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FCC/ISED Test Report

Client: **Ainstein AI Inc.**

EUT: **2029 Becker Drive**
Bioscience & Technology Business Center,
Lawrence, KS 66047 USA

Product: **WAYV Air**

Test Report No.: **R20200129-20-01C**

Approved By:

Nic S. Johnson, NCE
Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

Date: **5 October 2020**

Total Pages: **34**

A2LA ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
Original	14 August 2020	Approved by – NJohnson Prepared by KVepuri
A	21 September 2020	Updated Table 1 Repeated fundamental measurements at 0.1m
B	1 October 2020	Added conducted emissions data Antenna gain changed to 21 dBm Added note about detection bandwidth to Section 3.1.1.
C	5 October 2020	Added LISN to equipment list

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Table of Contents

1 Summary of Test Results

1.1 Emissions Test Results

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15

Testing was performance in accordance with the methods published in ANSI C63.10-2013

Table 1 - Emissions Test Results

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 15.255 (c)(3)	Equivalent Isotropically Radiated Power	Pass
FCC Part 15.255(e)(1)	Occupied Bandwidth	Pass
FCC Part 15.209	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands, below 40 GHz), FCC Part 15.255(d) (unrestricted)	Transmitter Radiated Emissions	Pass
FCC Part 15.255 (f)	Frequency Stability	Pass
FCC Part 15.209 (restricted bands), FCC Part 15.255(d) (unrestricted)	Band Edge Measurement	Pass
FCC Part 15.207	Conducted Emissions	N/A

2 EUT Description

2.1 Equipment under Test (EUT)

Table 2 - Equipment under Test (EUT)

EUT	WAYV Air
EUT Received	3/26/2020
EUT Tested	4/2/2020 - 6/3/2020
Serial No.	0300AK319C190081(Swept frequency, normal operation); 0300AK319C190070 (Low Ch); 0300AK319C190095 (Mid Ch); 0300AK319C190069 (High Ch);
Operating Band	57 GHz - 71 GHz

2.2 Laboratory Description

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number:	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:
Relative humidity of 32 ± 4%
Temperature of 22 ± 3° Celsius

2.3 EUT Setup

The EUT was powered by 12 VDC battery for all the tests unless specified and set to transmit continuously on the default frequency channels.

Channel	Frequency
	GHz
Low	60.3
Mid	62.0
High	63.6

3 Test Results

3.1 Radiated Emissions

Test: FCC Part 15.255 (c)(3)
Test Method: ANSI C63.10-2013, Section(s) 9.8,9.9,9.10,9.12, 9.13
Test Result: Complies

3.1.1 Test Description

Emissions measurements were made using a spectrum analyzer with an external mixers and horn antennas. Measurements were taken at a distance of;

0.1m, Fundamental
3m, 30 MHz – 18 GHz
5 cm, 18 – 110 GHz
5 cm, 110 GHz – 140 GHz
1 cm, 140 – 220 GHz

The analyzer was set to a resolution bandwidth of 1 MHz and a video bandwidth of 50 MHz for the fundamental and harmonic measurement. The results were compared against the limits published in FCC Part 15.255 (c)(3). For fixed field disturbance sensors and short-range devices for interactive motion sensing, the peak transmitter conducted output power shall not exceed −10 dBm and the peak EIRP level shall not exceed 10 dBm. Radiated emissions below 40 GHz shall not exceed the general limits in §15.209. Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm2 at a distance of 3 meters

$$\mathrm{EIRP} = E_{\mathrm{Meas}} + 20\log\left(d_{\mathrm{Meas}}\right) - 104.7$$

where

EIRP	is the equivalent isotropically radiated power, in dBm
E_{Meas}	is the field strength of the emission at the measurement distance, in dBμV/m
d_{Meas}	is the measurement distance, in m

Section 15.255(c)(4) states:

> *The peak power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and has a video bandwidth of at least 10 MHz. The average emission levels shall be measured over the actual time period during which transmission occurs.*

Since the sweep was stopped and an unmodulated carrier was measured, the detection bandwidth (RBW) used was sufficient to fully encompass the emission and provide an accurate reading of the total peak power in the band, meeting the intent of the requirement.

Section 15.255(e)(1) states:

> *Transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).*

Per the results of measurements in Section 3.2, the maximum instantaneous 6 dB bandwidth of the device is 148 kHz. The peak conducted power limit would then be:

Limit(dBm) = 500 mW x (0.148 / 100) MHz = 0.74 mW = 10log(1.37) dBm = -1.31 dBm

The highest conducted value measured was –11.10 dBm, so the EUT meets this requirement with a margin of 9.79 dB.

3.1.2 Test Results

No radiated emissions measurements were found in excess of the limits. Test result data can be seen below.

3.1.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 33 ± 5%
Temperature of 22 ±2° C

3.1.4 Test Setup

For measurements from 18 – 200 GHz, RF absorber was not used. The antennas used were directional antennas and all measurements were performed line-of-sight. Reflections from the floor or any other surface were not a significant factor in the measurements. See Section 2.3 for further details.

3.1.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.	Calibration due
A091418	SunAR RF Motion	JB1	Bicon Antenna	6 Mar 2020	6 Mar 2021
100021	Rohde and Schwarz	ESH2-Z5	LISN	3 Mar 2020	3 Mar 2021
6415	EMCO-ETS	3115	DRG Horn	16 Mar 2020	16 Mar 2022
2576	ETS	3116	Horn Antenna	9 Mar 2020	9 Mar 2022
MY59050109	Keysight	N9038A	MXE Signal Analyzer	23 Apr 2019	23 Apr 2021
MY51391050	Keysight	M1970V-002	Mixer, 50 – 80 GHz	13 Apr 2019	13 Apr 2020
MY56390145	Keysight	M1971W	Mixer, 75 – 110 GHz	12 Apr 2019	12 Apr 2020
700307	V11.25	700307	TDK Emissions Lab S/W	NA	NA
32/2016	Pasternack	PE9881-24	WR-15 Horn Antenna	CNR***	CNR***
16434-01	Sage Millimeter	SAZ-2410-10-S1	WR-10 Horn Antenna	CNR***	CNR***
3903A03916	Agilent	11970Q	Mixer, 33 – 50 GHz	CNR**	CNR**
Ncee1	Pasternack	SH122-23	WR-22 Horn Antenna	CNR***	CNR***
181004-2	OML	DPL313B	Diplexer	CNR**	CNR**
200707-1	OML	M08HWDX	Mixer, 90 – 140 GHz	07 July 2020	07 July 2022
20070701	OML	M08RH	WR-8 Horn Antenna	CNR***	CNR***
200707-1	OML	M05HWDX	Mixer, 140 – 220 GHz	07 July 2020	07 July 2022
20070701	OML	MR05RH	WR-5 Horn Antenna	CNR***	CNR***

**Calibration Not Required, internal verification
***Calibration not required, standard gain horn antenna. All mixers and pre-amplifiers were calibrated with associated cables.

3.1.6 Test Pictures and/or Figures

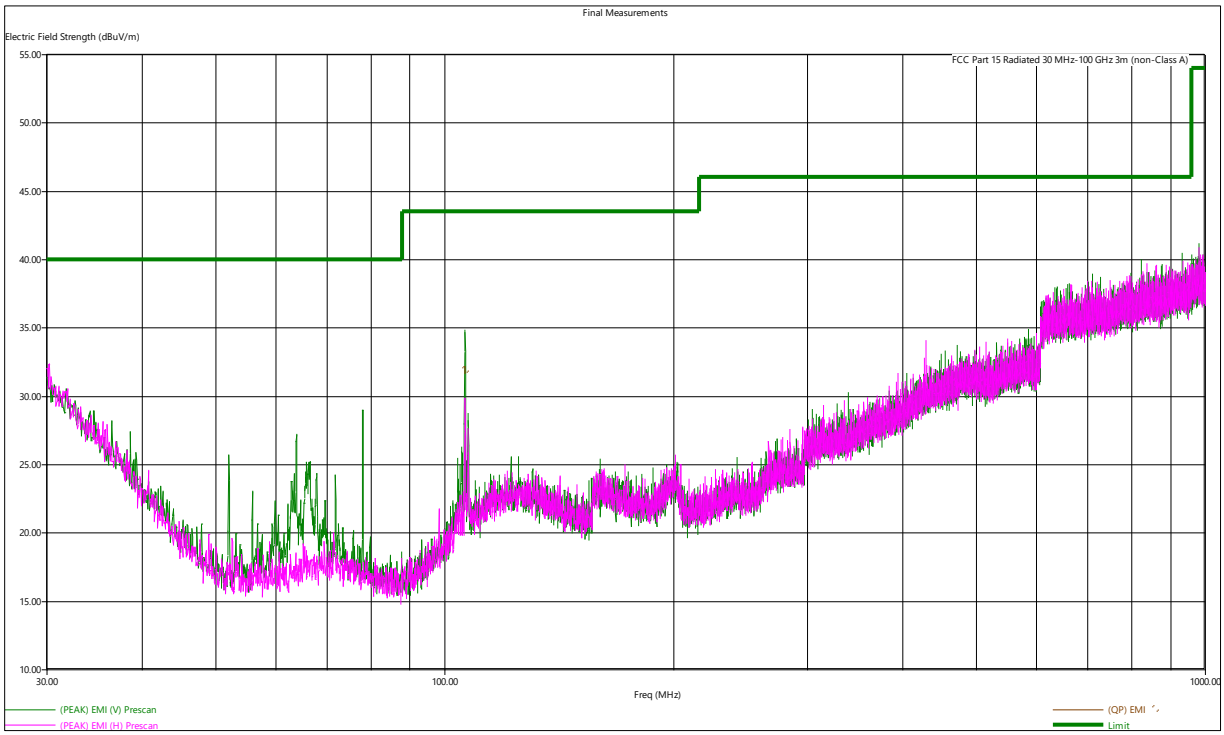

Figure 1 - Radiated Emissions Data Plot, 30M-1GHz

Table 3 - Radiated Emissions Quasi-Peak Data, 30MHz – 59GHz

Frequency	Level	Limit	Margin	Height	Angle	Polarity
MHz	dBµV/m	dBµV/m	dB	cm	deg	
106.283280	31.87	43.52	11.65	300.00	348.00	V
2413.250000	39.45	53.98	14.53	399.00	72.00	V

Limit calculations:

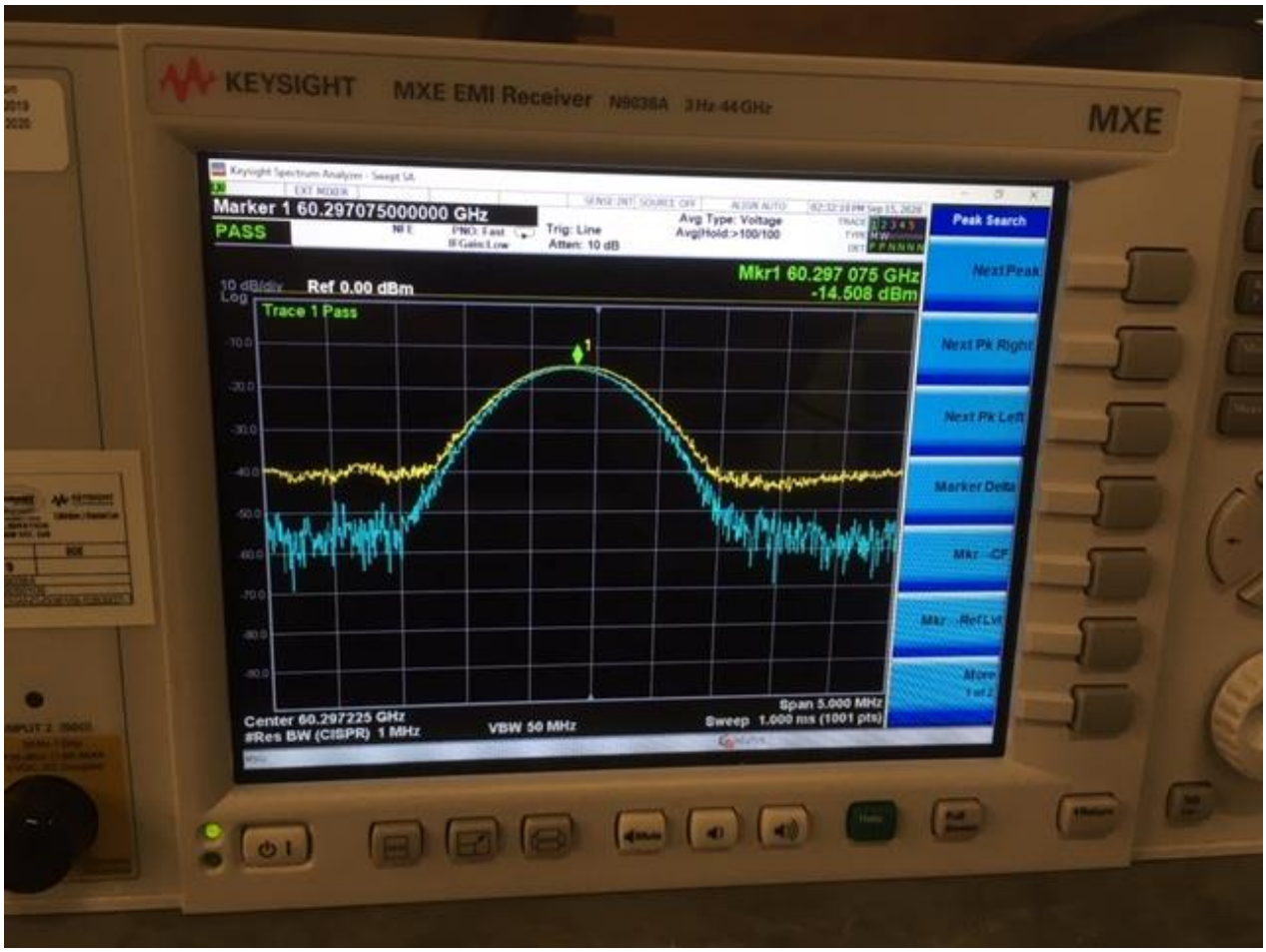

Figure 2 - Analyzer Measurement – Fundamental, Low Channel (Single Frequency)

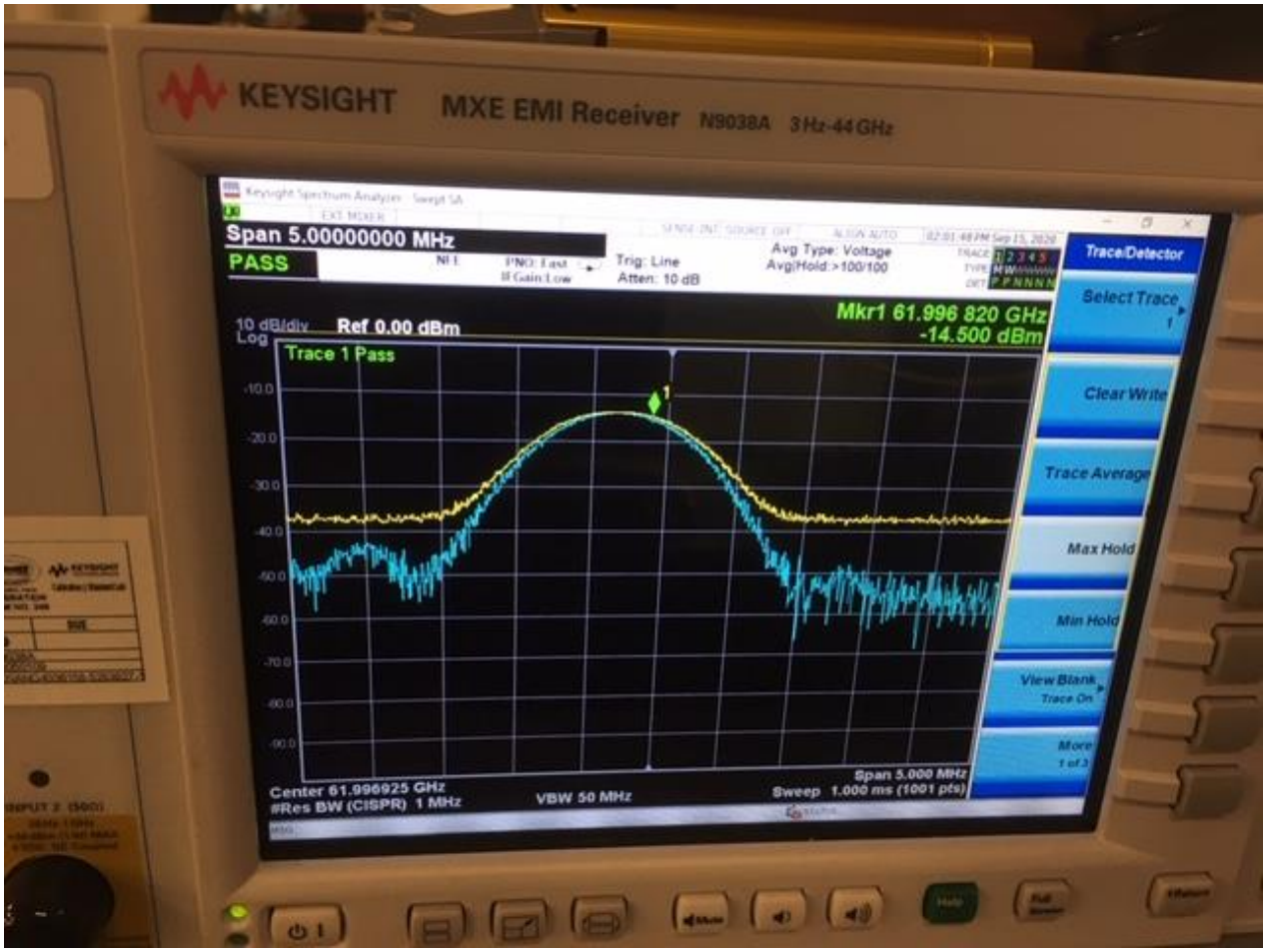

Figure 3 - Analyzer Measurement – Fundamental, Mid Channel (Single Frequency)

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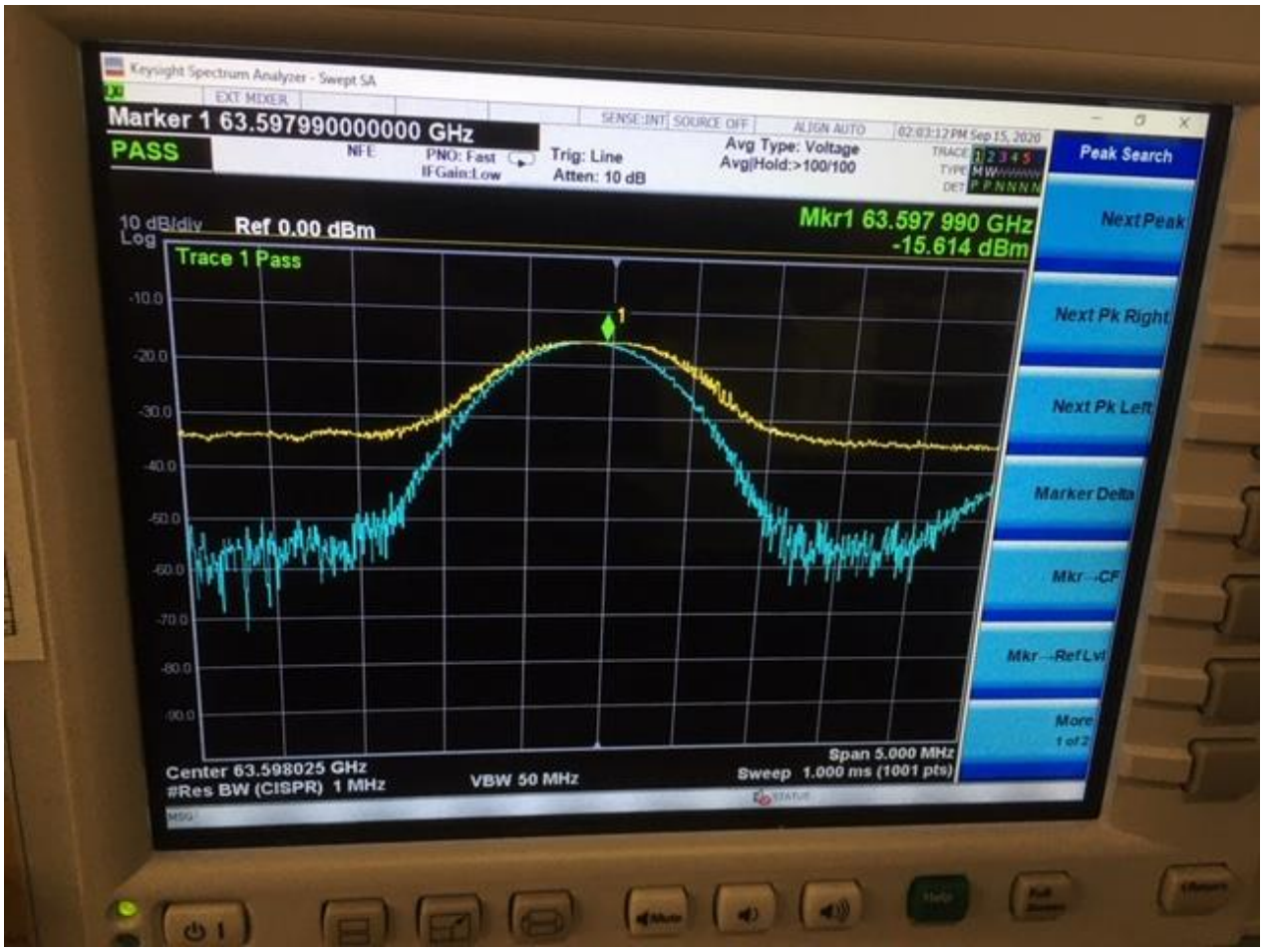


Figure 4 - Analyzer Measurement – Fundamental, High Channel (Single Frequency)

Corrected measurement as recorded on spectrum analyzer

Fundamental Measurements								
Channel	Frequency	Analyzer level	EIRP	EIRP Limit	EIRP Margin	Conducted level*	Conducted Limit	Conducted Margin
	GHz	dBm	dBm	dBm	dB	dBm		dB
Low	60.300000	-14.508	9.82	10.00	0.18	-11.18	-10.00	1.18
Mid	62.000000	-14.500	9.90	10.00	0.10	-11.10	-10.00	1.10
High	63.600000	-15.614	8.92	10.00	1.08	-12.08	-10.00	2.08

*Conducted values were calculated from antenna gain and EIRP values.
Conducted value = EIRP (dBm) – EUT Antenna gain

EUT Antenna gain = 21 dBi

Measurement antenna factor = 42.0 dB/m at 60.3 GHz
42.1 dB/m at 62.0 GHz
42.2 dB/m at 63.6 GHz

Field Strength @ 0.1m (dBm) = Analyzer Level (dBm) + Measurement antenna factor (dB/m)

EIRP(dBm) = Field Strength @ 0.1m (dBm) + (107 – 104.7+20log(0.1)) {converts 0.1m FS to EIRP]

Mixer corrections are taken into account automatically in the receiver.

Spurious emissions:

Channel	Frequency	Analyzer Reading	EIRP	EIRP	EIRP Level	Limit @3m	Margin
	GHz	dBm	dBm @ 5 cm	dBm @ 3m	pW/cm² @ 3m	pW/cm²	pW/cm²
Low	120.600000	-97.18	-37	-72.56	55.46	90.00	34.54
Mid	124.000000	-100.18	-39.71	-75.27	29.72	90.00	60.28
High	126.600000	-98.94	-38.53	-74.09	38.99	90.00	51.01
Channel	Frequency	Analyzer Reading	EIRP	EIRP	EIRP Level	Limit @3m	Margin
	GHz	dBm	dBm @ 1 cm	dBm @ 3m	pW/cm² @ 3m	pW/cm²	pW/cm²
Low	180.900000	-97.13	-42.53	-92.07	0.62	90.00	89.38
Mid	186.000000	-94.14	-31.63	-81.17	7.64	90.00	82.36
High	189.900000	-100.32	-37.04	-86.58	2.20	90.00	87.80

EIRP(dBm @ 5cm) = Analyzer reading (dBm) + Antenna Factor (dB/m) + Mixer Coversion Loss (dB) + (107 – 104.7+20log(0.05)) = AR + AF + MCL – 23.72

EIRP(dBm @ 1cm) = Analyzer reading (dBm) + Antenna Factor (dB/m) + Mixer Coversion Loss (dB) + (107 – 104.7+20log(0.01)) = AR + AF + MCL – 40.00

Antenna Factor	120.6 GHz	47.7 dB/m
	124.0 GHz	48.0 dB/m
	126.6 GHz	48.2 dB/m
	180.9 GHz	51.3 dB/m
	186.0 GHz	51.5 dB/m
	189.9 GHz	51.7 dB/m
Mixer CL	120.6 GHz	36.20 dB
	124.0 GHz	36.19 dB
	126.6 GHz	35.93 dB
	180.9 GHz	41.00 dB
	186.0 GHz	48.71 dB
	189.9 GHz	49.28 dB

EIRP(dBm @ 3m) = EIRP(dBm @ 5cm) – 20log(.05/3) = EIRP@5cm – 35.56

EIRP(dBm @ 3m) = EIRP(dBm @ 1cm) – 20log(.01/3) = EIRP@1cm – 49.54

EIRP (pW) = [10 ^ [EIRP(dBm) / 10]] x 10^9 (convert milli to pico)

Power Density (pW/cm^2) = EIRP (pW) / $4\pi d^2$
d = limit measurement distance = 3 meters

3.2 Bandedges and Occupied Bandwidth

Test: FCC Part 15.255 (e)(1)

Test Method: ANSI C63.10-2013, Section(s) 6.10.5, 6.10.6, 6.9.2

Test Result: Complies

3.2.1 Limits of bandedge measurements:

1. Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.
2. Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 at a distance of 3 meters.

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

3.2.2 Test procedures:

The EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 1MHz and the EMI receiver was used to scan from the bandedge to the fundamental frequency with a peak detector. The highest emissions level beyond the bandedge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.255. Measurements were performed as radiated measurements in the same manner as Section 3.1 of this report. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 1 MHz VBW. The occupied bandwidth was measured using the spectrum analyzers 99% occupied bandwidth setting.

3.2.3 Deviations from test standard:

No deviation.

3.2.4 Test setup:

All the measurements were done at 1m test distance.

3.2.5 EUT operating conditions:

The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest frequency channel, and the highest frequency channel.

Test results:

Band Edges

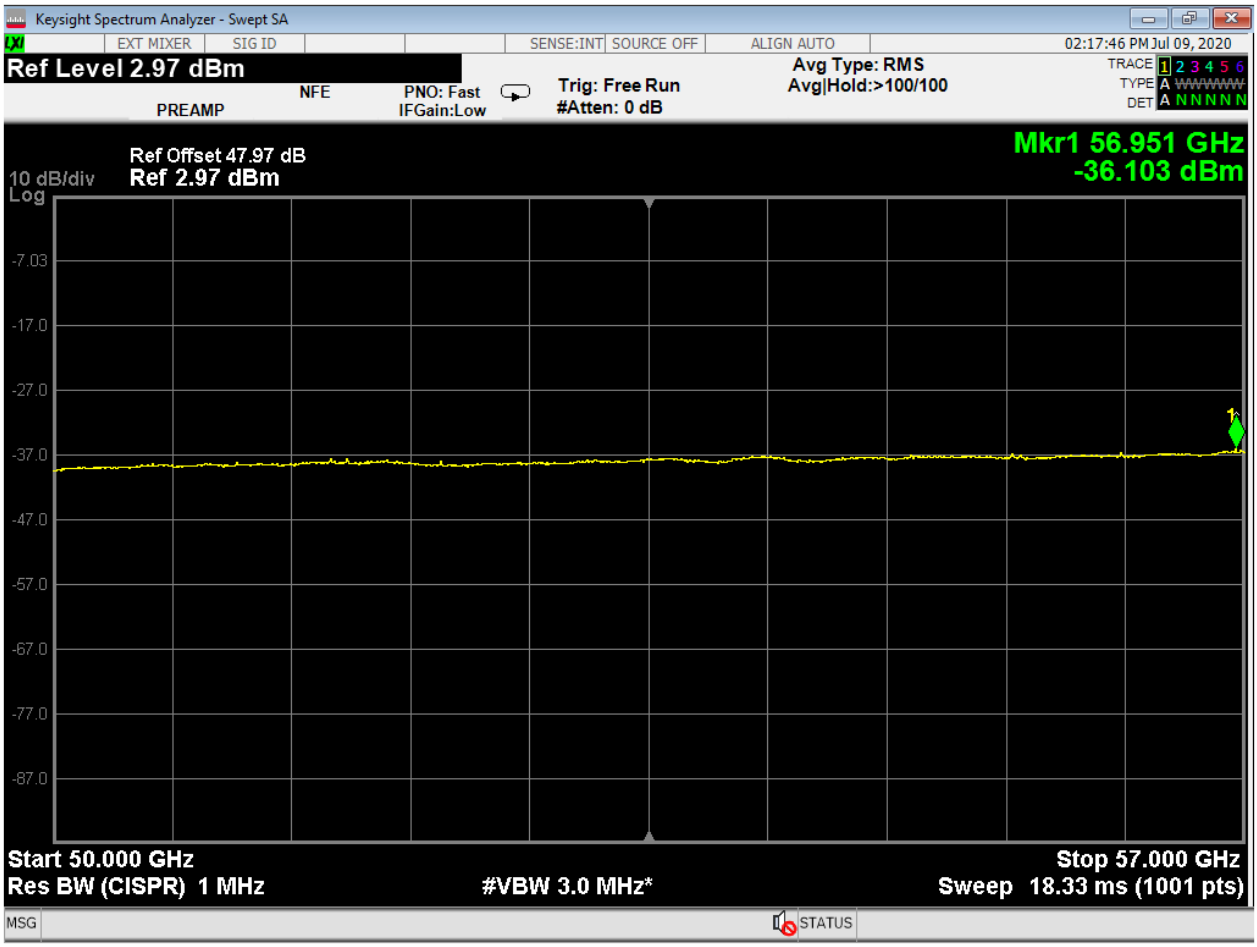


Figure 5 – Lower Band Edge, Single Frequency

Corrected measurement as recorded on spectrum analyzer

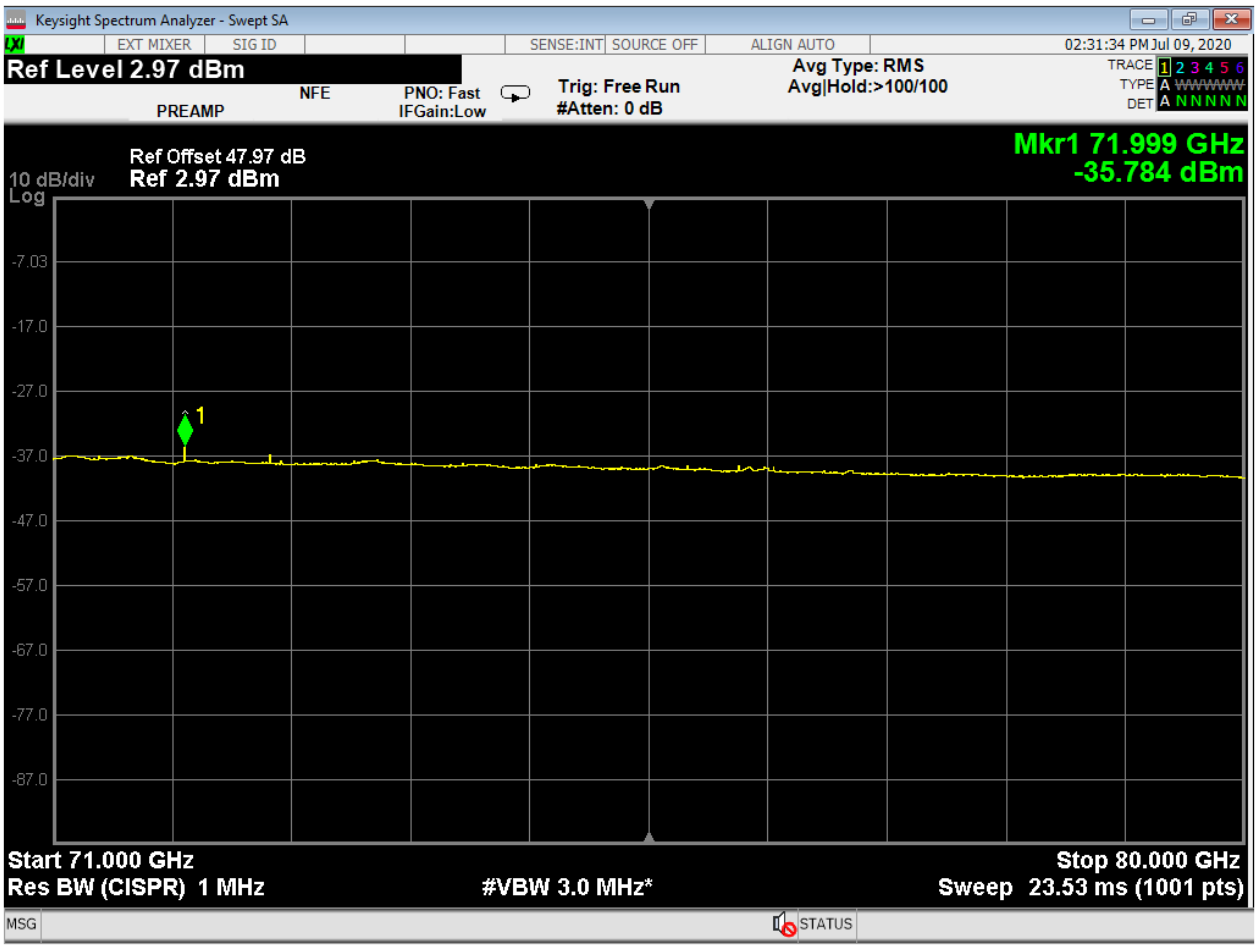


Figure 6 – Higher Band Edge, Single Frequency
Corrected measurement as recorded on spectrum analyzer

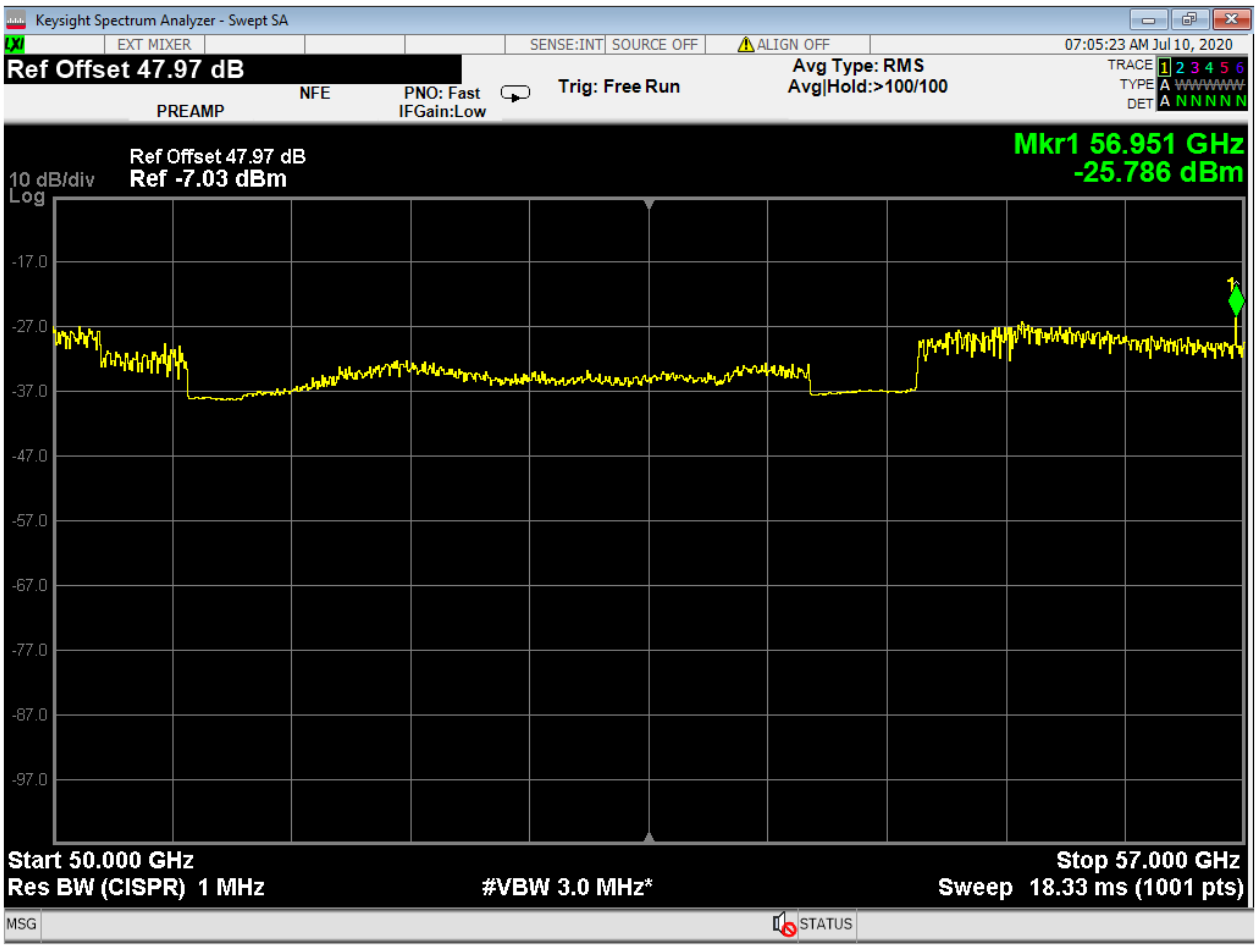


Figure 7 – Lower Band Edge, Sweep Frequency
Corrected measurement as recorded on spectrum analyzer

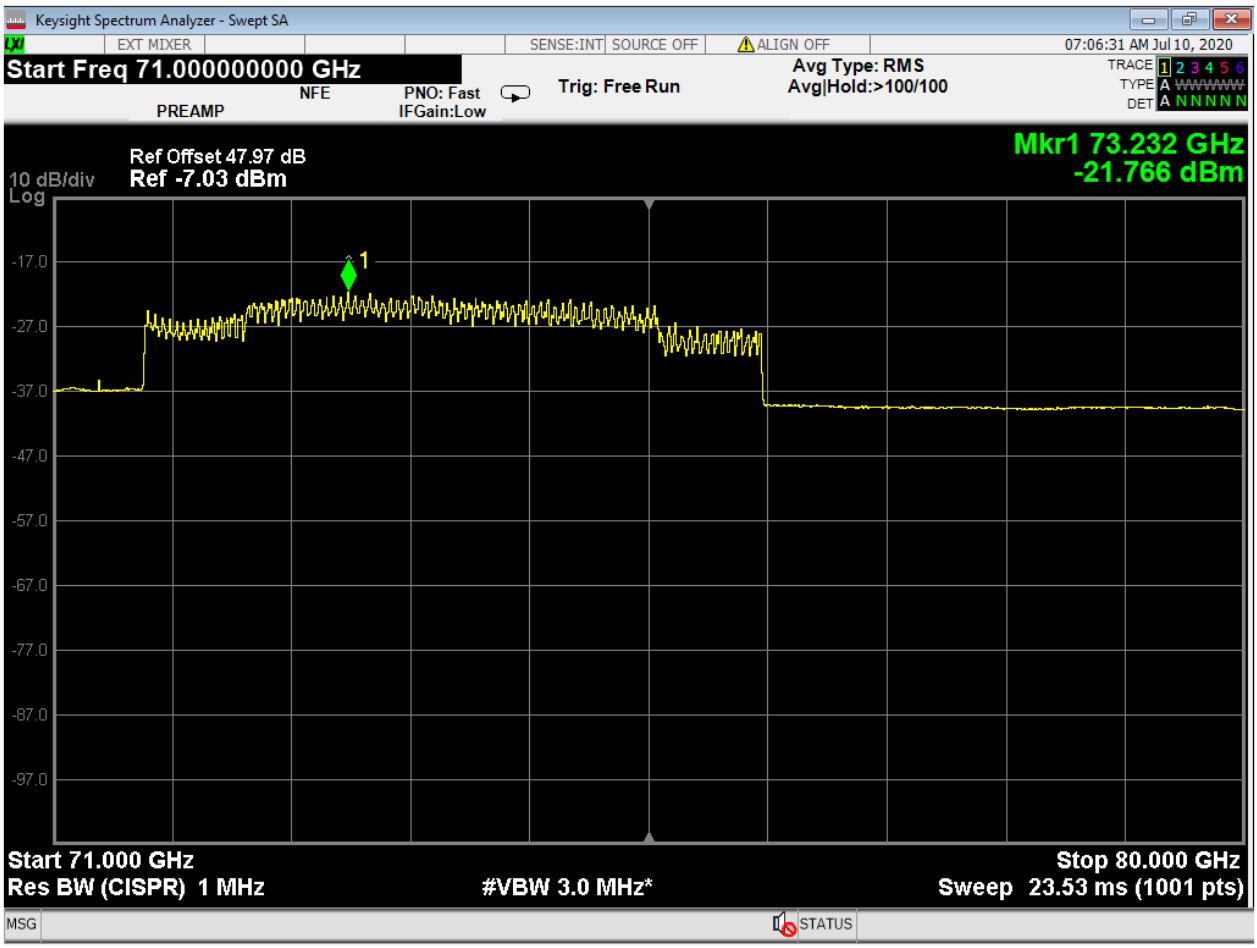


Figure 8 – Higher Band Edge, Sweep Frequency
Corrected measurement as recorded on spectrum analyzer

Band Edges							
Channel	Frequency	Analyzer Reading	Field Stregnth	EIRP	Power density Level	Limit @3m	Margin
	GHz	dBm	dBm @ 1m	dBm	pW/cm² @ 3m	pW/cm²	dB
Low	57.000000	-84.07	-42.07	-65.79	2.332211	90.00	87.66779
High	71.000000	-83.75	-41.75	-65.47	2.510544	90.00	87.48946
High (Swept)	71.000000	-73.76	-31.56	-55.28	26.22816	90.00	63.77184
Low (Swept)	57.000000	-69.74	-27.54	-51.26	66.18626	90.00	23.81374

Analyzer reading (dBm) = Value from screen capture – 47.97 (ref offset)

Measurement antenna factor = 42.0 dB/m at 60.3 GHz
42.2 dB/m at 63.6 GHz

Field Strength @ 5cm (dBm) = Analyzer Level (dBm) + Measurement antenna factor (dB/m)

EIRP(dBm) = Field Strength @ 5cm (dBm) + (107 – 104.7+20log(.05)) {converts 1m FS to EIRP} = FS@1m -23.72

Mixer corrections are taken into account automatically in the receiver.

EIRP (pW) = [10 ^ [EIRP(dBm) / 10]] x 10^9 (convert milli to pico)

Power Density (pW/cm^2) = EIRP (pW) / $4\pi d^2$
d = limit measurement distance = 3 meters

Occupied Bandwidth

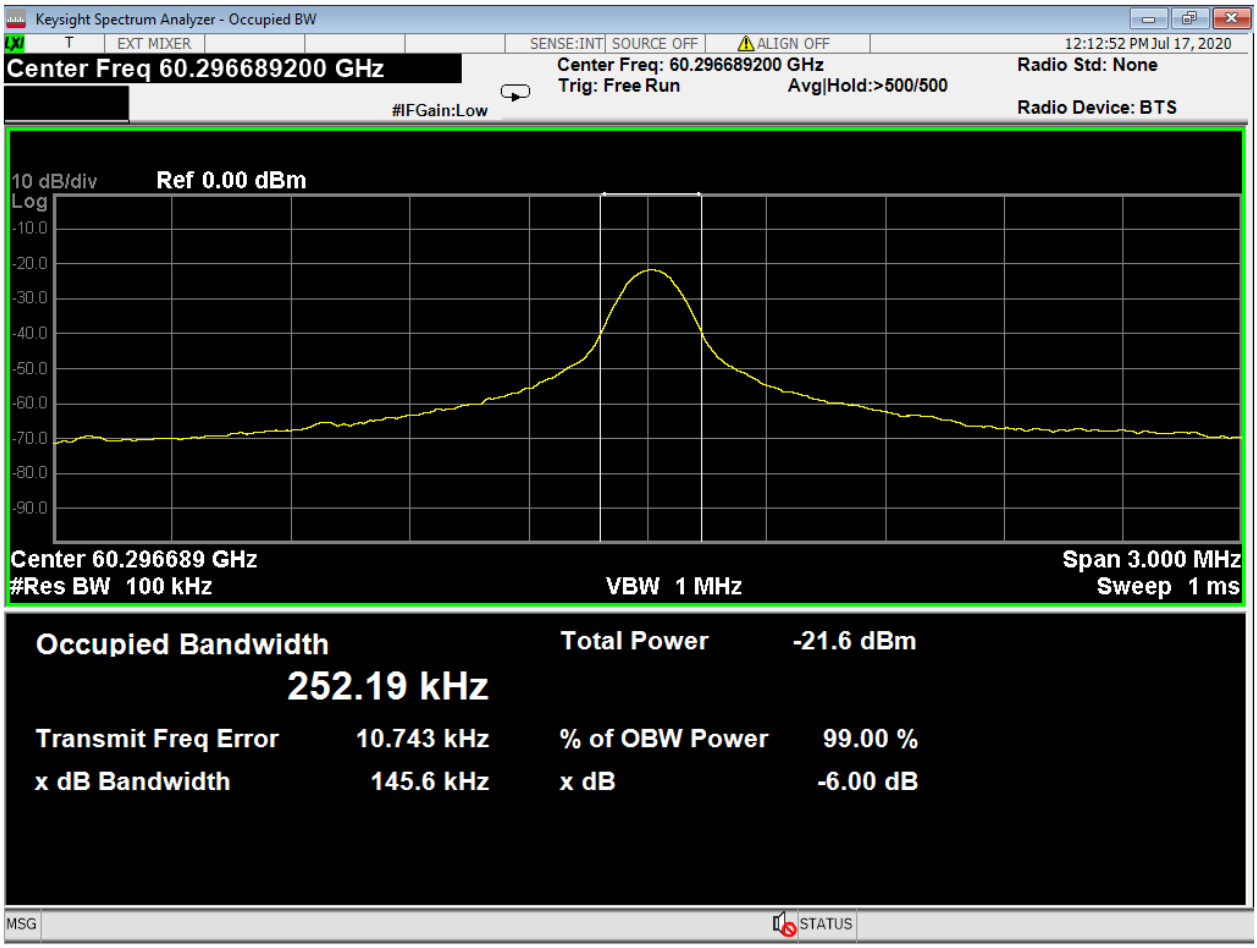


Figure 9 – Occupied Bandwidth, Low channel

Uncorrected measurement as recorded on spectrum analyzer

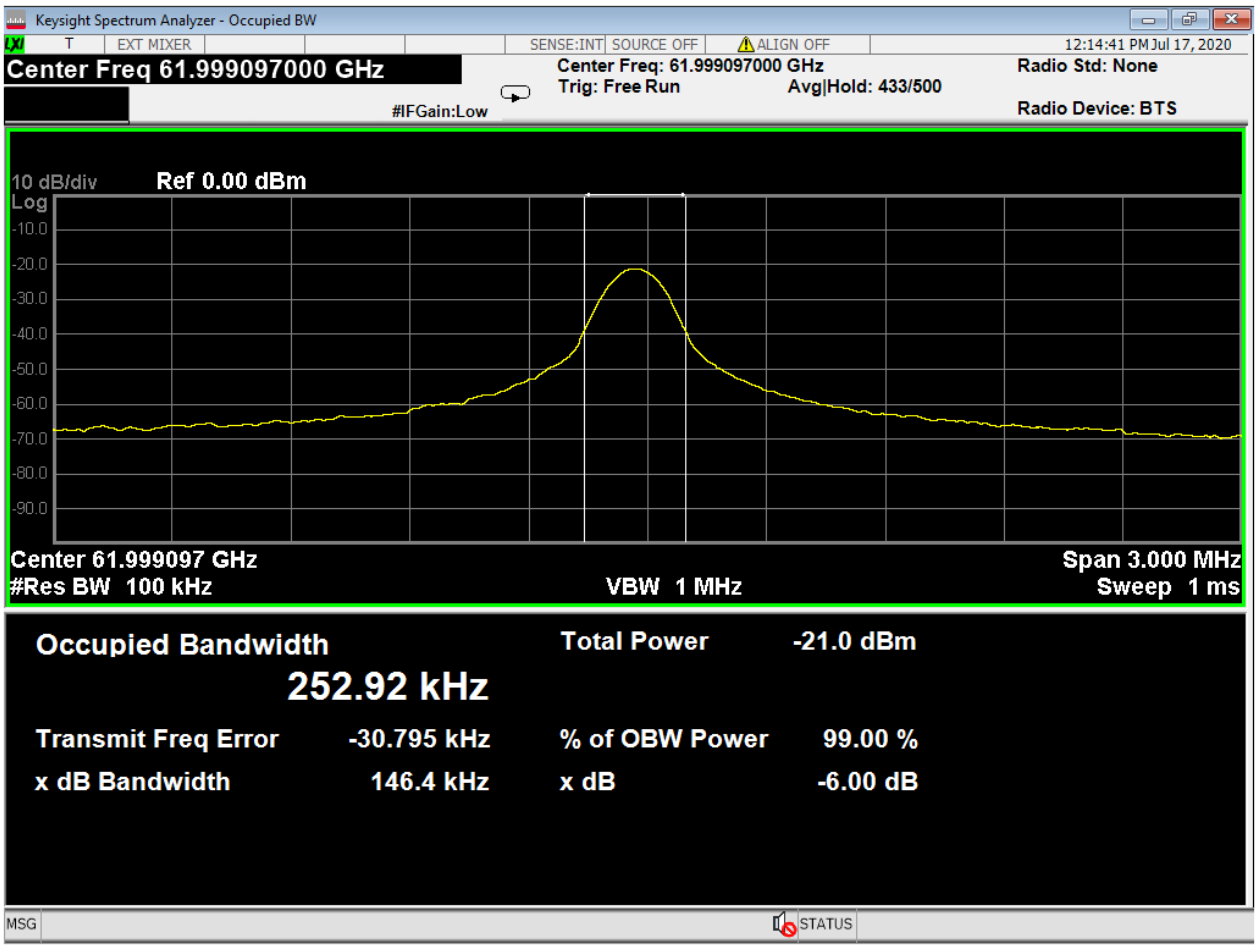


Figure 10 – Occupied Bandwidth, Mid channel

Uncorrected measurement as recorded on spectrum analyzer

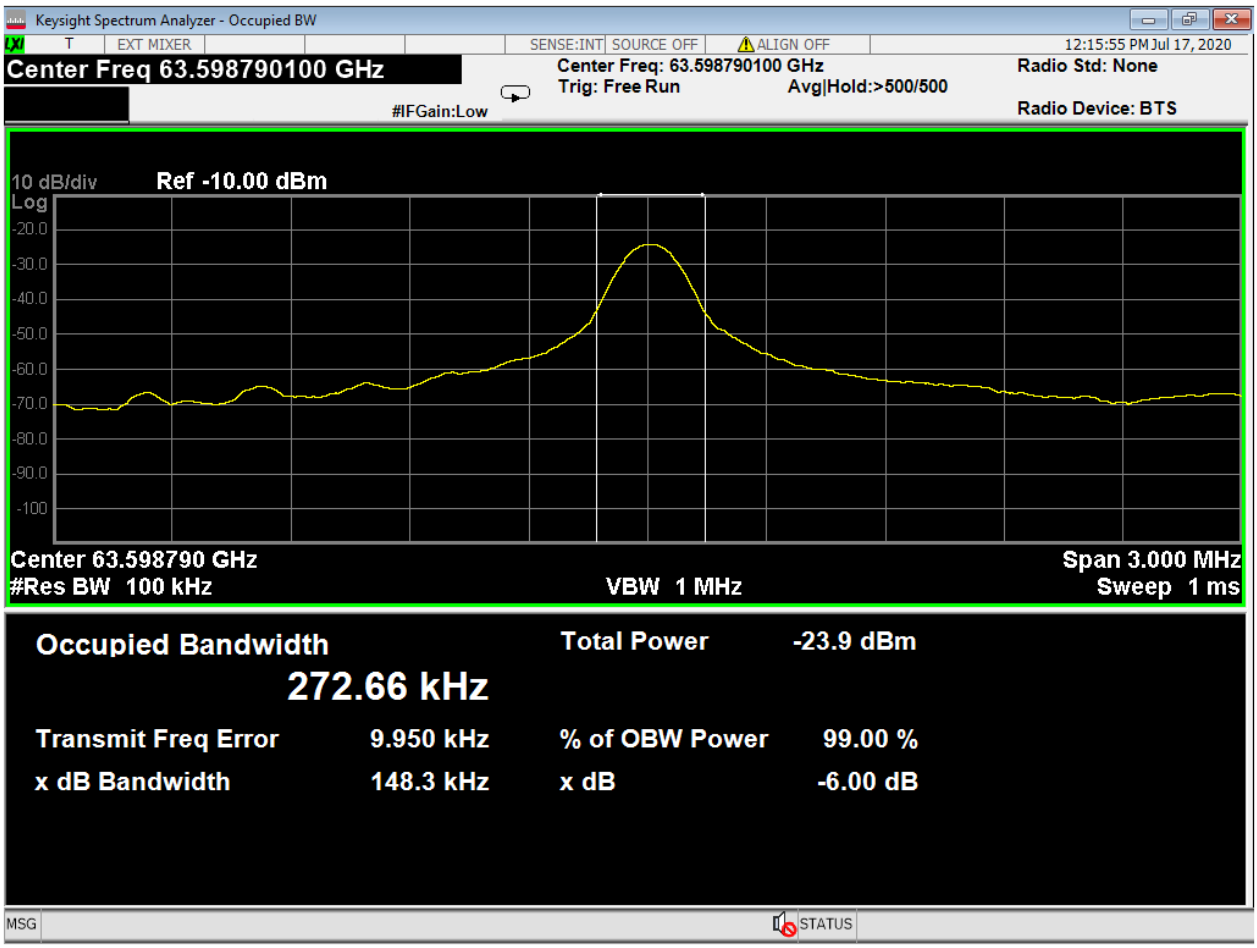


Figure 11 – Occupied Bandwidth, High channel

Uncorrected measurement as recorded on spectrum analyzer

3.3 Frequency Stability

Test: FCC Part 15.255 (f)

Test Method: ANSI C63.10-2013, Section 9.14

Test Result: Complies

3.3.1 Test Description

Frequency error was determined using the build in frequency error function of the spectrum analyzer. The analyzer finds the occupied bandwidth, calculates the center of the given band then returns the deviation with respect to the given transmit frequency. The temperature was varied from -20°C to -50°C.

Frequency stability. Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

3.3.2 Test Results

No results were found to be in excess of the limits. A plot of the results can be seen below.

3.3.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility on the 10-meter chamber ground plane. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 30 ± 5%
Temperature of 23 ±2° C

3.3.4 Test Setup

See Section 2.3 for further details.

3.3.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
31373	Thermotron	SE1000-5-5	Temp chamber	NA
ID # 2130155	Omega	iTHX-SD	3m Temp. Humidity Meter	2018 Jan 31*

*3 Year Cal Cycle

3.3.6 Test results

Table 4 - Frequency Range Measurements

Temp in C°	-20	-10	0	10	20	30	40	50
Freq (GHz)	**Deviation (kHz)**							
60.300000	592	614	569	1290	2350	2650	1890	2450
62.000000	545	595	598	1240	1200	800	1450	1990
63.600000	579	687	585	1410	1290	1320	1650	2410

Table 5 - Voltage Range Measurements

Voltage Variation	10.2V	12V	13.8V
Freq(GHz)	**Deviation(kHz)**		
60.296600	567	550	593
61.998550	689	696	626
63.598700	594	780	563

3.4 Conducted AC Mains Emissions

Test Method: ANSI C63.10-2013, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

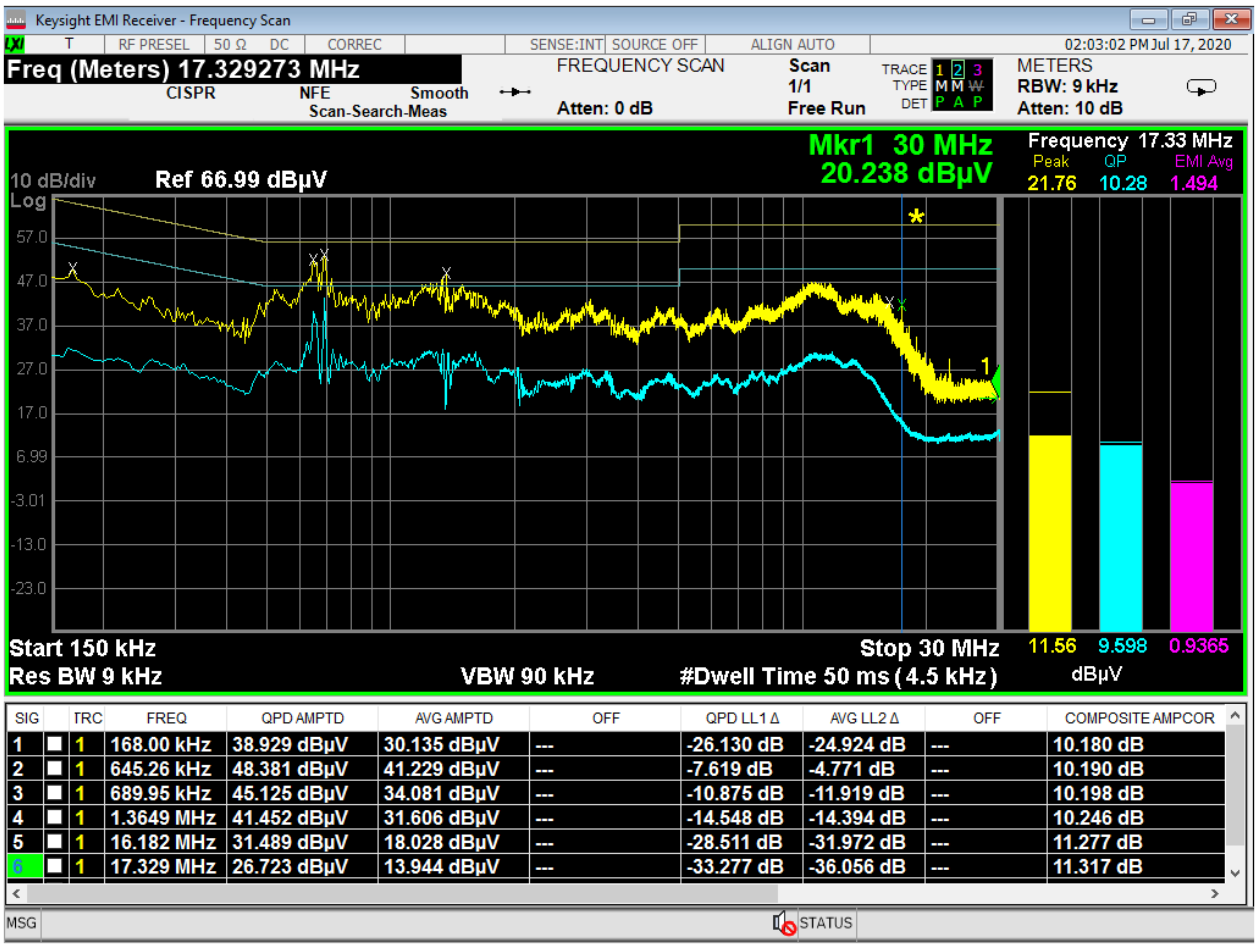
Test Procedures:

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
d. Results were compared to the 15.207 limits.

Deviation from the test standard:
No deviation

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the middle channel.

Test Results: PASS


Keysight EMI Receiver - Frequency Scan
RF PRESEL
50 Ω DC
CORREC
SENSE:INT
SOURCE OFF
ALIGN AUTO
02:03:02 PM Jul 17, 2020
Freq (Meters) 17.329273 MHz
CISPR
NFE
Smooth
Scan-Search-Meas
FREQUENCY SCAN
Atten: 0 dB
Scan
1/1
Free Run
TRACE 1 2 3
TYPE M M W
DET P A P
METERS
RBW: 9 kHz
Atten: 10 dB
Mkr1 30 MHz
20.238 dBµV
Frequency 17.33 MHz
Peak QP EMI Avg
21.76 10.28 1.494
10 dB/div
Ref 66.99 dBµV
Log
57.0
47.0
37.0
27.0
17.0
6.99
-3.01
-13.0
-23.0
Start 150 kHz
Res BW 9 kHz
VBW 90 kHz
Stop 30 MHz
#Dwell Time 50 ms (4.5 kHz)
11.56 9.598 0.9365
dBµV
SIG TRC FREQ QPD AMPTD AVG AMPTD OFF QPD LL1 Δ AVG LL2 Δ OFF COMPOSITE AMPCOR
1 1 168.00 kHz 38.929 dBµV 30.135 dBµV --- -26.130 dB -24.924 dB --- 10.180 dB
2 1 645.26 kHz 48.381 dBµV 41.229 dBµV --- -7.619 dB -4.771 dB --- 10.190 dB
3 1 689.95 kHz 45.125 dBµV 34.081 dBµV --- -10.875 dB -11.919 dB --- 10.198 dB
4 1 1.3649 MHz 41.452 dBµV 31.606 dBµV --- -14.548 dB -14.394 dB --- 10.246 dB
5 1 16.182 MHz 31.489 dBµV 18.028 dBµV --- -28.511 dB -31.972 dB --- 11.277 dB
6 1 17.329 MHz 26.723 dBµV 13.944 dBµV --- -33.277 dB -36.056 dB --- 11.317 dB
MSG
STATUS

L terminal


Keysight EMI Receiver - Frequency Scan
RF PRESEL
50 Ω DC
CORREC
SENSE:INT
SOURCE OFF
ALIGN AUTO
02:10:26 PM Jul 17, 2020
Freq (Meters) 16.222385 MHz
CISPR
NFE
Smooth
Scan-Search-Meas
FREQUENCY SCAN
Atten: 0 dB
Scan
1/1
Free Run
TRACE 1 2 3
TYPE M M W
DET P A P
METERS
RBW: 9 kHz
Atten: 10 dB
Mkr1 30 MHz
22.081 dBµV
Frequency 16.22 MHz
Peak QP EMI Avg
20.21 9.470 0.5334
10 dB/div
Ref 66.99 dBµV
Log
57.0
47.0
37.0
27.0
17.0
6.99
-3.01
-13.0
-23.0
Start 150 kHz
Res BW 9 kHz
VBW 90 kHz
Stop 30 MHz
#Dwell Time 50 ms (4.5 kHz)
10.08 9.262 -0.026
dBµV
SIG TRC FREQ QPD AMPTD AVG AMPTD OFF QPD LL1 Δ AVG LL2 Δ OFF COMPOSITE AMPCOR
1 1 163.91 kHz 36.856 dBµV 26.231 dBµV --- -28.407 dB -29.032 dB --- 10.180 dB
2 1 640.45 kHz 45.675 dBµV 34.558 dBµV --- -10.325 dB -11.442 dB --- 10.190 dB
3 1 3.7676 MHz 25.927 dBµV 14.890 dBµV --- -30.073 dB -31.110 dB --- 10.457 dB
4 1 15.448 MHz 35.617 dBµV 19.125 dBµV --- -24.383 dB -30.875 dB --- 11.253 dB
5 1 15.736 MHz 34.185 dBµV 18.171 dBµV --- -25.815 dB -31.829 dB --- 11.262 dB
6 1 16.222 MHz 32.902 dBµV 15.728 dBµV --- -27.098 dB -34.272 dB --- 11.279 dB
MSG
STATUS

N terminal

Annex A - Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

Power (watts) = 10^[Power (dBm)/10] x 1000

Field Strength (dBµV/m) = Field Strength (dBm) = 107 (for 50Ω measurement systems)

Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

Conversion from 3m field strength to EIRP (d=3):

EIRP = (FS x d^2)/30 = FS [(d^2)/30] = FS [0.3}

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = -95.23

10log(10^) is the conversion from micro to milli

Annex B – Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	150kHz – 18GHz	±3.30 dB

Expanded uncertainty values are calculated to a confidence level of 95%.

CISPR 16-4-2:2011 was used to calculate the above values.

REPORT END