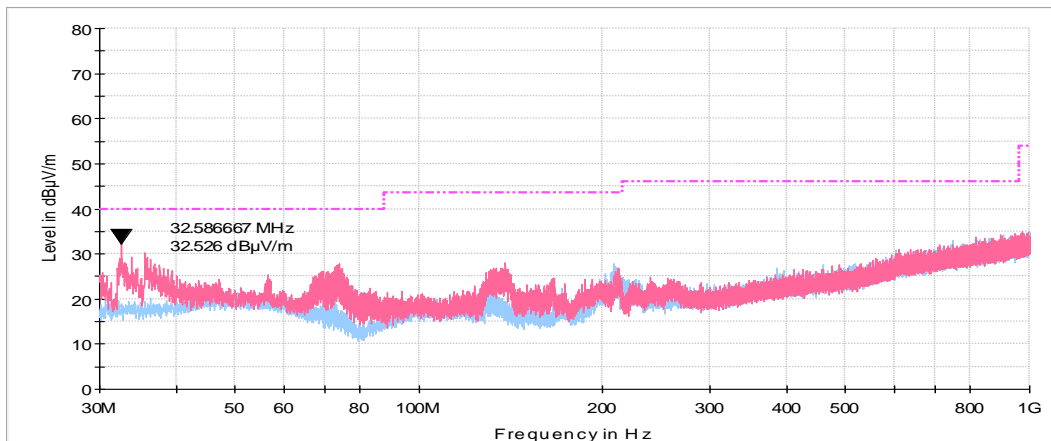
Plot 7.3.5 Radiated emission measurements from 30 MHz to 1000 MHz mid at carrier frequency

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical/Horizontal



Plot 7.3.6 Radiated emission measurements from 30 MHz to 1000 MHz at high carrier frequency

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical/Horizontal

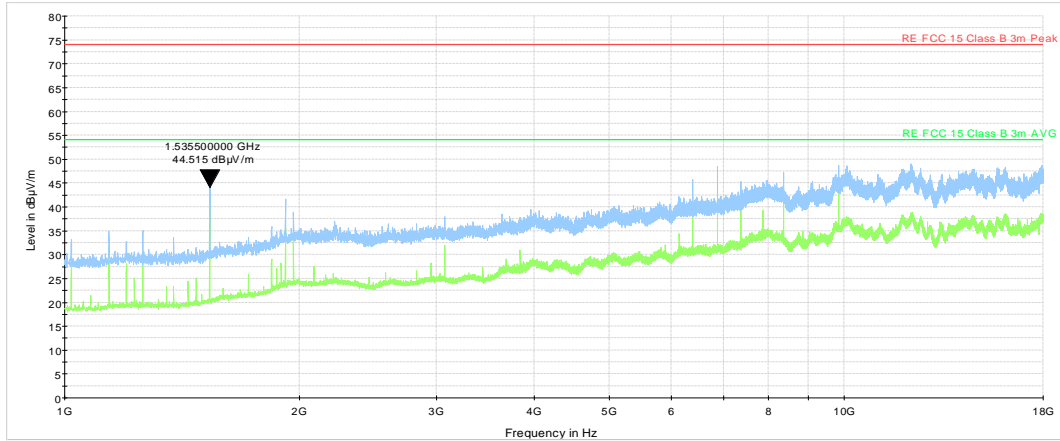




Test specification: Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Jun-19 - 31-Jul-19			
Temperature: 24 °C	Relative Humidity: 44 %	Air Pressure: 1004 hPa	Power: 48 VDC
Remarks:			

Plot 7.3.7 Radiated emission measurements from 1GHz to 18GHz at the low carrier frequency

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical/Horizontal



Plot 7.3.8 Radiated emission measurements from 1GHz to 18GHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber
 TEST DISTANCE: 3 m
 ANTENNA POLARIZATION: Vertical/Horizontal

