



TEST REPORT

Test Report No. : UL-RPT-RP-12783364-116-FCC

Applicant : Disruptive Technologies Research AS
Model No. : Cloud Connector US
FCC ID : 2ATFX-100590
Technology : 902 – 928 MHz (DTS)
Test Standard(s) : FCC Parts 15.207, 15.209(a) & 15.247

For details of applied tests refer to test result summary

1. This test report shall not be reproduced in full or partial, without the written approval of UL International Germany GmbH.
2. The results in this report apply only to the sample tested.
3. The test results in this report are traceable to the national or international standards.
4. Test Report Version 1.0
5. Result of the tested sample: **PASS**

Prepared by: Krume Ivanov
Title: Laboratory Engineer
Date: 03 December 2019

Approved by: Jakob Reschke
Title: Project Engineer
Date: 03 December 2019



Deutsche
Akkreditierungsstelle
D-PL-19381-02-00

This laboratory is accredited by DAkkS.
The tests reported herein have been performed in
accordance with its' terms of accreditation.

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1. Customer Information

1.1.Applicant Information

Company Name:	Disruptive Technologies Research AS
Company Address:	Ytrebygdsveien 215, 5258 Blomsterdalen, Bergen, Norway
Contact Person:	Bengt Johannes Lundberg
Contact E-Mail Address:	bengt.lundberg@disruptive-technologies.com
Contact Phone No.:	+47 91633887

1.2.Manufacturer Information

Company Name:	Zollner Elektronik AG
Company Address:	Manfred-Zollner-Straße 1, 93499 Zandt, Germany
Contact Person:	Thomas Glasschröder (QA Manager)
Contact E-Mail Address:	thomas_glasschroeder@zollner.de
Contact Phone No.:	+49 9944-201-7146

2. Summary of Testing

2.1. General Information

Applied Standards

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.209
Test Firm Registration:	399704

Location

Location of Testing:	UL International Germany GmbH Hedelfinger Str. 61 70327 Stuttgart Germany
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Date information

Order Date:	22 March 2019
EUT arrived:	30 September 2019
Test Dates:	30 September 2019 to 02 October 2019
EUT returned:	-/-

2.2. Summary of Test Results

Clause	Measurement	Complied	Did not comply	Not performed	Not applicable
Part 15.207	Transmitter AC Conducted Emissions	☒	☐	☐	☐
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	☒	☐	☐	☐
Part 15.35(c)	Transmitter Duty Cycle	☒	☐	☐	☐
Part 15.247(e)	Transmitter Power Spectral Density	☒	☐	☐	☐
Part 15.247(b)(3)	Transmitter Maximum Peak Output Power	☒	☐	☐	☐
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	☒	☐	☐	☐
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	☒	☐	☐	☐

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019
Title:	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

2.4. Deviations from the Test Specification

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

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Disruptive Technologies
Model Name or Number:	Cloud Connector US
Test Sample Serial Number:	bhrqmesc0001233subm0 (Radiated sample)
Hardware Version Number:	100590-1.1
Firmware Version Number	101631
Software Version Number:	develop/2.0.0.136, endre.bjorsvik/channel-hopping-request/2.0.0.2
FCC ID:	2ATFX-100590

Brand Name:	Disruptive Technologies
Model Name or Number:	Cloud Connector US
Test Sample Serial Number:	bhrrmsc0001233sucq0 (Conducted sample with RF port)
Hardware Version Number:	100590-1.1
Firmware Version Number	101631
Software Version Number:	develop/2.0.0.136, endre.bjorsvik/channel-hopping-request/2.0.0.2
FCC ID:	2ATFX-100590

Brand Name:	Disruptive Technologies
Model Name or Number:	Cloud Connector US
Test Sample Serial Number:	bhrucqkc0001233sue5g (AC-conducted sample)
Hardware Version Number:	100590-1.1
Firmware Version Number	101631
Software Version Number:	develop/2.0.0.136, endre.bjorsvik/channel-hopping-request/2.0.0.2
FCC ID:	2ATFX-100590

3.2. Description of EUT

The equipment under test was a gateway with an 915 MHz RF-Technology, that relays communication between sensors and the cloud. Wireless communication in the frequency band 902-928 MHz is used to the sensors whereas communication over Ethernet is used to the cloud. The equipment is powered over Ethernet.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Tested Technology:	902-928 MHz (DTS) Standard Mode	
Power Supply Requirement:	Nominal	36 – 57 V AC, Typical 48 V AC
Type of Unit:	Transceiver	
Channel Spacing:	1000 kHz	
Modulation:	Frequency Shift Keying (FSK)	
Data Rate (kbps):	240	
Measured Maximum Conducted Output Power:	24.81 dBm	
Integrated Antennas	Antenna 1 & Antenna 2	
Antenna 1 Gain:	0.0 dBi	
Antenna 1 Type:	Integrated PCB Antenna	
Antenna 1 Details :	PCB No. 100605 PCB Revision: 1.1.0 Manufacturer: DISRUPTIVE TECHNOLOGIES	
Antenna 2 Gain:	0.0 dBi	
Antenna 2 Type:	Integrated PCB Antenna	
Antenna 2 Details :	PCB No. 100605 PCB Revision: 1.1.0 Manufacturer: DISRUPTIVE TECHNOLOGIES	
Transmit Frequency Range:	903.250 MHz to 926.750 MHz	
Transmit Channels (Fixed Frequency) Tested:	Channel ID	Channel Frequency (MHz)
	Bottom	903.250
	Middle	915.000
	Top	926.750

3.5. Support Equipment

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

A. Support Equipment (In-house)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Wireless Gigabit VDSL/ADSL Modem Router	TP-LINK	Archer VR600-	216C713000272
2	RJ 45 Cable Yellow Cat6A	Not stated	Not stated	Not stated
3	8 Gigabit PoE Switch	Hewlett Packard Enterprise Company	J9562A	CN6280303J
4	Advanced Wireless N Router	TP-Link	TL-WR941ND	12292404777

B. Support Equipment (Manufacturer supplied)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Ethernet switch with power-over-ethernet (PoE) Injector	D-Link	DPE-101GI	SQ031HB003386
2	Switching Power Supply (PoE)	mimosa	POE16R-560	502-00005
3	POE/LAN Cable 5 m (M12x Coded to RJ45)	Not stated	1407473	Not stated
4	Laptop computer	Apple	MacBook Pro	C02T60V0GY25
5	50 Ohm terminations	Huber + Suhner	65_SMA-50-0-20	Not stated
6	SMA Jack to RF Switch Probe 50 Ohm	Not stated	Not stated	Not stated
7	50 cm RF SMA Plug Right angle to SMA Jack Cable	Not stated	Not stated	Not stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

☒ Transmitting Mode – Standard Mode Fixed Channel Frequency Mode.

4.2. Configuration and Peripherals

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

- **EUT Power Supply:**
 - For AC Conducted measurement the EUT was powered via 8 Gigabit Power Over Ethernet (PoE) Switch, connected to 120 V AC 60 Hz.
 - For all conducted measurements the EUT was powered via mimosa RJ45 Switching Power Over Ethernet Supply (PoE), connected to 120 V AC 60 Hz.
 - For all radiated measurements the EUT was powered via D-Link Power Over Ethernet (PoE), connected to 120 V AC 60Hz.
- **Test Mode Activation:**
 - The test mode settings were activated using a test setup instructions “2019-07-24 Instructions for UL to operate CCONs.pdf” supplied by customer.
 - The Test mode configuration files were installed on MacBook supplied by customer.
 - The application was used to enable continuous transmission mode, to select test modes (Fixed Frequency), test channels & supported integrated Antenna types as required.
 - The EUT was made to transmit continuously with a duty cycle of more than 98 %. Therefore no duty cycle corrections are required for radiated emissions measured with Average detector.
 - All supported integrated antennas are reported under section 3.4.
- **Conducted Measurements:**
 - RF Output Power, Power Spectral Density, Occupied Channel Bandwidth & Duty Cycles were measured with conducted sample.
 - All measurements were performed on Antenna Port 1 with Antenna Port 2 terminated with 50 Ω termination.
 - The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors. The RF cable attenuation (maximum 0.4 dB at the tested frequencies) from the EUT to Analyzer including the 10 dB attenuation at the Spectrum Analyzer input and 1.0 dB for the W.FL-SMA RF-cable attenuation was added as a reference level offset (11.4 dB) to each of the conducted plots.
- **AC Conducted Emissions Measurements:**
 - AC conducted tests were performed with all supported integrated antennas .
 - AC conducted tests were performed with all test modes (Fixed Frequency).
 - The Toyo EMI Software EP5/CE Ver 4.0.1. was used for these measurements.

- **Radiated Band Edge & Spurious Emission Measurements:**
- Radiated Band edge & Spurious Emission were performed with all supported integrated antennas.
- Before starting final radiated measurements “worst case verification” with the EUT in Standing-position & Laying-position for each supported Antenna was performed by Lab.
 - Antenna 1: The EUT in Laying position was found to be the worst case therefore this report includes relevant results.
 - Antenna 2: The EUT in Standing position was found to be the worst case therefore this report includes relevant results.
- Radiated spurious emissions were performed with the EUT positioned on the turn table and rotating 360 degrees while the antenna height varies from 1 to 4 m over the measurement frequency range.
- EMC32 V10.1.0 Software was used for the Radiated spurious emission measurement.

5. Measurements, Examinations and Derived Results

5.1. General Comments

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

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

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Vladimir Eppel	Test Date:	02 October 2019
Test Sample Serial Number:	bhrucqkc0001233sue5g		
Test Site Identification	SR 7/8		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	39

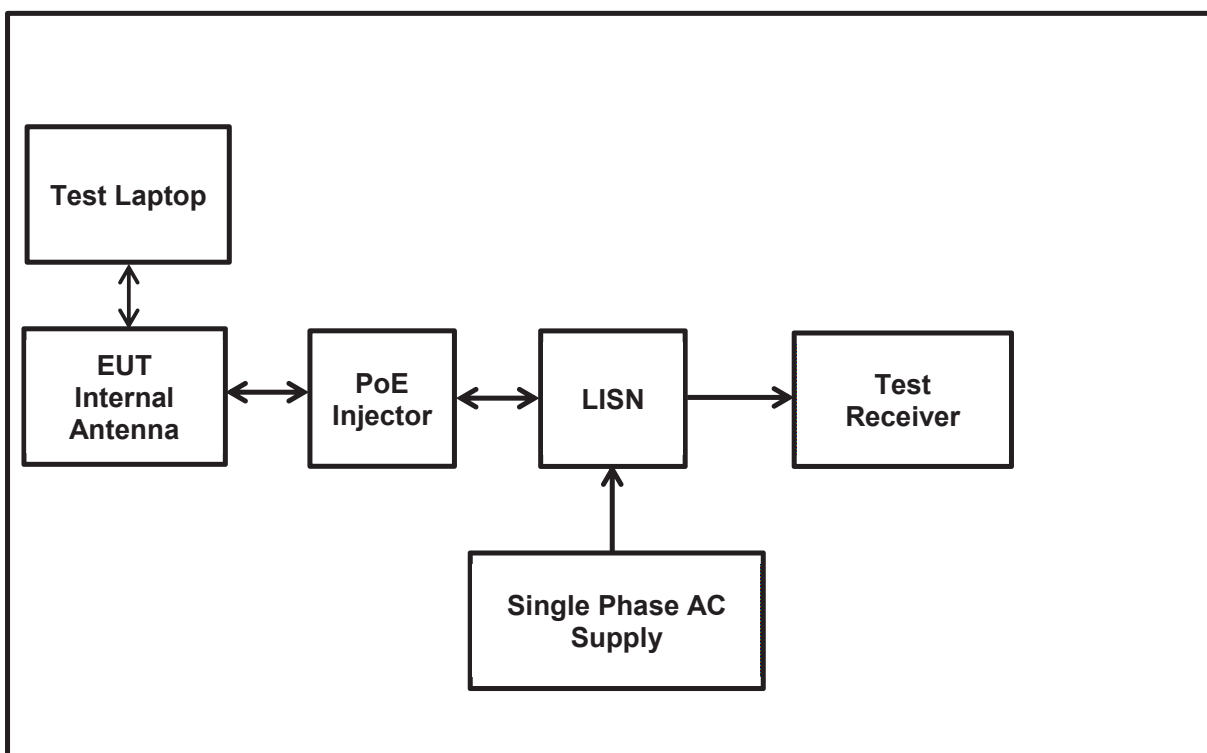
Settings of the Instrument

Detector	Quasi Peak /Average Peak
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Note:

1. The EUT was connected to 120 VAC 60 Hz single phase supply via a LISN.
2. AC conducted tests were performed with all supported integrated antennas .
3. AC conducted tests were performed with all test modes (Fixed Frequency).
4. For fixed frequency mode EUT was configured on top channel for antenna 1 and bottom channel for antenna 2.

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)**Standard Mode / Fixed Frequency Mode / Top Channel / Antenna 1****Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	QP-Limit (dB μ V)	Margin (dB)	Result
0.152	Live	36.2	65.9	29.7	Complied
0.15802	Live	35.1	65.6	30.5	Complied
0.17255	Live	32.4	64.8	32.4	Complied
0.18758	Live	29.8	64.1	34.3	Complied
0.41002	Live	23.2	57.6	34.4	Complied
0.72966	Live	14.8	56.0	41.2	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	AV-Limit (dB μ V)	Margin (dB)	Result
0.152	Live	17	55.9	36.3	Complied
0.15802	Live	19	55.6	38.6	Complied
0.17255	Live	16.6	54.8	37.6	Complied
0.18758	Live	14.7	54.1	35.8	Complied
0.41002	Live	16.6	47.6	28	Complied
0.72966	Live	20.5	46	39.3	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)**Standard Mode / Fixed Frequency Mode / Top Channel / Antenna 1****Results: Neutral / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	QP-Limit (dB μ V)	Margin (dB)	Result
0.15351	Neutral	36.0	65.8	29.8	Complied
0.16503	Neutral	34.2	65.2	31.0	Complied
0.17655	Neutral	31.8	64.6	32.8	Complied
0.18707	Neutral	30.0	64.2	34.2	Complied
0.22265	Neutral	23.7	62.7	39.0	Complied
0.36192	Neutral	25.4	58.7	33.3	Complied

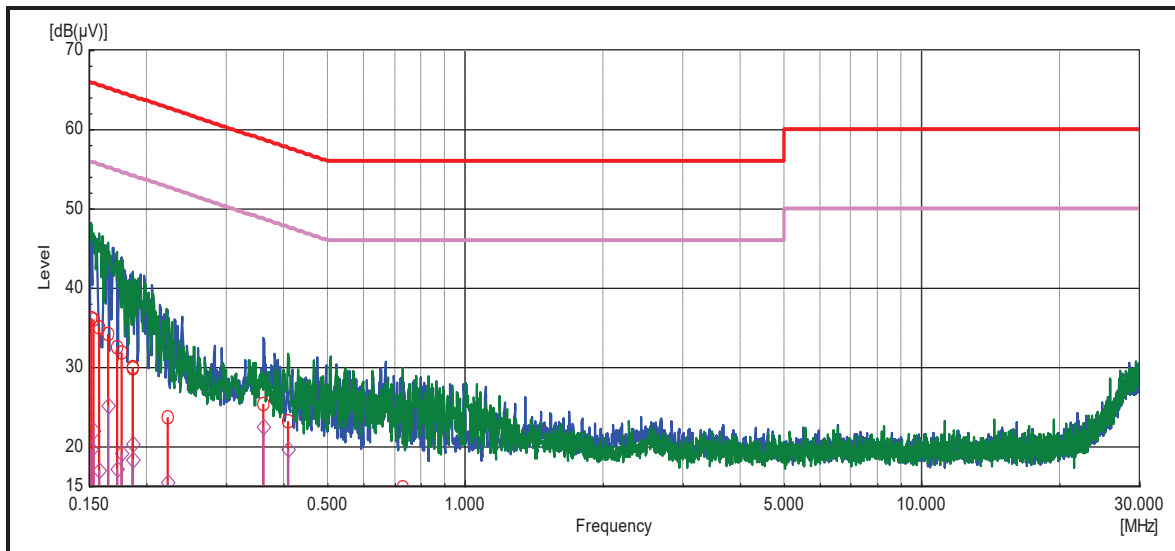
Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	AV-Limit (dB μ V)	Margin (dB)	Result
0.15351	Neutral	22.0	55.8	33.8	Complied
0.16503	Neutral	25.2	55.2	30.0	Complied
0.17655	Neutral	19.1	54.6	35.5	Complied
0.18707	Neutral	20.3	54.2	33.9	Complied
0.22265	Neutral	15.5	52.7	37.2	Complied
0.36192	Neutral	22.5	48.7	26.2	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)
Standard Mode / Fixed Frequency Mode / Top Channel / Antenna 1

Plot: Live and Neutral Line



Note: The plots show the max hold (peak detector) pre-scan results measured. Blue graph represents the result of the N-Line; green graph - the results for L1-Line. The bar graphs indicate the final measurement result applying the dedicated detector at selected frequencies for each limit line (red cycle for quasi peak limit; violet cycle for average limit).

Legend (Conducted Emissions)	
Items	Description
	Blue graph is the result of peak measurement phase L
	Green graph is the result of peak measurement phase N
	Limit line Quasi-Peak
	Limit line Average
	Final item Quasi-Peak
	Final item Average

Transmitter AC Conducted Spurious Emissions (continued)**Standard Mode / Fixed Frequency Mode / Bottom Channel / Antenna 2****Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	QP-Limit (dB μ V)	Margin (dB)	Result
0.160	Live	34.6	65.5	30.9	Complied
0.163	Live	34.2	65.3	31.1	Complied
0.173	Live	32.2	64.8	32.6	Complied
0.203	Live	26.7	63.5	36.8	Complied
0.208	Live	25.9	63.3	37.4	Complied
0.338	Live	24.5	59.2	34.7	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	AV-Limit (dB μ V)	Margin (dB)	Result
0.16002	Live	17	55.5	38.5	Complied
0.16303	Live	19	55.3	36.3	Complied
0.17355	Live	16.6	54.8	38.2	Complied
0.20311	Live	14.7	53.5	38.8	Complied
0.20862	Live	16.6	53.3	36.7	Complied
0.33838	Live	20.5	49.2	28.7	Complied

Result: Pass

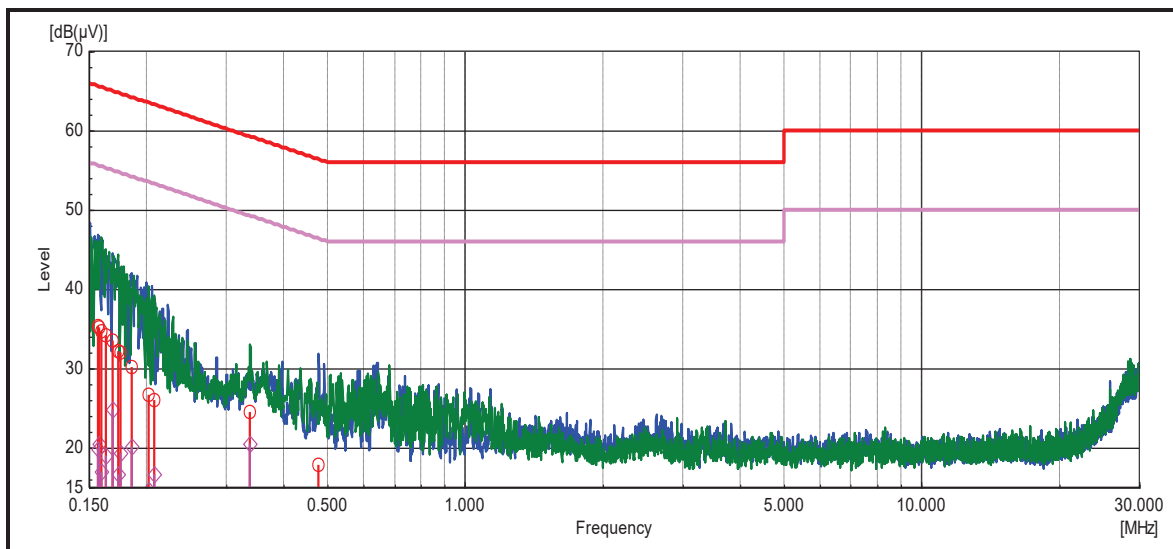
Transmitter AC Conducted Spurious Emissions (continued)**Standard Mode / Fixed Frequency Mode / Bottom Channel / Antenna 2****Results: Neutral / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	QP-Limit (dB μ V)	Margin (dB)	Result
0.15701	Neutral	35.3	65.6	30.3	Complied
0.15802	Neutral	35.1	65.6	30.5	Complied
0.16904	Neutral	33.5	65.0	31.5	Complied
0.17605	Neutral	32.0	64.7	32.7	Complied
0.18657	Neutral	30.1	64.2	34.1	Complied
0.47816	Neutral	17.8	56.4	38.6	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	AV-Limit (dB μ V)	Margin (dB)	Result
0.15701	Neutral	19.9	55.6	35.7	Complied
0.15802	Neutral	20.5	55.6	35.1	Complied
0.16904	Neutral	24.8	55.0	30.2	Complied
0.17605	Neutral	19.3	54.7	35.4	Complied
0.18657	Neutral	20.2	54.2	34.0	Complied
0.47816	Neutral	13.3	46.4	33.1	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)**Standard Mode / Fixed Frequency Mode / Bottom Channel / Antenna 2****Plot: Live and Neutral Line**

Note: The plots show the max hold (peak detector) pre-scan results measured. Blue graph represents the result of the N-Line; green graph - the results for L1-Line. The bar graphs indicate the final measurement result applying the dedicated detector at selected frequencies for each limit line (red cycle for quasi peak limit; violet cycle for average limit).

Legend (Conducted Emissions)	
Items	Description
	Blue graph is the result of peak measurement phase L
	Green graph is the result of peak measurement phase N
	Limit line Quasi-Peak
	Limit line Average
	Final item Quasi-Peak
	Final item Average

5.2.2. Transmitter Minimum 6 dB Bandwidth**Test Summary:**

Test Engineer:	Ajit Phadtare	Test Date:	30 September 2019
Test Sample Serial Number:	bhrrmsc0001233sucq0		
Test Site Identification	SR 9		

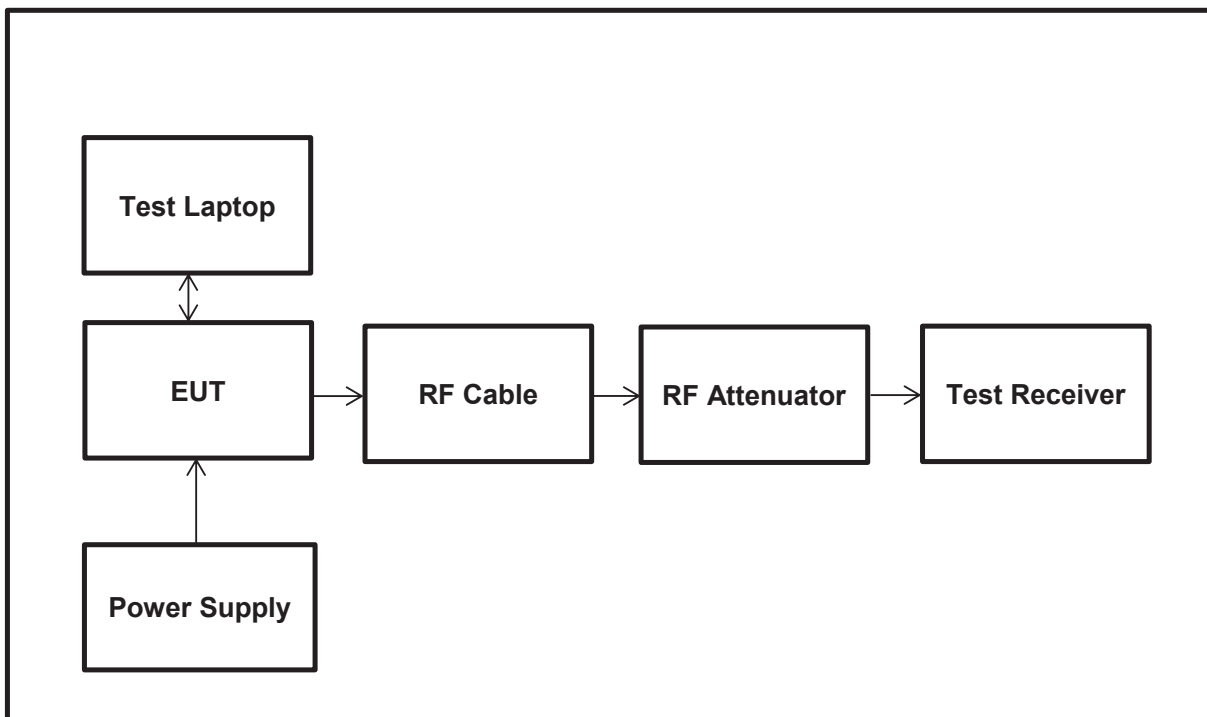
FCC Reference:	Part 15.247(a)(2)
Test Method Used:	FCC KDB 558074 Section 8.2 referring ANSI C63.10:2013 Section 11.8.1 Option 1

Environmental Conditions:

Temperature (°C):	22.9
Relative Humidity (%):	32

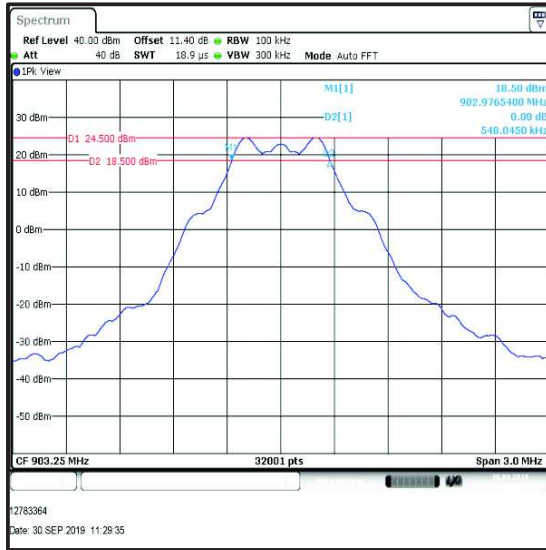
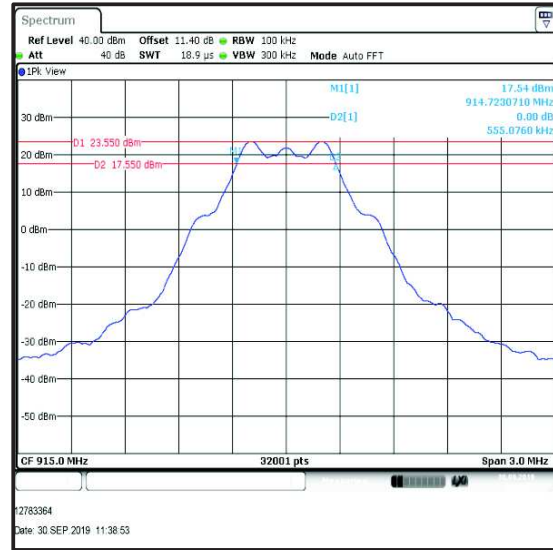
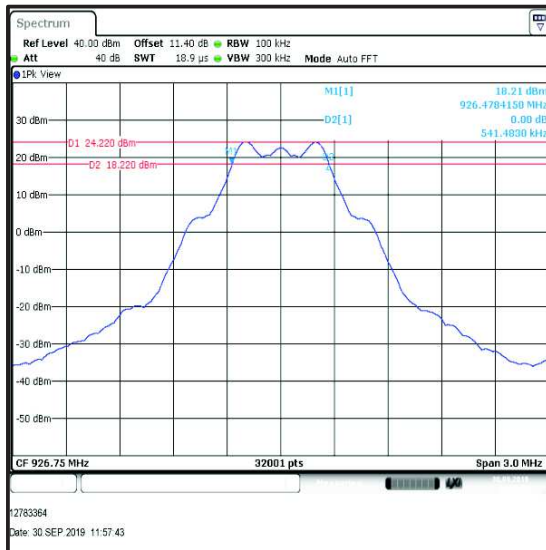
Notes:

1. 6 dB DTS bandwidth tests were performed using a spectrum analyser in accordance with FCC KDB 558074 Section 8.2 referring ANSI C63.10 Section 11.8 (11.8.1 Option 1 measurement procedure). The spectrum analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
2. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors. The RF cable attenuation (maximum 0.4 dB at the tested frequencies) from the EUT to Analyzer including the 10 dB attenuation at the Spectrum Analyzer input and 1.0 dB for the W. FL-SMA RF cable attenuation was added as a reference level offset (11.4 dB) to each of the conducted plots.

Test Setup:

Transmitter Minimum 6 dB Bandwidth (continued)**Results:**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	548.045	≥500	48.045	Complied
Middle	555.076	≥500	55.076	Complied
Top	541.483	≥500	41.483	Complied

**Bottom Channel****Middle Channel****Top Channel****Result: Pass**

5.2.3. Transmitter Duty Cycle**Test Summary:**

Test Engineer:	Ajit Phadtare	Test Date:	30 September 2019
Test Sample Serial Number:	bhrrmsc0001233sucq0		
Test Site Identification	SR 9		

FCC Reference:	Part 15.35(c)
Test Method Used:	FCC KDB 558074 Section 6.0

Environmental Conditions:

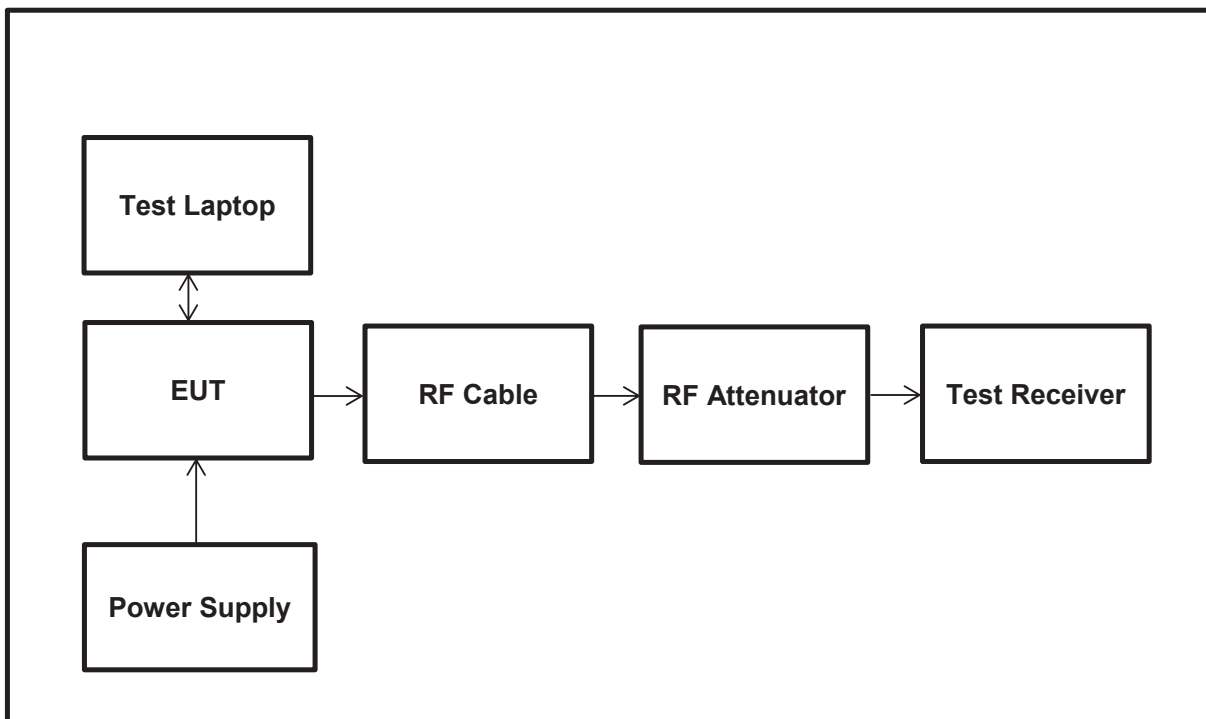
Temperature (°C):	24
Relative Humidity (%):	44

Note(s):

The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

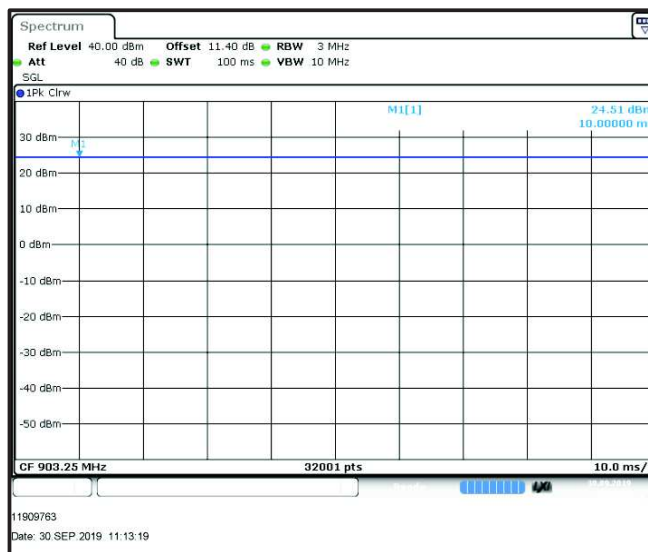
$10 \log (1 / (\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}]))$.

Duty cycle: $10 \log (1 / (10.00 \text{ ms} / 10.00 \text{ ms})) = 0.00 \text{ dB}$

Test Setup:

Transmitter Duty Cycle (continued)**Results:**

Pulse Duration (ms)	Period (μ s)	Duty Cycle (dB)
10.00	10.00	0.00



5.2.4. Transmitter Power Spectral Density**Test Summary:**

Test Engineer:	Ajit Phadtare	Test Date:	30 September 2019
Test Sample Serial Number:	bhrrmsc0001233sucq0		
Test Site Identification	SR 9		

FCC Reference:	Part 15.247(e)
Test Method Used:	FCC KDB 558074 Sections 8.4 referencing ANSI C63.10 Sections 11.10.3

Environmental Conditions:

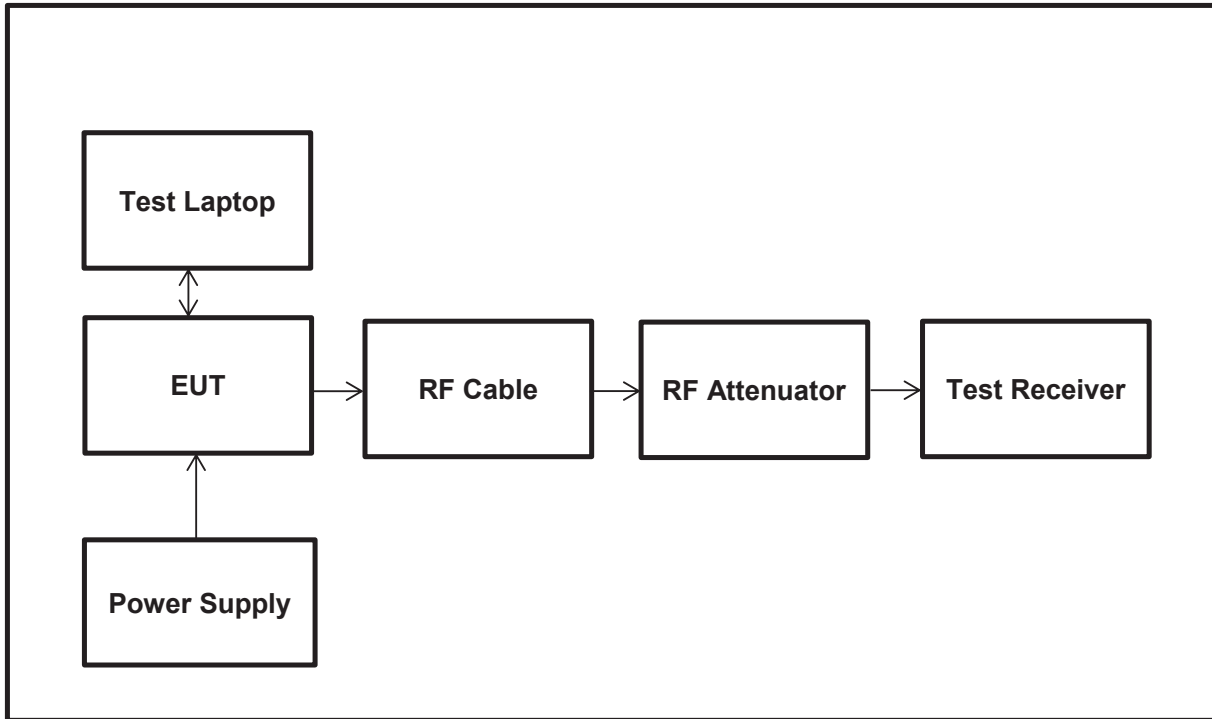
Temperature (°C):	24
Relative Humidity (%):	44

Settings of the Instrument

RBW/VBW	3 kHz/10 kHz
Span	3 MHz
Sweep time	Auto
Detector	RMS

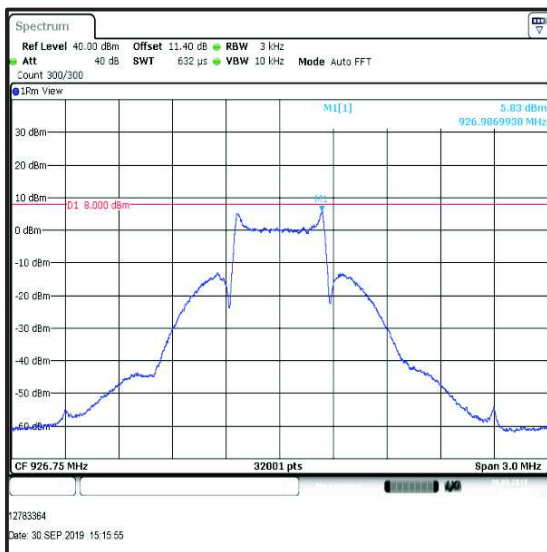
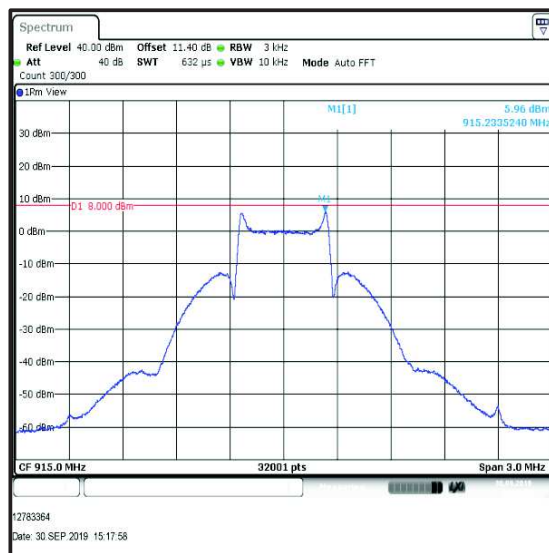
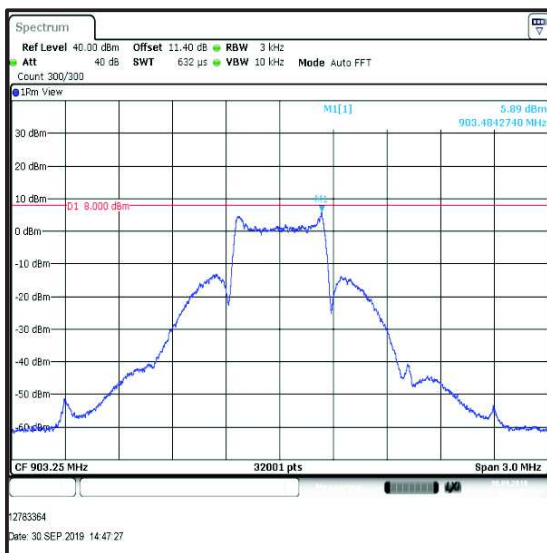
Note(s):

1. Final measurements were performed using the above configurations on the bottom, middle and top channels.
2. The EUT was transmitting at 100% duty cycle and testing was performed in accordance with ANSI C63.10 Section 11.10.3 Method AVGPDS-1. The signal analyser resolution bandwidth was set to 3 kHz and video bandwidth 10 kHz. An RMS detector was used and sweep time set manually to perform trace averaging over 300 traces. The span was set to 3 MHz. The highest peak of the measured signal was recorded.
3. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors. The RF cable attenuation (maximum 0.4 dB at the tested frequencies) from the EUT to Analyzer including the 10 dB attenuation at the Spectrum Analyzer input and 1.0 dB for the W. FL-SMA RF-cable attenuation was added as a reference level offset (11.4 dB) to each of the conducted plots.

Transmitter Power Spectral Density (continued)**Test Setup:**

Transmitter Power Spectral Density (continued)**Results: Standard Mode / Antenna 1**

Channel	Output Power (dBm/3 kHz)	Limit (dBm/3kHz)	Margin (dB)	Result
Bottom	5.89	8.0	2.11	Complied
Middle	5.96	8.0	2.04	Complied
Top	5.83	8.0	2.17	Complied

**Result: Pass**

5.2.5. Transmitter Maximum Average Output Power**Test Summary:**

Test Engineer:	Ajit Phadtare	Test Date:	30 September 2019
Test Sample Serial Number:	bhrrmsc0001233sucq0		
Test Site Identification	SR 9		

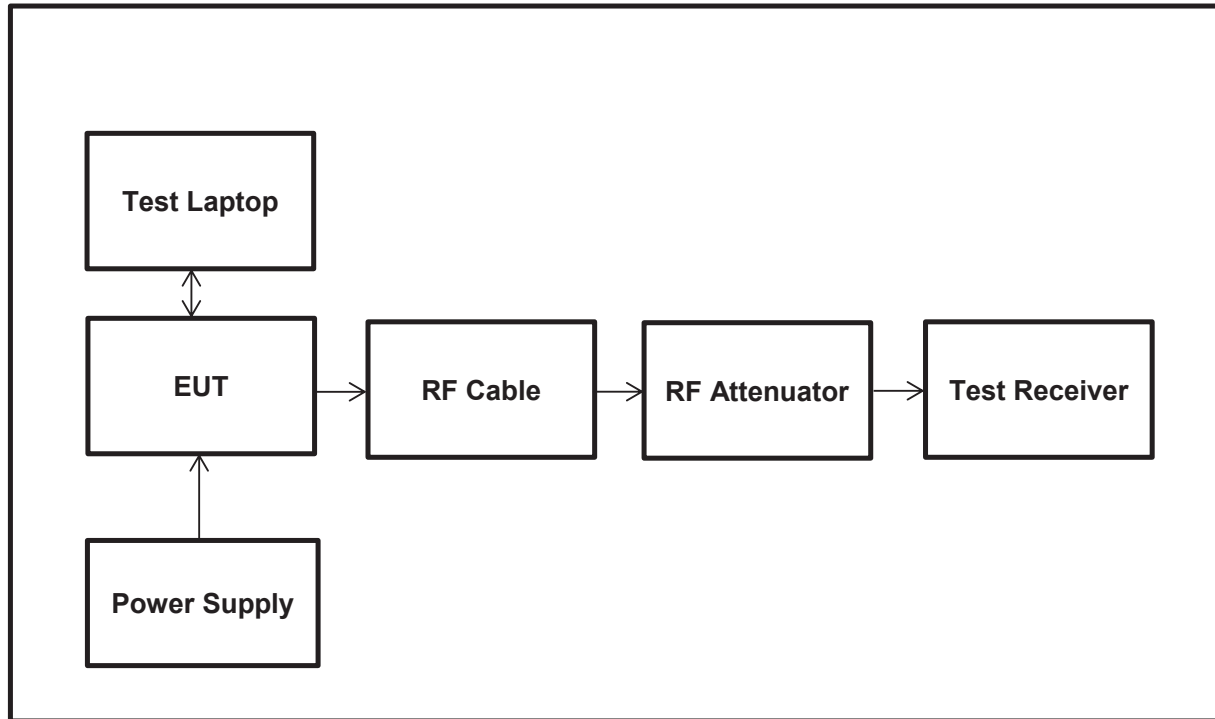
FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Section 8.3.2.2 referencing ANSI C63.10 Section 11.9.2.2.2

Environmental Conditions:

Temperature (°C):	22.9
Relative Humidity (%):	32

Notes:

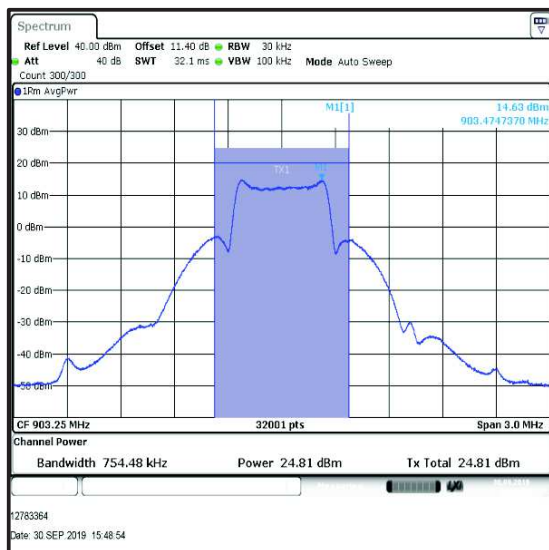
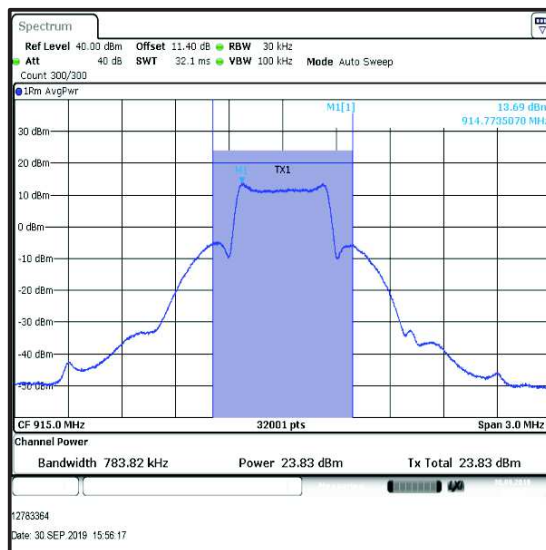
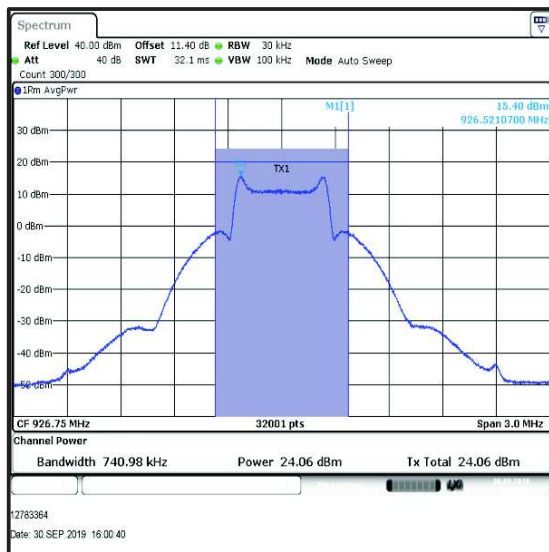
1. The EUT was transmitting at 100% duty cycle.
2. The testing was performed in accordance with KDB 558074 Section 8.3.2.2 referencing ANSI C63.10 Section 11.9.2.2.2.
3. The signal analyser's integration function was used to integrate average power across the 99% occupied bandwidth of test channel.
 - 99% occupied bandwidth of Bottom channel: 754.48 kHz
 - 99% occupied bandwidth of Middle channel: 783.82 kHz
 - 99% occupied bandwidth of Top channel: 740.98 kHz
4. The signal analyser resolution bandwidth was set to 30 kHz and video bandwidth 100 kHz. An RMS detector was used and sweep time set manually to perform trace averaging over 300 traces. The span was set to at least 1.5 times the 99% occupied bandwidth.
5. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors. The RF cable attenuation (maximum 0.4 dB at the tested frequencies) from the EUT to Analyzer including the 10 dB attenuation at the Spectrum Analyzer input and 1.0 dB for the W. FL-SMA RF-cable attenuation was added as a reference level offset (11.4 dB) to each of the conducted plots.
6. The declared antenna gain was added to conducted power to obtain the EIRP.

Transmitter Maximum Average Output Power (continued)**Test setup:**

Transmitter Maximum Average Output Power (continued)**Results: Standard Mode / Antenna 1**

Channel	Conducted Average Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	24.81	30.0	5.19	Complied
Middle	23.83	30.0	6.17	Complied
Top	24.06	30.0	5.94	Complied

Channel	Conducted Average Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	24.81	0.0	24.81	36.0	11.19	Complied
Middle	23.83	0.0	23.83	36.0	12.17	Complied
Top	24.06	0.0	24.06	36.0	11.94	Complied

Transmitter Maximum Average Output Power (continued)**Plots: Standard Mode / Antenna 1****Bottom Channel****Middle Channel****Top Channel****Result: Pass**

5.2.6. Transmitter Radiated Emissions**Test Summary:**

Test Engineer:	Krume Ivanov	Test Date:	01 October 2019
Test Sample Serial Number:	bhrqmesc0001233subm0		
Test Site Identification	SR 1/2		

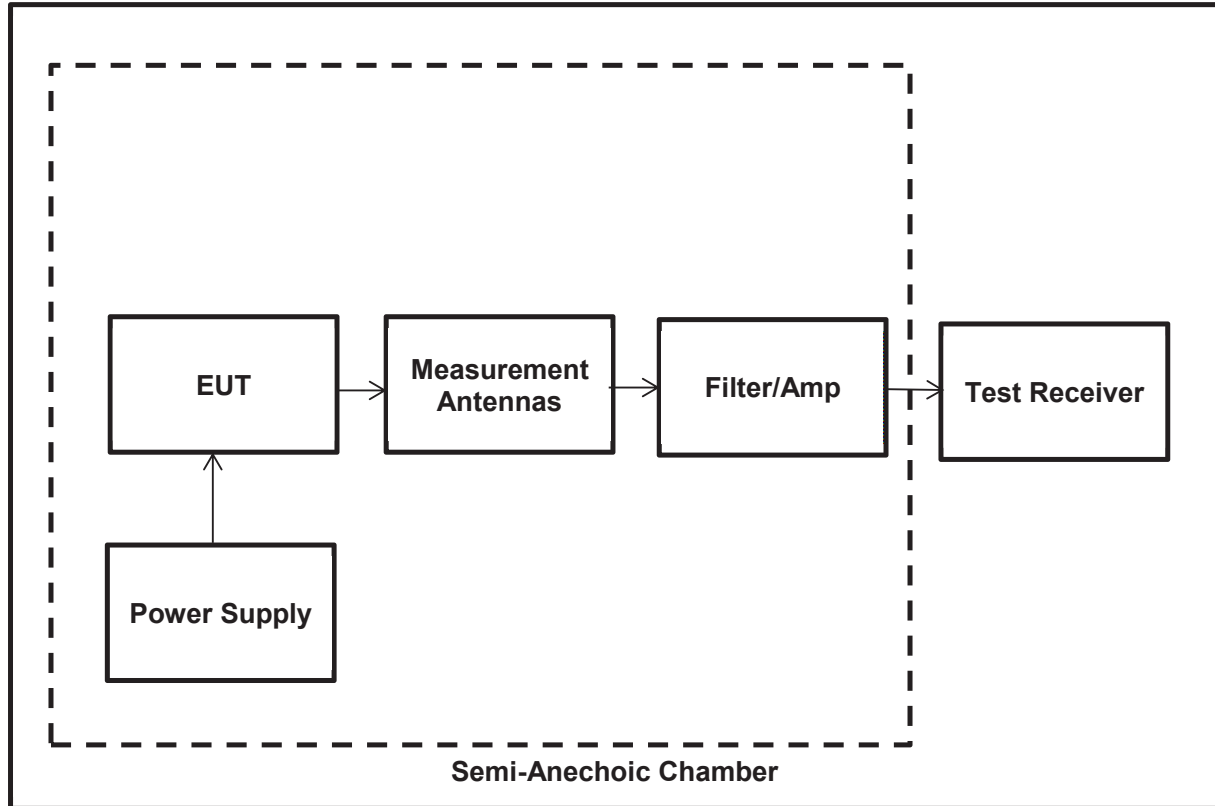
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referring ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.4
Frequency Range	9 kHz to 30 MHz

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	28

Note(s):

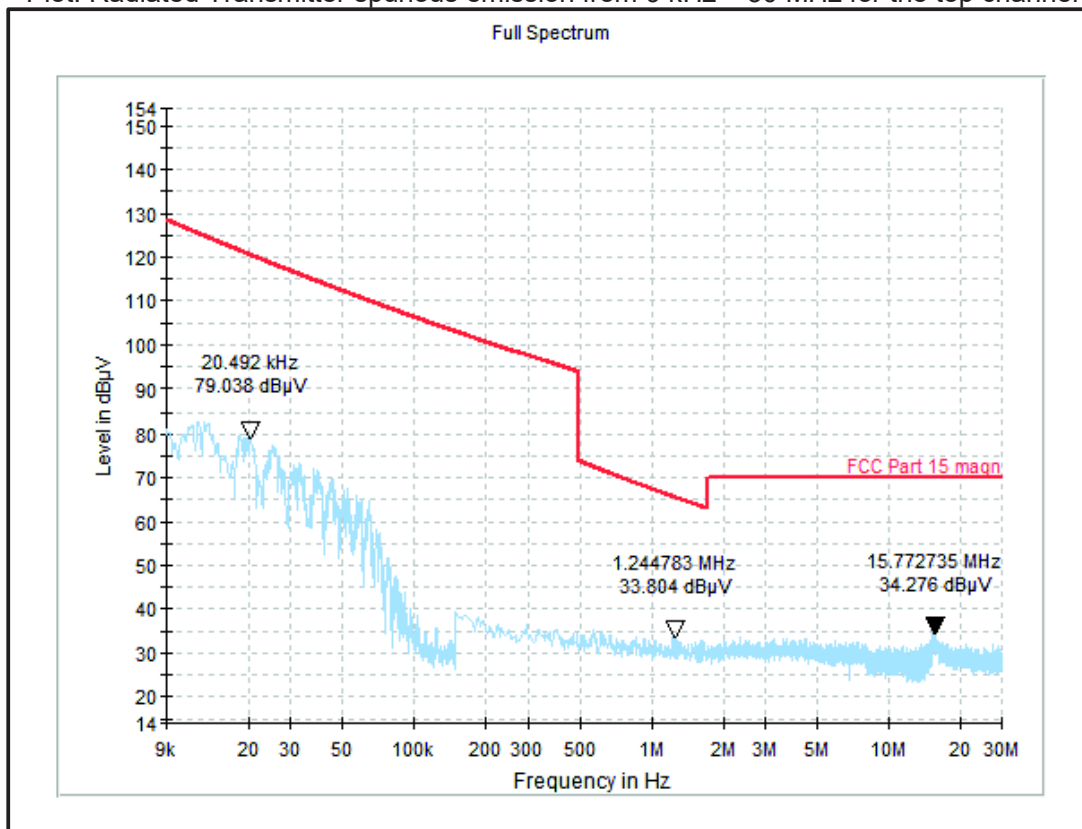
1. In accordance with FCC KDB 414788, an alternative test site may be used for the measurement below 30 MHz (The OATS / SAC comparison data is available upon request). Therefore the result from the semi-anechoic chamber tests is shown in this section of the test report.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. The preliminary scans showed similar emission levels below 30 MHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT for the antenna 1 set on the top Channel only and for the antenna 2 set on the bottom channel only.
4. Measurements below 30 MHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 meters. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable.
5. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
6. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 9 kHz, using a CISPR quasi-peak detector and span big enough to see the whole emission.

Transmitter Radiated Emissions (continued)**Test Setup:**

Transmitter Radiated Emissions (continued)**Results: Standard Mode / Top Channel / Antenna 1**

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
No critical spurious emissions were detected					

Plot: Radiated Transmitter spurious emission from 9 kHz – 30 MHz for the top channel

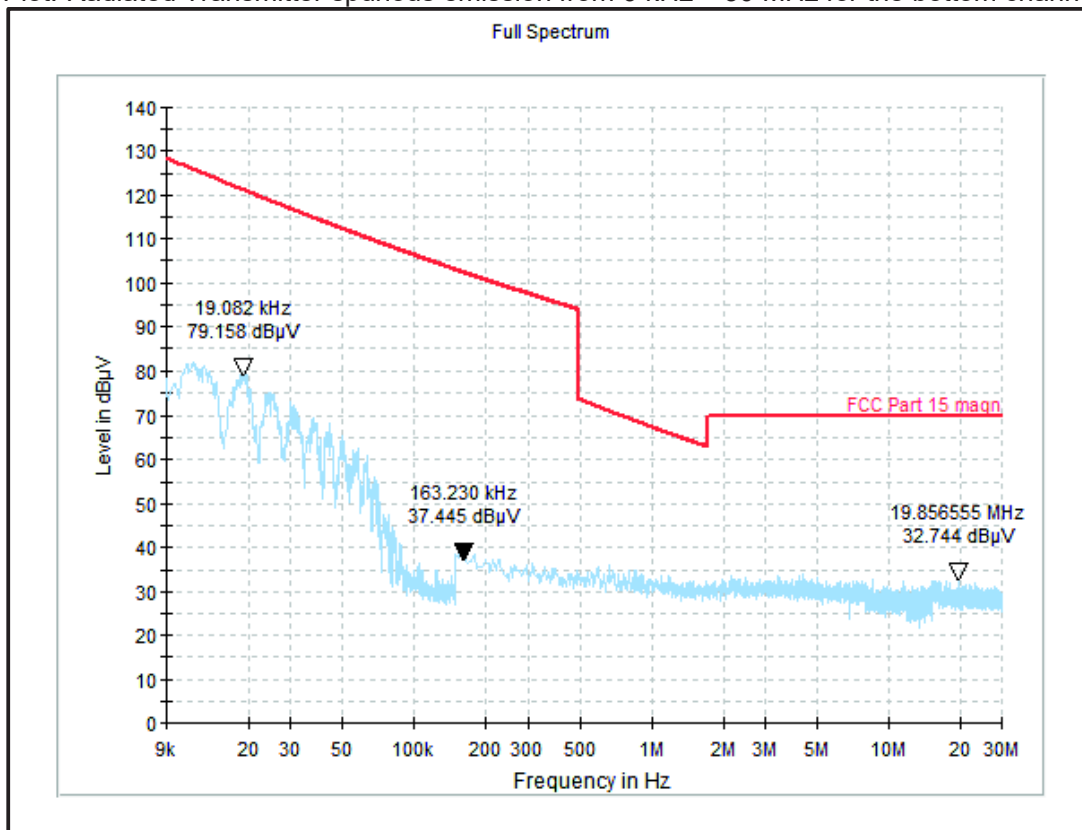


Result: **Pass**

Transmitter Radiated Emissions (continued)**Results: Standard Mode / Bottom Channel / Antenna 2**

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
No critical spurious emissions were detected					

Plot: Radiated Transmitter spurious emission from 9 kHz – 30 MHz for the bottom channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Test Summary:**

Test Engineer:	Krume Ivanov	Test Date:	30 September & 01 October 2019
Test Sample Serial Number:	bhrqmesc0001233subm0		
Test Site Identification	SR 1/2		

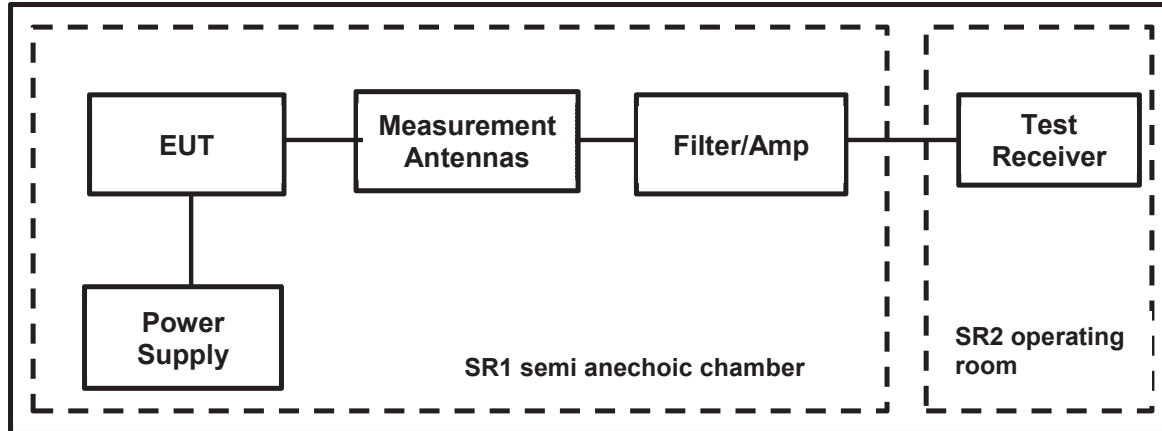
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referring ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	23 & 21
Relative Humidity (%):	40 & 28

Note(s):

7. The emissions shown at frequencies between approximately 903 to 927 MHz on the 30 MHz to 1 GHz plots are the EUT fundamental for the given channel.
8. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
9. Measurements below 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 meters. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 meter to 4 meters.
10. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
11. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span big enough to see the whole emission.

Transmitter Radiated Emissions (continued)**Test Setup:**

Transmitter Radiated Emissions (continued)**Results: Standard Mode / Bottom Channel / Antenna 1**

Frequency (MHz)	Antenna Polarization	Quasi-Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
48.090	Vertical	20.72	40.00	19.28	Complied
80.130	Vertical	22.61	40.00	17.39	Complied

Results: Standard Mode / Middle Channel / Antenna 1

Frequency (MHz)	Antenna Polarization	Quasi-Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
80.175	Vertical	23.74	40.00	16.26	Complied

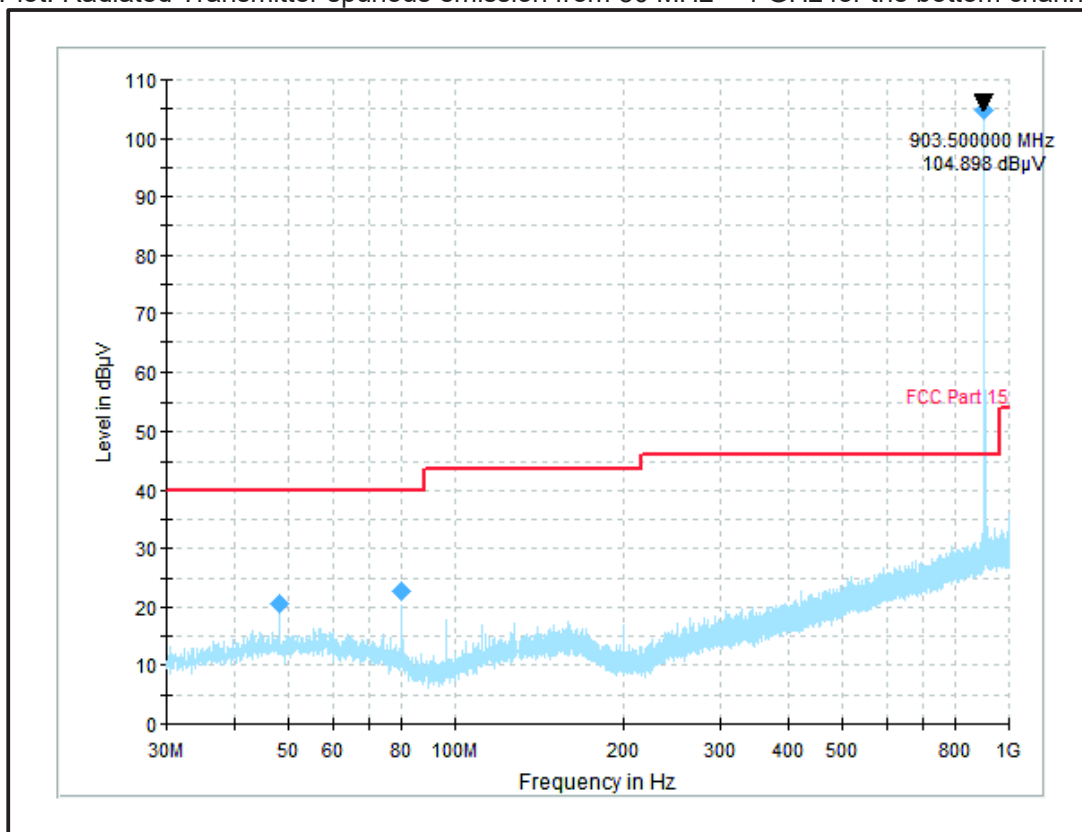
Results: Standard Mode / Top Channel / Antenna 1

Frequency (MHz)	Antenna Polarization	Quasi-Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
80.175	Vertical	24.50	40.00	15.50	Complied
96.195	Vertical	19.81	43.50	23.69	Complied
200.010	Vertical	18.52	43.50	24.98	Complied

Result: Pass

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 1**

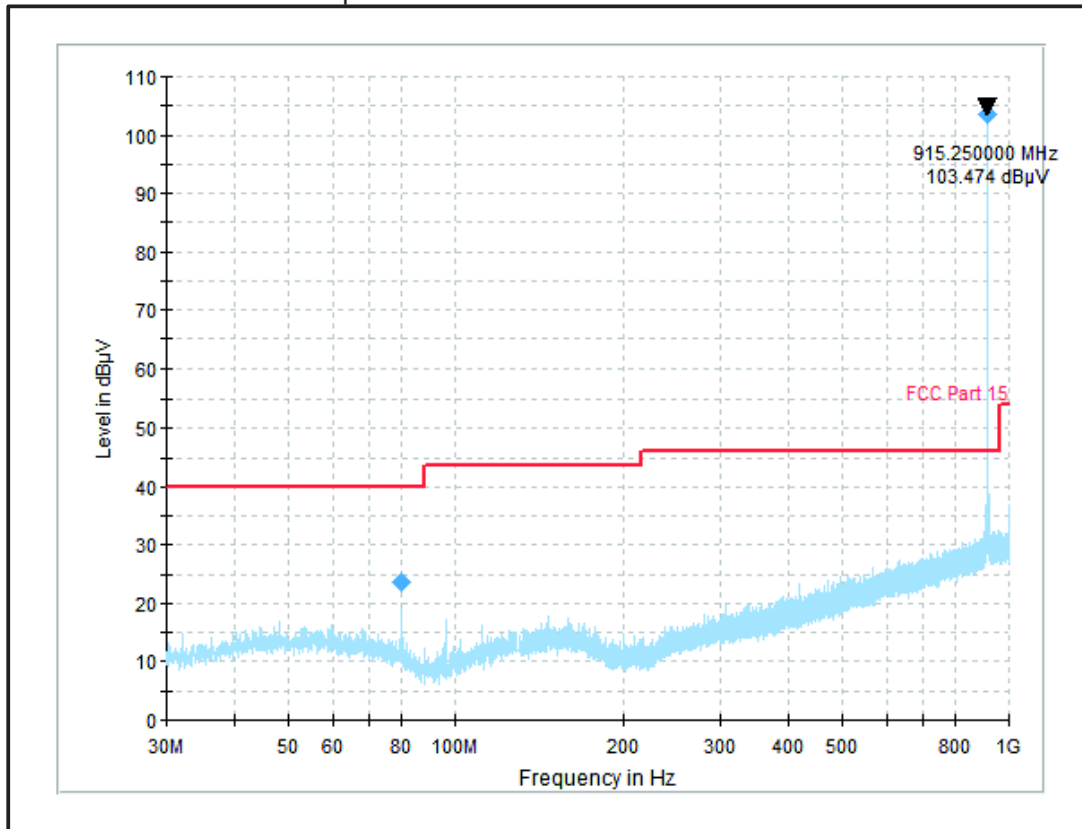
Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the bottom channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 1**

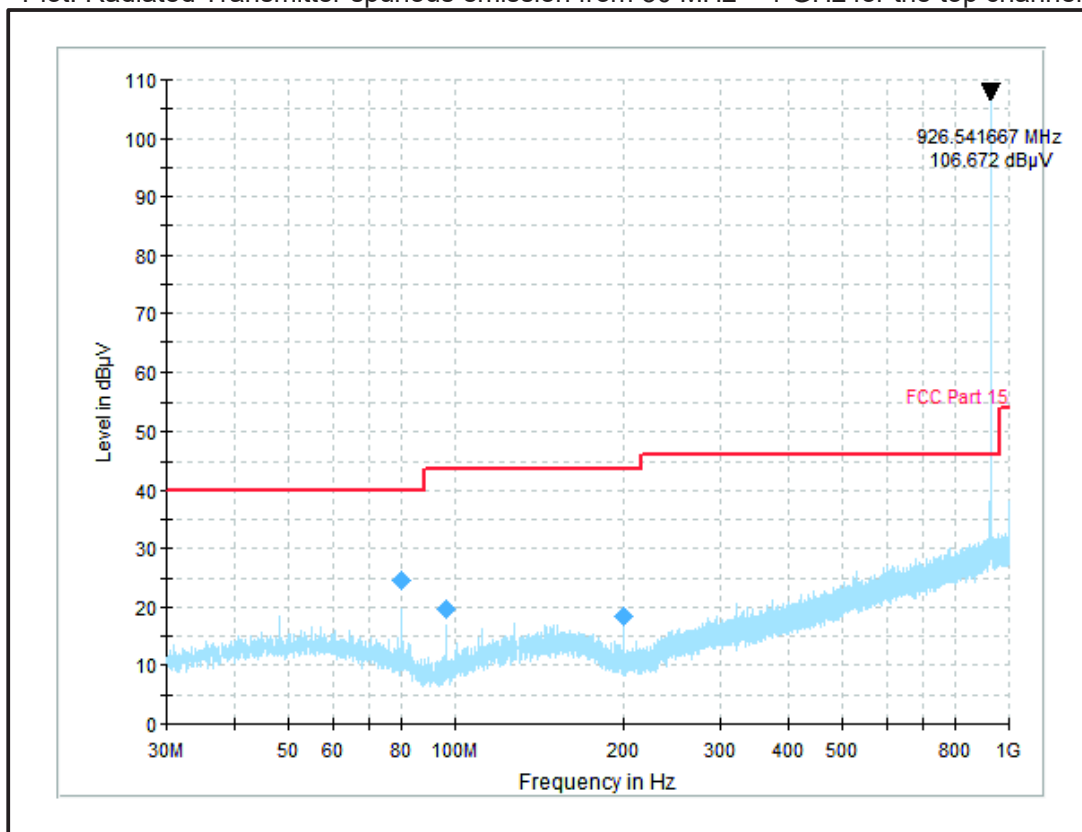
Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the middle channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 1**

Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the top channel



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

Result: **Pass**

Transmitter Radiated Emissions (continued)**Results: Standard Mode / Bottom Channel / Antenna 2**

Frequency (MHz)	Antenna Polarization	Quasi-Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
48.090	Vertical	20.65	40.00	19.35	Complied
80.175	Vertical	23.93	40.00	16.07	Complied

Results: Standard Mode / Middle Channel / Antenna 2

Frequency (MHz)	Antenna Polarization	Quasi-Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
48.090	Vertical	20.62	40.00	19.38	Complied
80.175	Vertical	23.88	40.00	16.12	Complied
128.280	Vertical	19.47	43.50	24.03	Complied

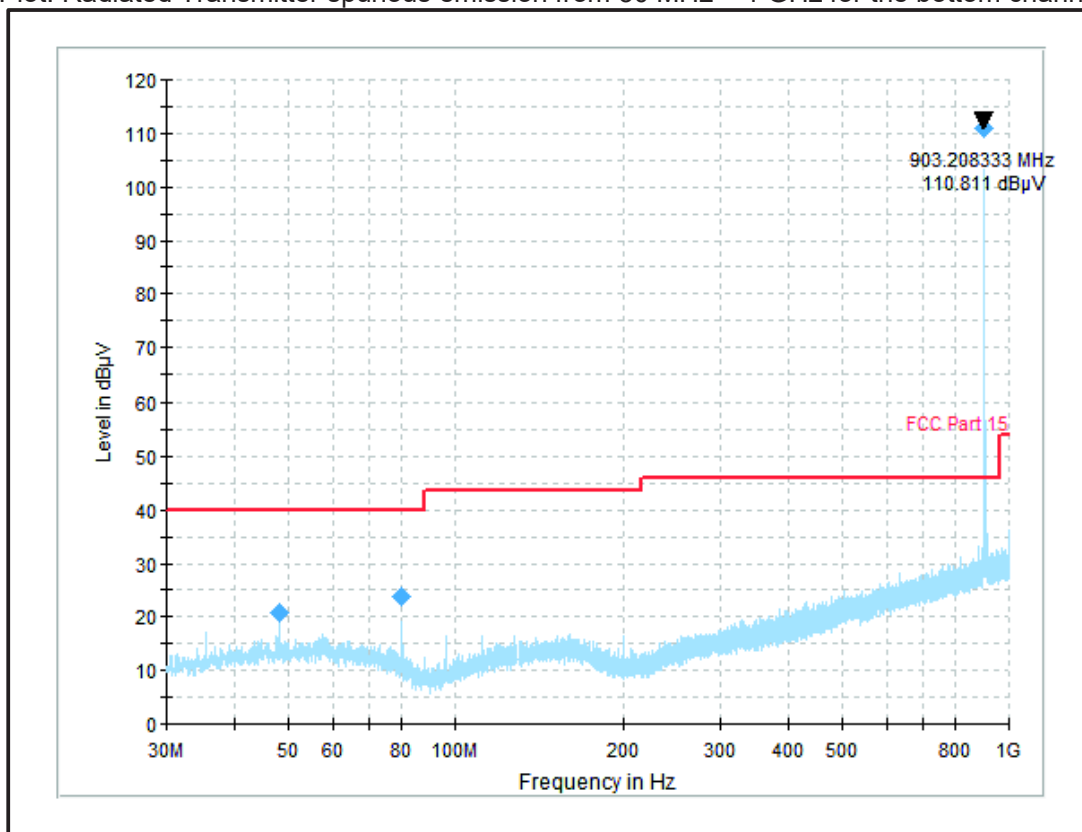
Results: Standard Mode / Top Channel / Antenna 2

Frequency (MHz)	Antenna Polarization	Quasi-Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
80.175	Vertical	23.69	40.00	16.31	Complied

Result: Pass

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 2**

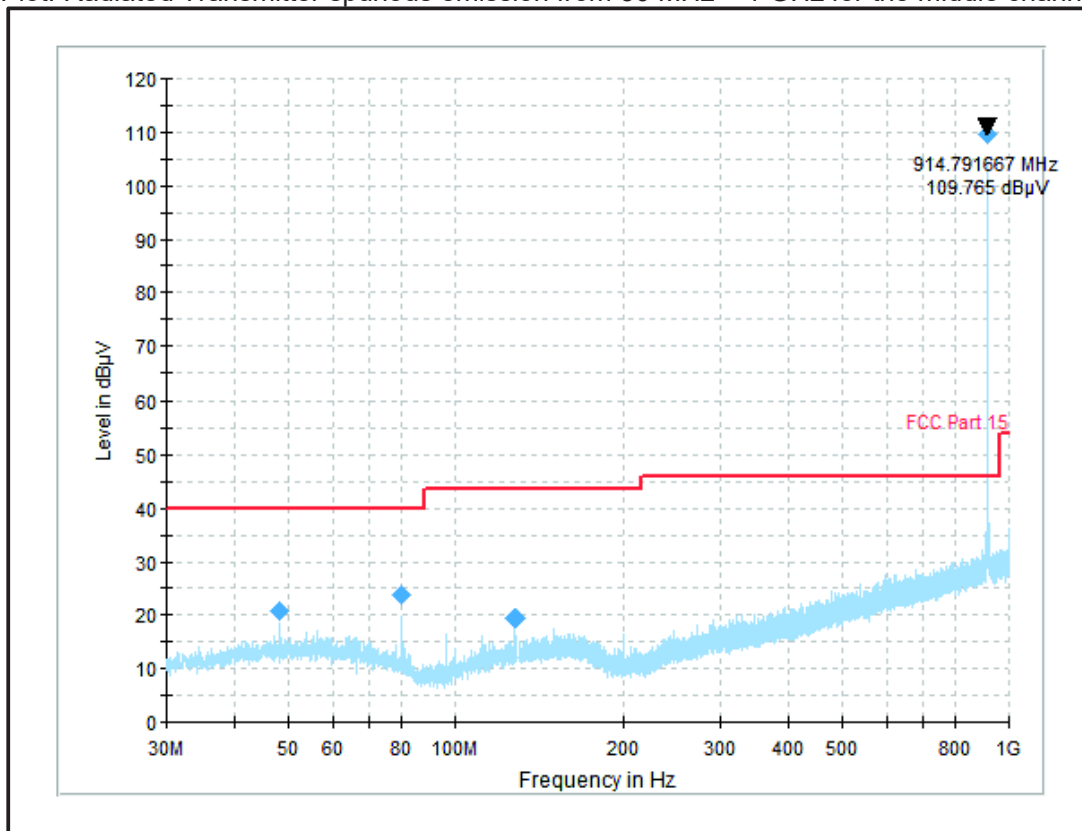
Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the bottom channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 2**

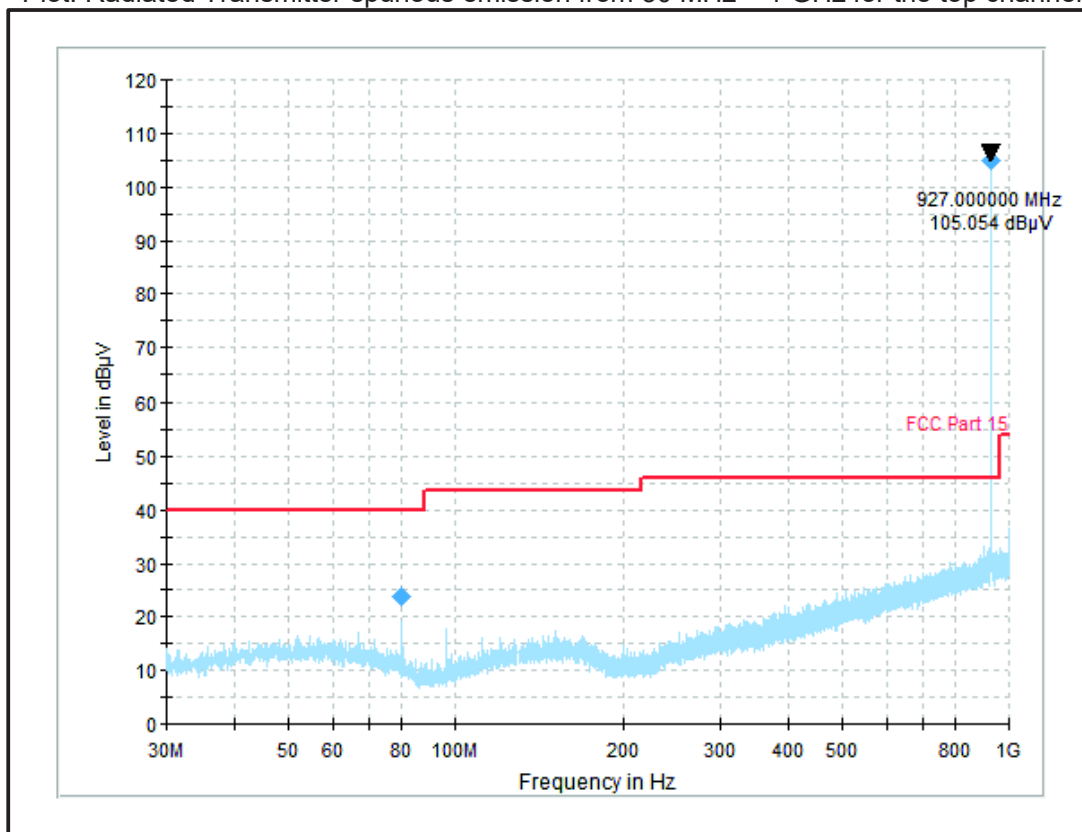
Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the middle channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 2**

Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the top channel



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

Result: **Pass**

Transmitter Radiated Emissions (continued)**Test Summary:**

Test Engineer:	Krume Ivanov	Test Date:	02 October 2019
Test Sample Serial Number:	bhrqmesc0001233subm0		
Test Site Identification	SR 1/2		

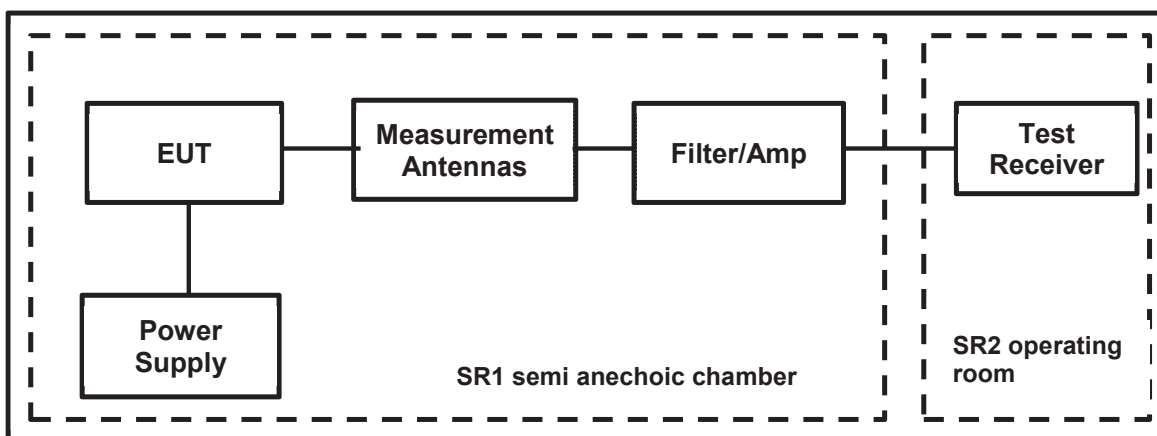
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referring ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.6
Frequency Range	1 GHz to 10 GHz

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	28

Note(s):

12. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
13. Pre-scans above 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with absorbers on the ground at a distance of 3 meters. The EUT was placed at a height of 1.5 meters above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 meters above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with absorbers on the ground at a distance of 3 meters. The EUT was placed at a height of 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 meter to 4 meters.
14. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto.
15. *In accordance with ANSI C63.10 Section 6.6.4.3 (Note 1), if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
16. The EUT was transmitting continuously with 100 % duty cycle, therefore no duty cycle correction was required.

Transmitter Radiated Emissions (continued)**Test Setup:**

Transmitter Radiated Emissions (continued)**Results: Standard Mode / Bottom Channel / Antenna 1**

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2077.375	Horizontal	41.54	54.00	12.46	Complied

Results: Standard Mode / Middle Channel / Antenna 1

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
1830.375	Horizontal	43.45	54.00	10.55	Complied

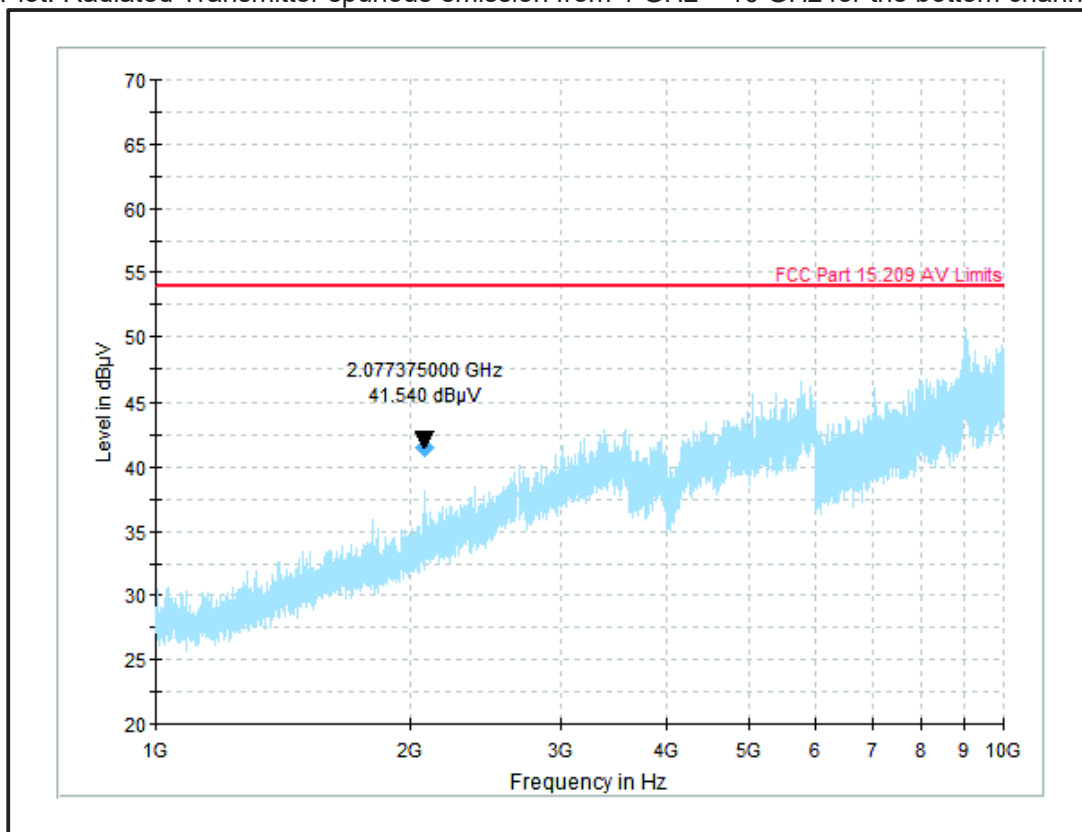
Results: Standard Mode / Top Channel / Antenna 1

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
1853.775	Vertical	45.51	54.00	8.49	Complied

Result: Pass

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 1**

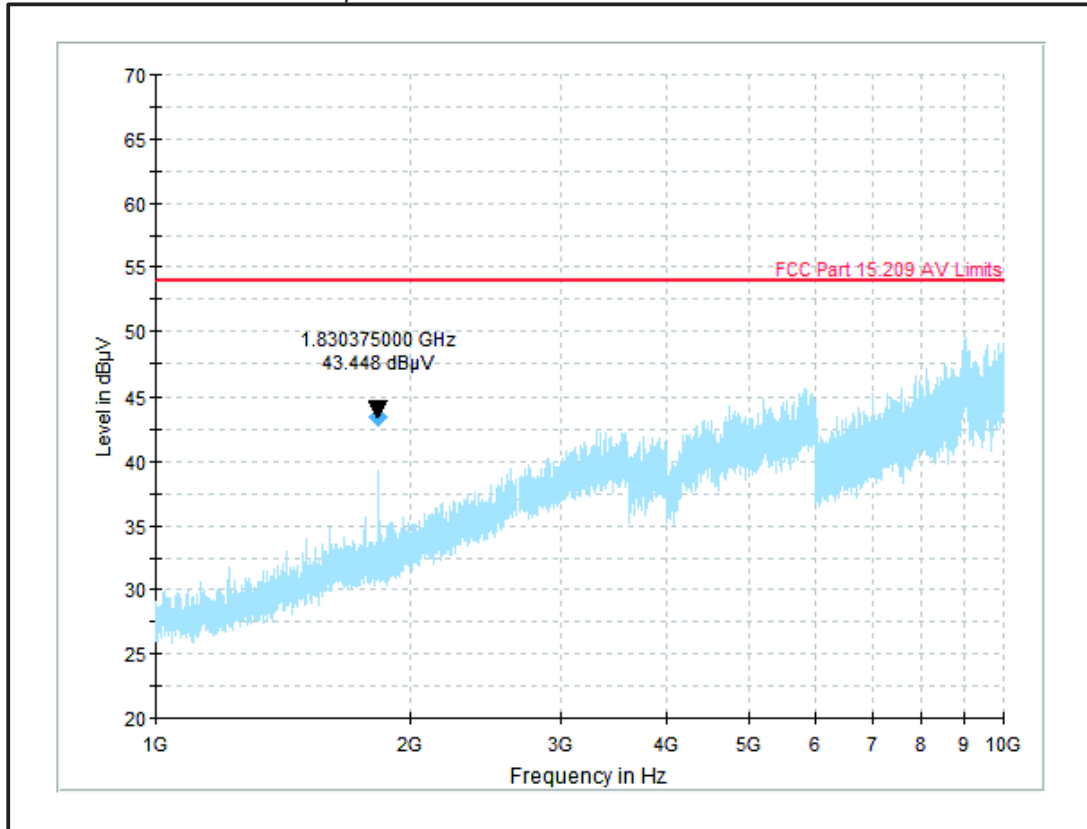
Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the bottom channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 1**

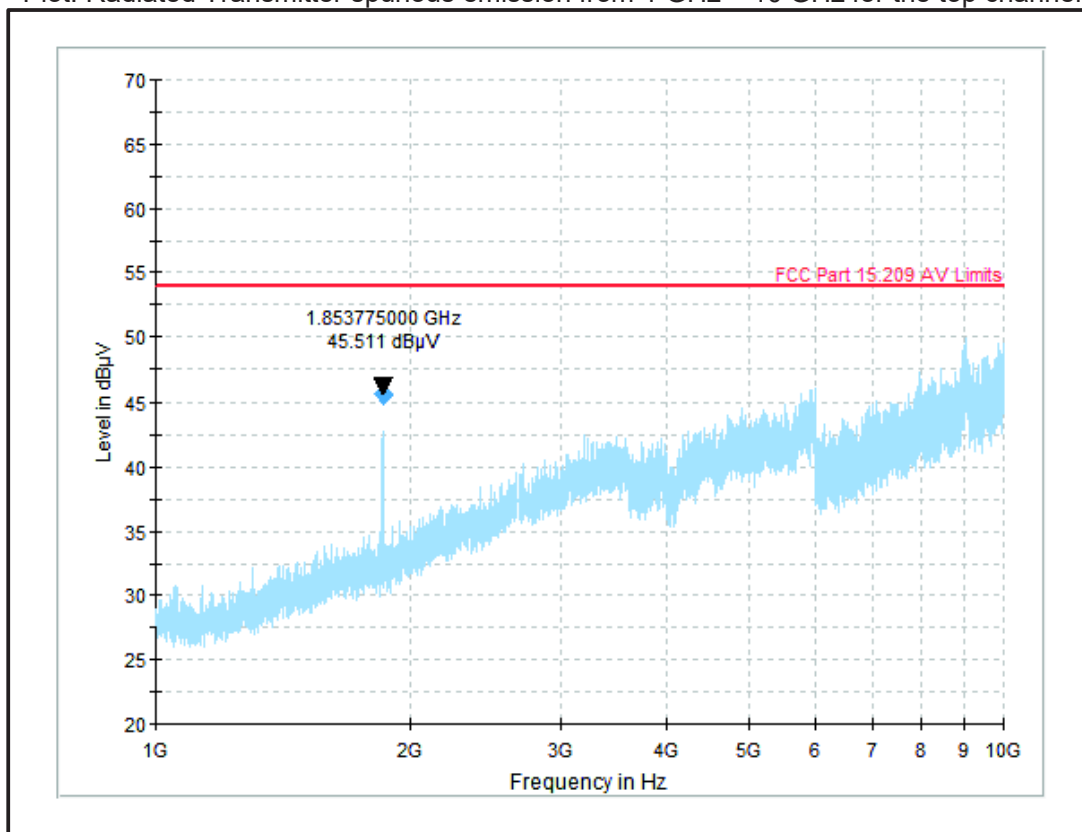
Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the middle channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 1**

Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the top channel



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

Result: Pass

Transmitter Radiated Emissions (continued)**Results: Standard Mode / Bottom Channel / Antenna 2**

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
1806.650	Vertical	42.30	54.00	11.70	Complied

Results: Standard Mode / Middle Channel / Antenna 2

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
No spurious emissions were detected					

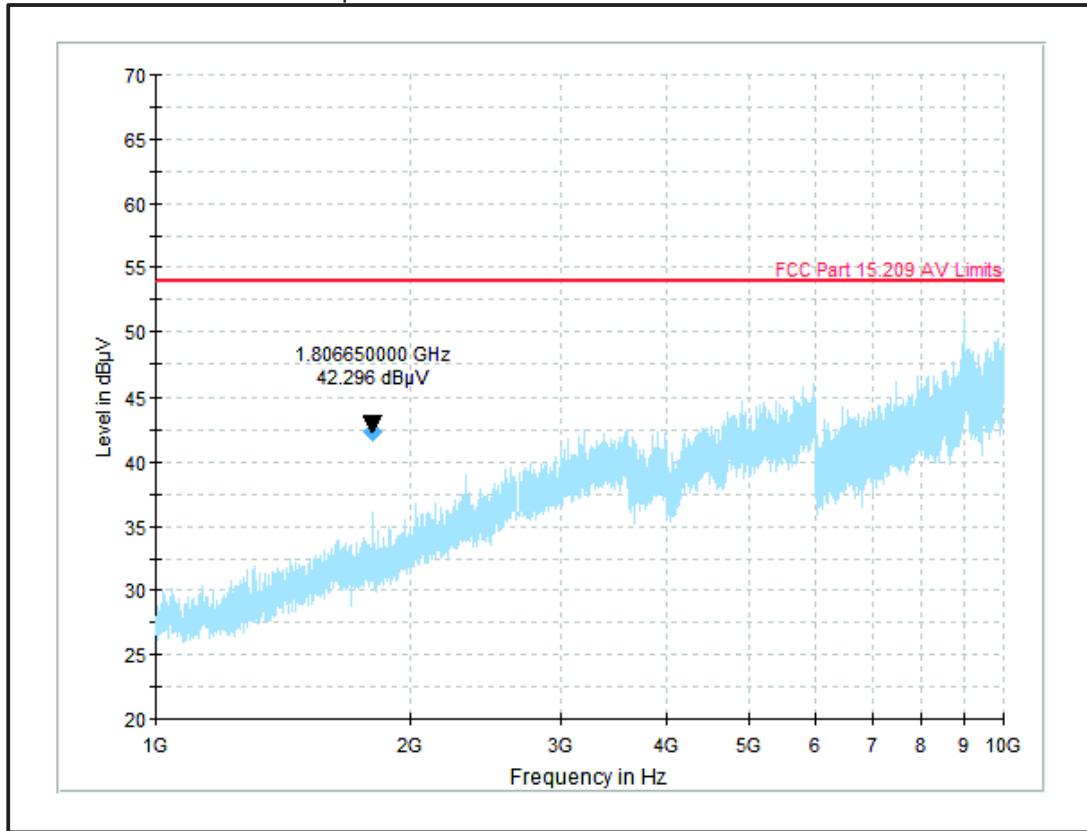
Results: Standard Mode / Top Channel / Antenna 2

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
1854.100	Horizontal	42.64	54.00	11.36	Complied

Result: Pass

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 2**

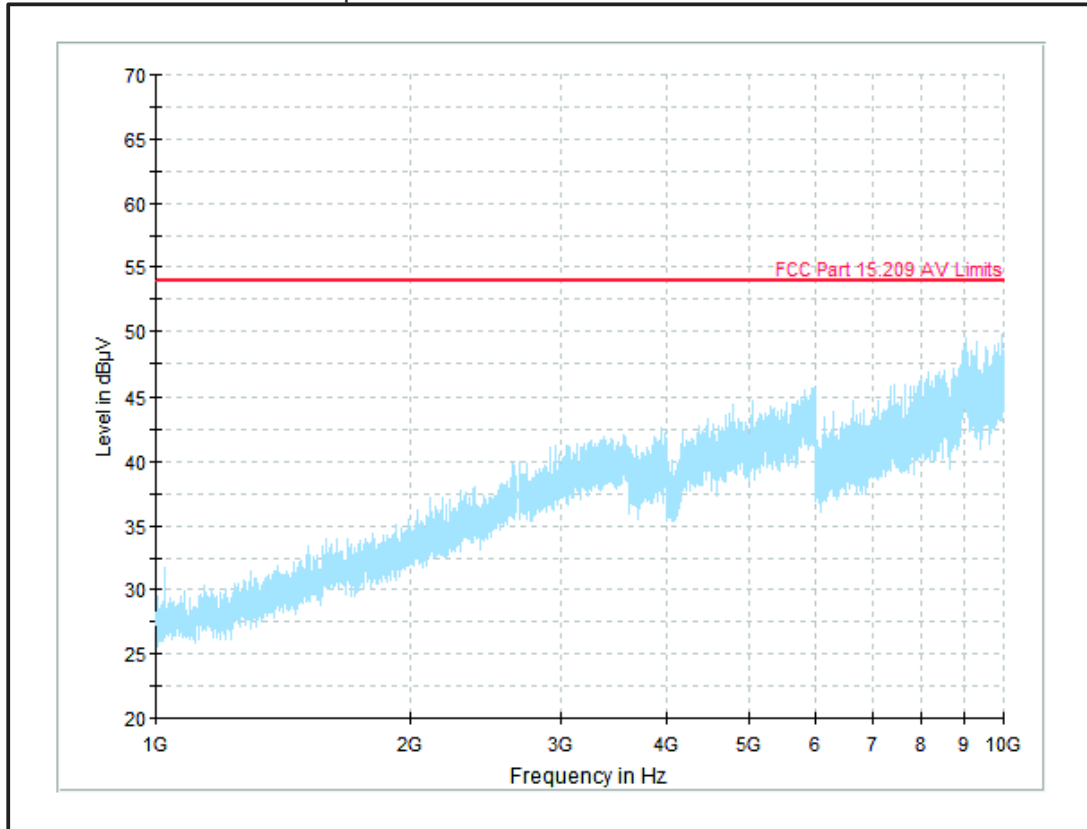
Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the bottom channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 2**

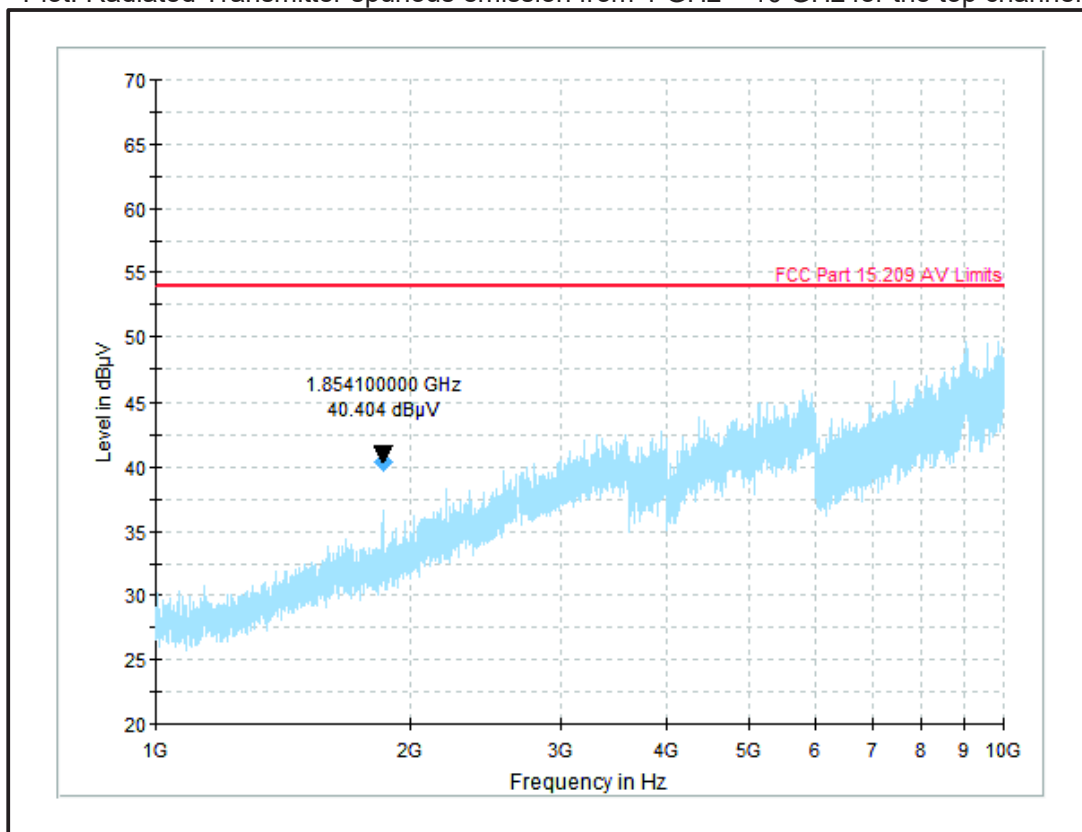
Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the middle channel



Result: **Pass**

Transmitter Radiated Emissions (continued)**Standard Mode / Antenna 2**

Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the top channel



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

Result: Pass

5.2.7. Transmitter Band Edge Radiated Emissions**Test Summary:**

Test Engineer:	Krume Ivanov	Test Date:	30 September 2019
Test Sample Serial Number:	bhrqmesc0001233subm0		
Test Site Identification	SR 1/2		

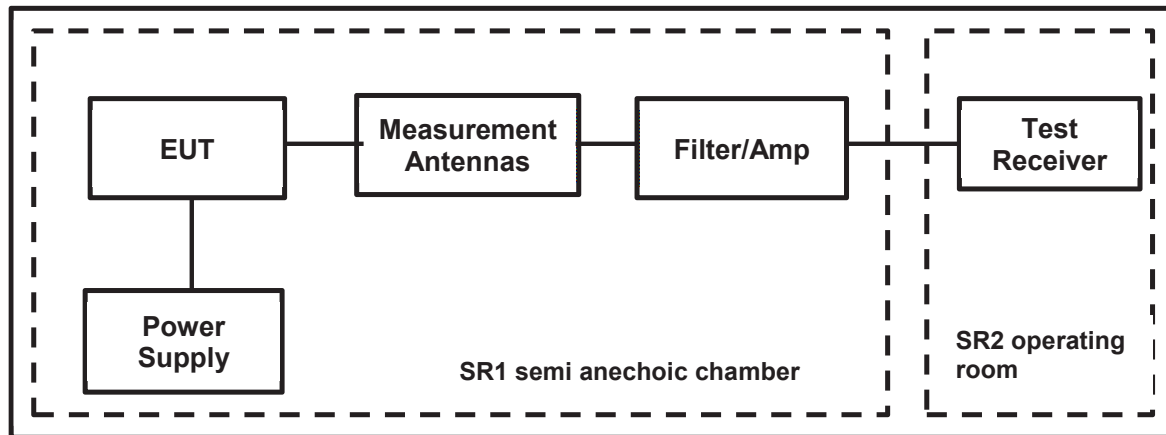
FCC Reference:	Part 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.7 referring ANSI C63.10:2013 Section 6.10.4, 6.10.5 & Section 11.11, 11.2 ,11.13

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	46

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The maximum conducted (average) output power was previously measured. In accordance with ANSI C63.10 Section 11.11.1(b), the lower band edge measurement should be performed with a peak detector and the -30 dBc limit applied.
3. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. Marker frequencies and levels were recorded.
4. The plots shown on the following page were performed using a peak detector.
5. The EUT was transmitting continuously with 100 % duty cycle, therefore no duty cycle correction was required.
6. In accordance with ANSI C63.10 Section 6.10.4 the measurements were carried out in fixed frequency mode.

Transmitter Band Edge Radiated Emissions (Continued)**Test Setup:**

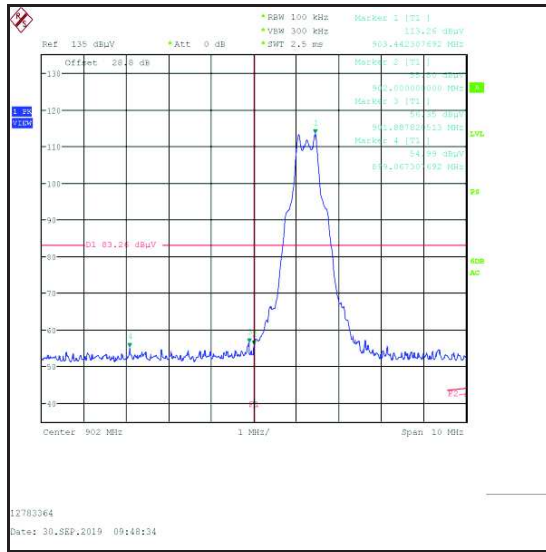
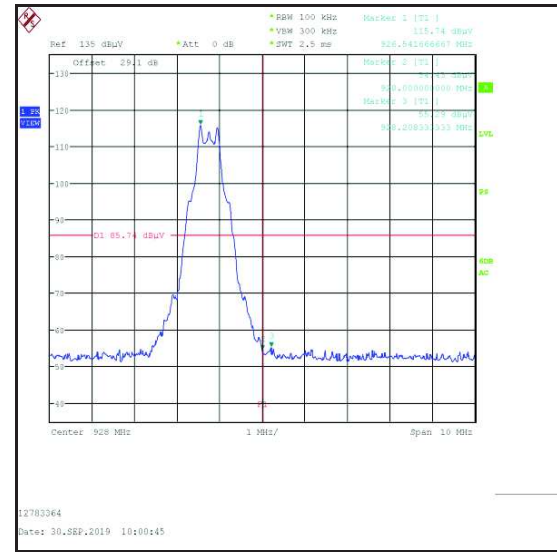
Transmitter Band Edge Radiated Emissions (continued)**Standard Mode / Antenna 1****Results: Lower Band Edge / Bottom Channel**

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
902.000	Horizontal	55.80	83.26	27.46	Complied
901.887	Horizontal	56.35	83.26	26.91	Complied
899.067	Horizontal	54.99	83.26	28.27	Complied

Results: Upper Band Edge / Top Channel

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
928.000	Horizontal	54.43	85.74	31.31	Complied
928.208	Horizontal	55.29	85.74	30.45	Complied

Result: Pass

Transmitter Band Edge Radiated Emissions (continued)**Standard Mode / Antenna 1****Lower Band Edge / Bottom Channel****Upper Band Edge / Top Channel**

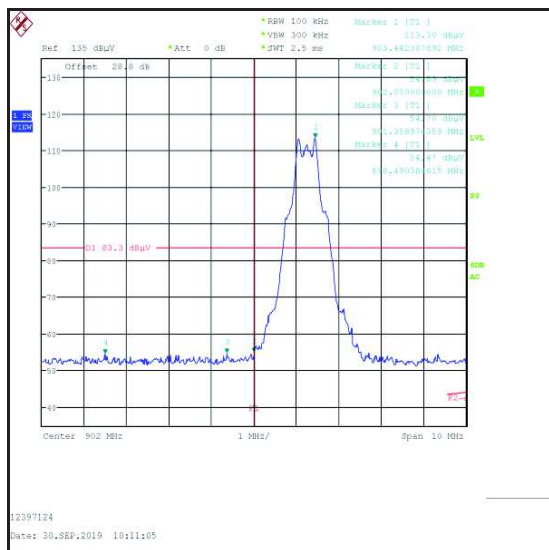
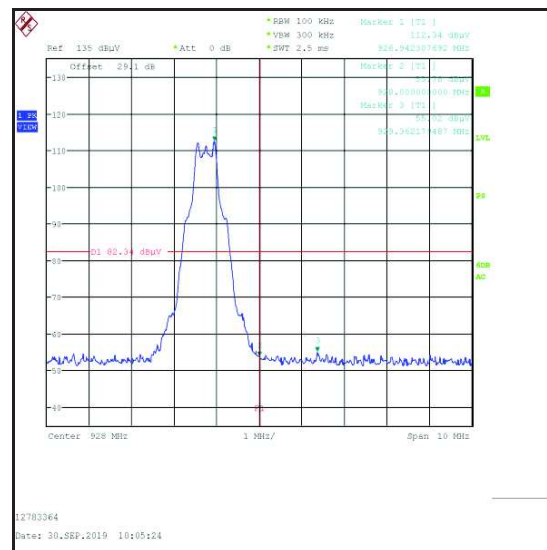
Transmitter Band Edge Radiated Emissions (continued)**Standard Mode / Antenna 2****Results: Lower Band Edge / Bottom Channel**

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
902.000	Vertical	54.89	83.30	28.41	Complied
901.358	Vertical	54.70	83.30	28.60	Complied
898.490	Vertical	54.47	83.30	28.83	Complied

Results: Upper Band Edge / Top Channel

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
928.000	Vertical	53.78	82.34	28.56	Complied
929.362	Vertical	55.02	82.34	27.32	Complied

Result: Pass

Transmitter Band Edge Radiated Emissions (continued)**Standard Mode / Antenna 2****Lower Band Edge / Bottom Channel****Upper Band Edge / Top Channel**

6. Measurement Uncertainty

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

Measurement Type	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	95%	± 2.49 dB
Minimum 6 dB Bandwidth	95%	± 0.87 %
Transmitter Duty Cycle	95%	± 3.4 %
Power Spectral Density	95%	± 0.59 dB
Conducted Maximum Average Output Power	95%	± 0.59 dB
Radiated Spurious Emissions	95%	± 3.10 dB
Band Edge Radiated Emissions	95%	± 3.10 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Used equipment

Test site: SR 1/2

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
1	Rohde & Schwarz	Antenna, Loop	HFH2-Z2	831247/012	7/11/2019	36
377	BONN Elektronik	Amplifier, Low Noise Pre	BLMA 0118-1A	025294B	7/10/2019	12
423	Bonn Elektronik	Amplifier, Low Noise Pre	BLMA 1840-1A	55929	7/16/2019	12
460	Deisl	Turntable	DT 4250 S	n/a	n/a	n/a
465	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	3/20/2019	24
496	Rohde & Schwarz	Antenna, log. - periodical	HL050	100297	2/19/2019	36
587	Maturo	antenna mast, tilting	TAM 4.0-E	011/7180311	n/a	n/a
588	Maturo	Controller	NCD	029/7180311	n/a	n/a
591	Rohde & Schwarz	Receiver	ESU 40	100244/040	7/9/2019	12
608	Rohde & Schwarz	Switch Matrix	OSP 120	101227	lab verification	n/a
628	Maturo	Antenna mast	CAM 4.0-P	224/19590716	n/a	n/a
629	Maturo	Kippenrichtung	KE 2.5-R-M	MAT002	n/a	n/a
-/-	Testo	Thermo-Hygrometer	608-H1	01	lab verification	n/a

Test site: SR 7/8

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
22	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/014	9/7/2019	12
23	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/013	9/7/2019	12
28	Rohde & Schwarz	Passive Probe	ESH2-Z3	none	11/7/2019	12
215	Rohde & Schwarz	Artificial Mains Network	ESH2-Z5	879675/002	5/7/2019	12
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	10/7/2019	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	8/7/2019	12
564	Teseq	Impedance stabilisation network (ISN)	ISN T800	26076	8/7/2019	24
616	Rohde & Schwarz	ISN	ENY81-CA6	101656	9/7/2019	12
-/-	Testo	Thermo-Hygrometer	608-H1	08	lab verification	n/a

Test site: SR 9

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
423	Bonn Elektronik	Amplifier, Low Noise Pre	BLMA 1840-1A	55929	7/16/2019	12
445	Huber & Suhner	RF Attenuator (10dB)	6810.17.AC	--	Cal Before Use	12
621	Ahlborn-Almemo	Temperatur-/Feuchtemessgerät	MA2470-S2	H16080099	3/15/2019	12
634	Rohde & Schwarz	Wireless Devices Test System	TS8997	--	lab verification	12
636	Rohde & Schwarz	switching unit	OSP120	101698	7/19/2019	12
637	Rohde & Schwarz	Spectrum Analyzer	FSV40	101587	7/11/2019	12
-/-	Testo	Thermo-Hygrometer	608-H1	07	lab verification	n/a

8. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version

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