



FCC RADIO TEST REPORT

FCC ID : TV7RAY60
Equipment : nRAYG-60ad
Brand Name : MikroTik
Model Name : nRAYG-60ad
Applicant : Mikrotikls SIA
Brivibas gatve 214i, Riga, LV-1039 Latvia
Manufacturer : MIKROTIKLS SIA
Brivibas gatve 214i, Riga, LV-1039 Latvia
Standard : 47 CFR FCC Part 15.255

The product was received on Mar. 02, 2020, and testing was started from Mar. 19, 2020 and completed on Apr. 07, 2020. We, SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in ANSI C63.10-2013, 47 CFR FCC Part 15.255 and Millimeter Wave Test Procedures, FCC KDB 414788 D01 v01r01 and shown compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.


Approved by: Cliff Chang

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)



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TEL : 886-3-656-9065
FAX : 886-3-656-9085
Report Temp.late No.: CB-A9_2 Ver1.0



Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	FCC 15.207	AC Power Conducted Emissions	PASS	-
3.2	FCC 15.255(e)	Occupied Bandwidth	PASS	-
3.3	FCC 15.255(c)	EIRP Power	PASS	-
3.4	FCC 15.255(c)	Peak Conducted Power	PASS	-
3.5	FCC 15.255(d)	Transmitter Spurious Emissions	PASS	-
3.6	FCC 15.255(f)	Frequency Stability	PASS	-
3.7	FCC 15.255(a),(h)	Operation Restriction and Group Installation	PASS	-

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

Reviewed by: Sam Chen

Report Producer: Sandy Chuang



1 General Description

1.1 Information

1.1.1 RF General Information

RF General Information	
Frequency Range	57-71 GHz
The Channel Plan(s)	Channel 1: 58.32 GHz Channel 2: 60.48 GHz Channel 3: 62.64 GHz Channel 4: 64.80 GHz

1.1.2 Modulation

IEEE 802.11ad Modulation Scheme

MCS Index	Modulation	Code rate	Data rate (Mbit/s)
0	$\pi/2$ -BPSK	1/2	27.5
1	$\pi/2$ -BPSK	1/2	385
2	$\pi/2$ -BPSK	1/2	770
3	$\pi/2$ -BPSK	5/8	962.5
4	$\pi/2$ -BPSK	3/4	1155
5	$\pi/2$ -BPSK	13/16	1251.25
6	$\pi/2$ -QPSK	1/2	1540
7	$\pi/2$ -QPSK	5/8	1925
8	$\pi/2$ -QPSK	3/4	2310

**1.1.3 Antenna Information**

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)	Remark
1	Mikrotik	60G-phased-array	60G-patch antenna array	N/A	42	Channel 1~3
					36	Channel 4

Note: The above information was declared by manufacturer.

1.1.4 Operating Conditions

Operating Conditions			
☒ -40 °C to +70 °C			
☐ 0 °C to +40 °C			
☐ Other:			
EUT Power Type	From PoE with Adapter		
Supply Voltage	☐ AC	State AC voltage	V
Supply Voltage	☒ DC	State DC voltage	24 V

1.1.5 Equipment Use Condition

Equipment Use Condition
☐ Fixed field disturbance sensors at 61-61.5GHz
☐ Except fixed field disturbance sensors at 61-61.5GHz
☒ Except fixed field disturbance sensors

1.1.6 User Condition

Intended Operation
☐ Indoor
☐ Outdoor (except outdoor fixed Point to Point)
☒ Outdoor fixed Point to Point

Note: The above information was declared by manufacturer.

1.1.7 Duty Cycle

Duty Cycle	Duty Cycle Factor (dB)
100 %	0



1.2 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ 47 CFR FCC Part 15.255
- ♦ ANSI C63.10-2013 Section 9. "Procedures for testing millimeter-wave systems"

The following reference test guidance is not within the scope of accreditation of TAF.

- ♦ FCC KDB 414788 D01 v01r01

1.3 Testing Location

Testing Location				
☐	HWA YA	ADD : No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)	TEL : 886-3-327-3456	FAX : 886-3-327-0973
☒	JHUBEI	ADD : No.8, Lane 724, Bo-ai St., Jhubei City, HsinChu County 302, Taiwan, R.O.C.	TEL : 886-3-656-9065	FAX : 886-3-656-9085

Test Condition	Test Site No.	Test Engineer	Test Environment	Test Date
AC Conduction	CO02-CB	Wei Li	23~24°C / 56~59 %	Apr. 07, 2020
Radiated	03CH05-CB	Cola Fan	21.2-23.1°C / 45-49 %	Mar. 19, 2020~ Mar. 27, 2020
RF Conducted	TH03-CB	Eddie Weng	23.4-24.4°C / 51-57 %	Mar. 19, 2020~ Mar. 27, 2020

Test site Designation No. TW0006 with FCC.

Test site registered number IC 4086D with Industry Canada.

2 Test Configuration of Equipment under Test

2.1 Test Channel Frequencies

Test Channel Frequencies Configuration	
Low Channel (GHz)	58.32
Middle Channel (GHz)	60.48
High Channel (GHz)	64.80

2.2 Conformance Tests and Related Test Frequencies

Test Item	Test Frequencies (GHz)
AC Power Conducted Emissions	60.48
Occupied Bandwidth	58.32, 60.48, 64.80
EIRP Power	58.32, 60.48, 64.80
Peak Conducted Power	58.32, 60.48, 64.80
Transmitter Spurious Emissions (below 1 GHz)	60.48
Transmitter Spurious Emissions (1 GHz-40 GHz)	58.32, 60.48, 64.80
Transmitter Spurious Emissions (above 40 GHz)	58.32, 60.48, 64.80
Frequency Stability	60.48

Note: The EUT can only be used at Y axis.

2.3 EUT Operation during Test

During the test, executed the test program to control the EUT continuously transmit RF signal.



2.4 Accessories

Accessories				
Equipment Name	Brand Name	Model Name	Rating	Remark
Adapter	MLF	MLF-A00122400380U0141	Input: 100-240V~50/60Hz 0.4A max Output: 24V, 0.38A	Equip with PoE use
PoE	MikroTik	RBGPOE	-	
Other				
Bracket*1				
Metal band*1				

2.5 Support Equipment

For AC Conduction test:

Support Equipment				
No.	Equipment	Brand Name	Model Name	FCC ID
A	LAN NB	DELL	E6430	N/A

For Radiated and RF Conducted tests:

Support Equipment				
No.	Equipment	Brand Name	Model Name	FCC ID
A	NB	DELL	E4300	N/A



2.6 Far Field Boundary Calculations

The far-field boundary is given as:

$$\text{far field} = (2 * L^2) / \lambda$$

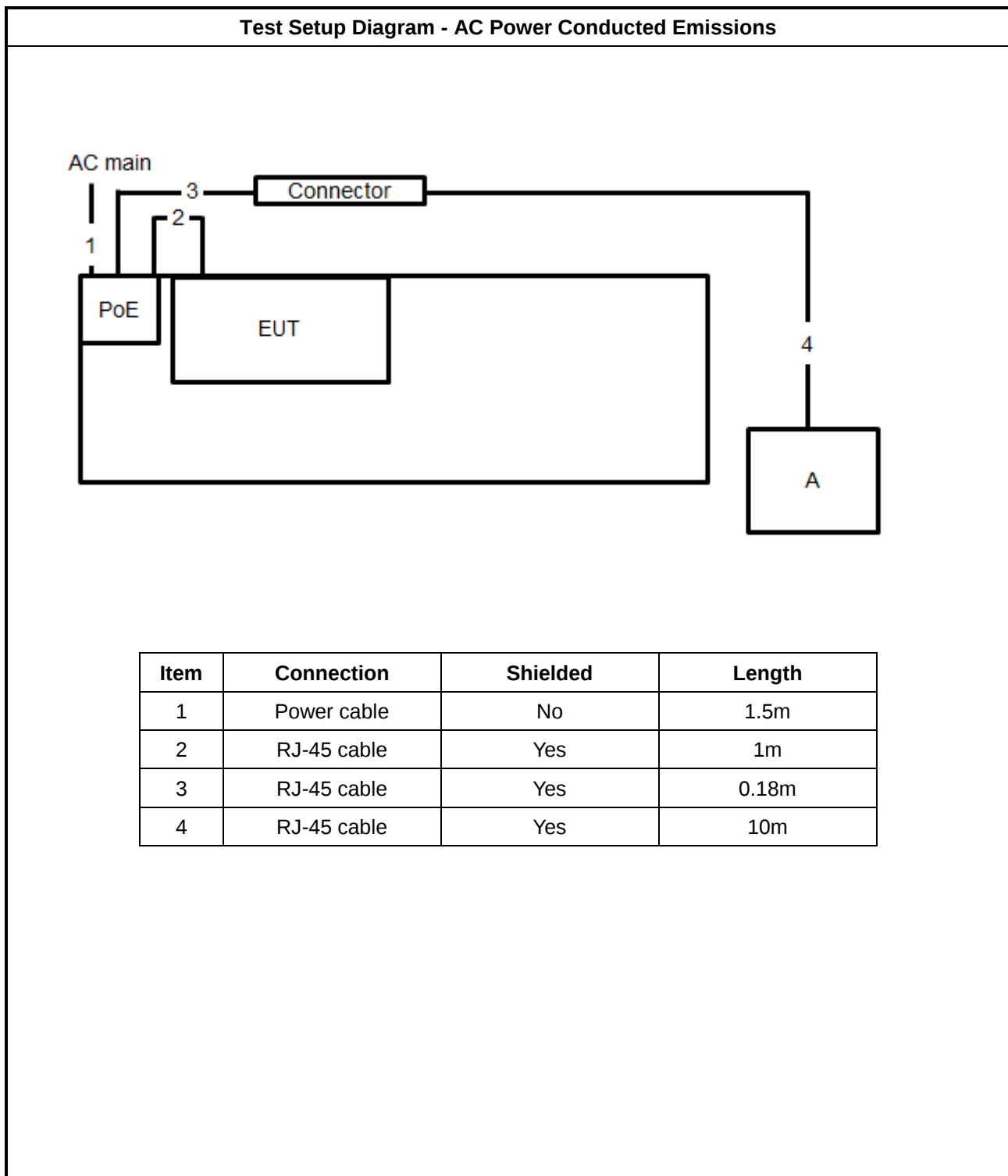
where:

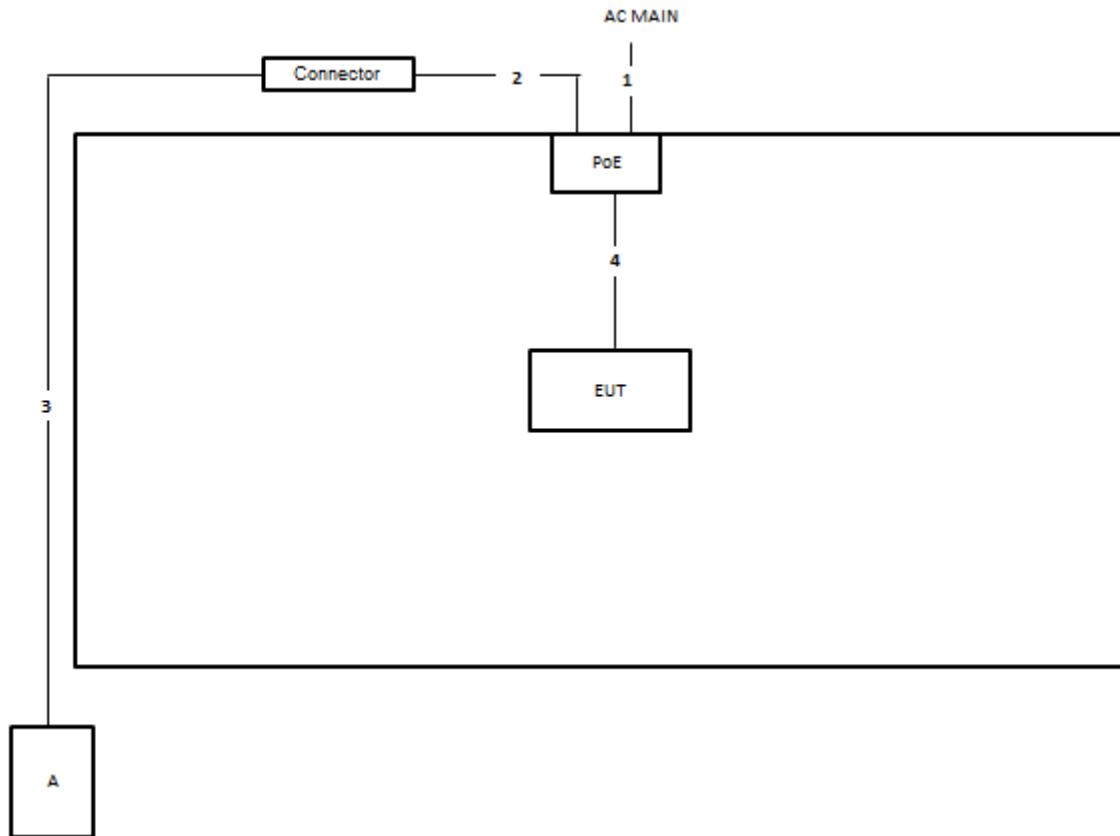
L = Largest Antenna Dimension, including the reflector, in meters

λ = wavelength in meters

Far Field (m)				
Frequency (GHz)	L (m)	Lambda (m)	d(Far Field) (m)	d(Far Field) (cm)
58.32	0.26	0.0051440	26.283	2628.29
60.48	0.26	0.0049603	27.256	2725.63
64.80	0.26	0.0046296	29.203	2920.32

2.7 Test Setup Diagram



Test Setup Diagram - Transmitter Spurious Emissions


Item	Connection	Shielded	Length
1	Power cable	No	1.5m
2	RJ-45 cable	Yes	0.18m
3	RJ-45 cable	No	10m
4	RJ-45 cable	Yes	1m



3 Transmitter Test Result

3.1 AC Power Conducted Emissions

3.1.1 Limit of AC Power Conducted Emissions

AC Power Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50
Note: * Decreases with the logarithm of the frequency.		

3.1.2 Measuring Instruments

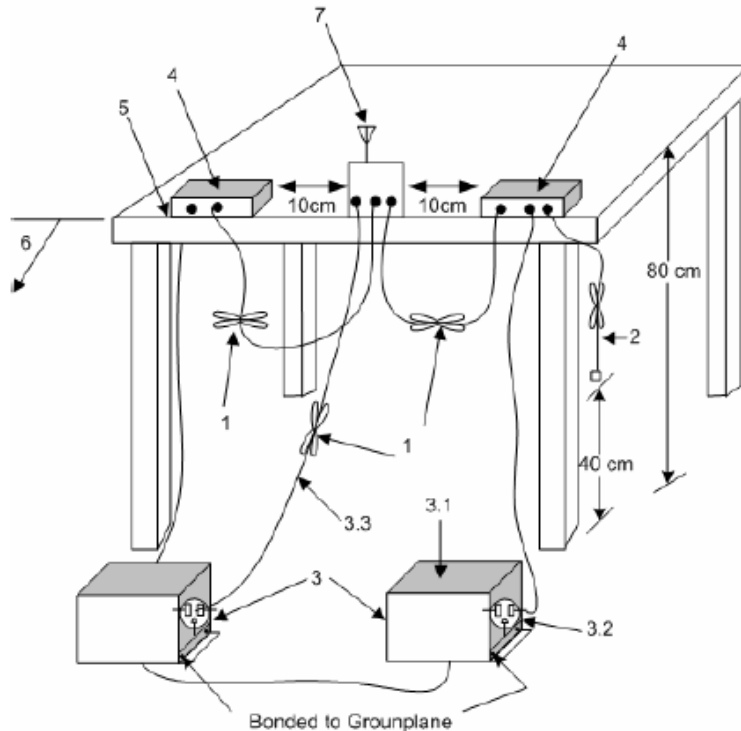
Refer a measuring instruments list in this test report.

3.1.3 Test Procedures

Method of measurement: Refer as ANSI C63.10-2013, clause 6.2.

3.1.4 Test Setup

AC Power Conducted Emissions



1—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long.

2—The I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

3—EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN may be placed on top of, or immediately beneath, reference ground plane.

3.1—All other equipment powered from additional LISN(s).

3.2—A multiple-outlet strip may be used for multiple power cords of non-EUT equipment.

3.3—LISN at least 80 cm from nearest part of EUT chassis.

4—Non-EUT components of EUT system being tested.

5—Rear of EUT, including peripherals, shall all be aligned and flush with edge of tabletop.

6—Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane.

7—Antenna can be integral or detachable. If detachable, then the antenna shall be attached for this test.



3.1.5 Test Result of AC Power Conducted Emissions

Test Conditions see ANSI C63.10, clause 5.11

Test Setup see ANSI C63.10, clause 6.2.3

NOTE 1: If equipment having different channel plan and nominal channel bandwidth modes (see test report clause 1.1.1), the measurements are uninfluenced by different channel plan and nominal channel bandwidth modes, may not need to be repeated for all modes. If equipment having different transmit operating modes (see test report clause 1.1.2), the measurements are uninfluenced by different transmit operating modes, may not need to be repeated for all the operating modes. Similar, if the equipment supports different modulations and/or data rates, the measurements described in ANSI C63.10, clause 5.12 may not need to be repeated for all these modulations and data rates. Simple comparison of engineering test across all operating modes, modulations and data rates may need to be performed to define the worse case combination to be used for the conformance testing.

NOTE 2: ">20dB" means the tables in this clause should only list values of spurious emissions that exceed the level of 20 dB below the applicable limit, see ANSI C63.4, clause 10.1.8.1.

3.1.6 Measurement Results Calculation

The measured Level is calculated using:

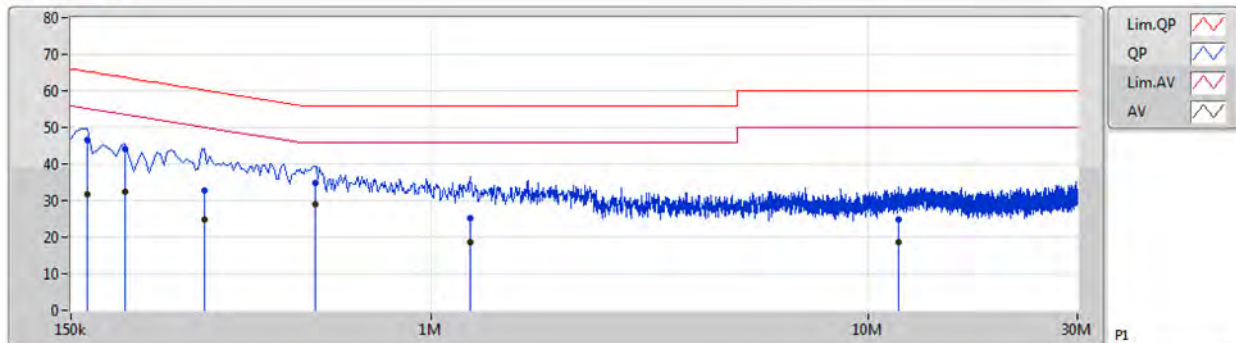
- a. Corrected Reading (dBuV) = LISN Factor + Cable Loss + Read Level = Level
- b. Margin = - Limit + (Read Level + LISN Factor + Cable Loss)



Phase	Line	Configuration	CTX
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Mode 1

07/04/2020



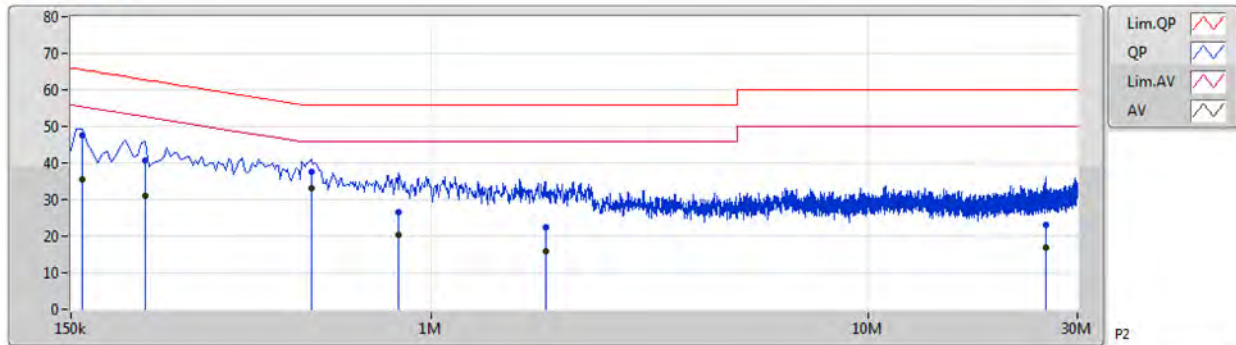
Type	Freq (Hz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Factor (dB)	Condition	Comment	Raw (dBuV)	AF (dB)	CL (dB)	AT (dB)			
QP	163.5k	46.47	65.27	-18.80	10.21	Line	-	36.26	0.05	0.06	10.10			
AV	163.5k	31.85	55.27	-23.42	10.21	Line	-	21.64	0.05	0.06	10.10			
QP	199.5k	44.04	63.63	-19.59	10.22	Line	-	33.82	0.05	0.07	10.10			
AV	199.5k	32.39	53.63	-21.24	10.22	Line	-	22.17	0.05	0.07	10.10			
QP	303k	32.80	60.17	-27.37	10.23	Line	-	22.57	0.05	0.08	10.10			
AV	303k	24.78	50.17	-25.39	10.23	Line	-	14.55	0.05	0.08	10.10			
QP	541.5k	34.93	56.00	-21.07	10.24	Line	-	24.69	0.05	0.09	10.10			
AV	541.5k	29.11	46.00	-16.89	10.24	Line	"Worst"	18.87	0.05	0.09	10.10			
QP	1.226M	25.16	56.00	-30.84	10.30	Line	-	14.86	0.07	0.13	10.10			
AV	1.226M	18.75	46.00	-27.25	10.30	Line	-	8.45	0.07	0.13	10.10			
QP	11.733M	24.97	60.00	-35.03	10.56	Line	-	14.41	0.27	0.18	10.11			
AV	11.733M	18.46	50.00	-31.54	10.56	Line	-	7.90	0.27	0.18	10.11			



Phase	Neutral	Configuration	CTX
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Mode 1

07/04/2020



Type	Freq (Hz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Factor (dB)	Condition	Comment	Raw (dBuV)	AF (dB)	CL (dB)	AT (dB)			
QP	159k	47.62	65.52	-17.90	10.21	Neutral	-	37.41	0.05	0.06	10.10			
AV	159k	35.63	55.52	-19.89	10.21	Neutral	-	25.42	0.05	0.06	10.10			
QP	222k	40.84	62.75	-21.91	10.22	Neutral	-	30.62	0.05	0.07	10.10			
AV	222k	30.94	52.75	-21.81	10.22	Neutral	-	20.72	0.05	0.07	10.10			
QP	532.5k	37.65	56.00	-18.35	10.24	Neutral	-	27.41	0.05	0.09	10.10			
AV	532.5k	33.22	46.00	-12.78	10.24	Neutral	"Worst"	22.98	0.05	0.09	10.10			
QP	843k	26.63	56.00	-29.37	10.27	Neutral	-	16.36	0.06	0.11	10.10			
AV	843k	20.21	46.00	-25.79	10.27	Neutral	-	9.94	0.06	0.11	10.10			
QP	1.824M	22.46	56.00	-33.54	10.33	Neutral	-	12.13	0.08	0.15	10.10			
AV	1.824M	15.77	46.00	-30.23	10.33	Neutral	-	5.44	0.08	0.15	10.10			
QP	25.49M	23.22	60.00	-36.78	10.68	Neutral	-	12.54	0.33	0.23	10.12			
AV	25.49M	17.03	50.00	-32.97	10.68	Neutral	-	6.35	0.33	0.23	10.12			

3.2 Occupied Bandwidth

3.2.1 Limit of Occupied Bandwidth

6dBc Bandwidth (see Note 1)	None
99% Occupied Bandwidth (see Note 2)	None
NOTE 1: The 6dBc bandwidth is the frequency bandwidth of the signal power at the -6 dBc points when measured with a 100 kHz resolution bandwidth. These measurements shall also be performed at normal test conditions.	
NOTE 2: The 99% occupied bandwidth is the frequency bandwidth of the signal power at the 99% channel power of occupied bandwidth when resolution bandwidth should be approximately 1 % to 5 % of the occupied bandwidth (OBW). These measurements shall also be performed at normal test conditions.	

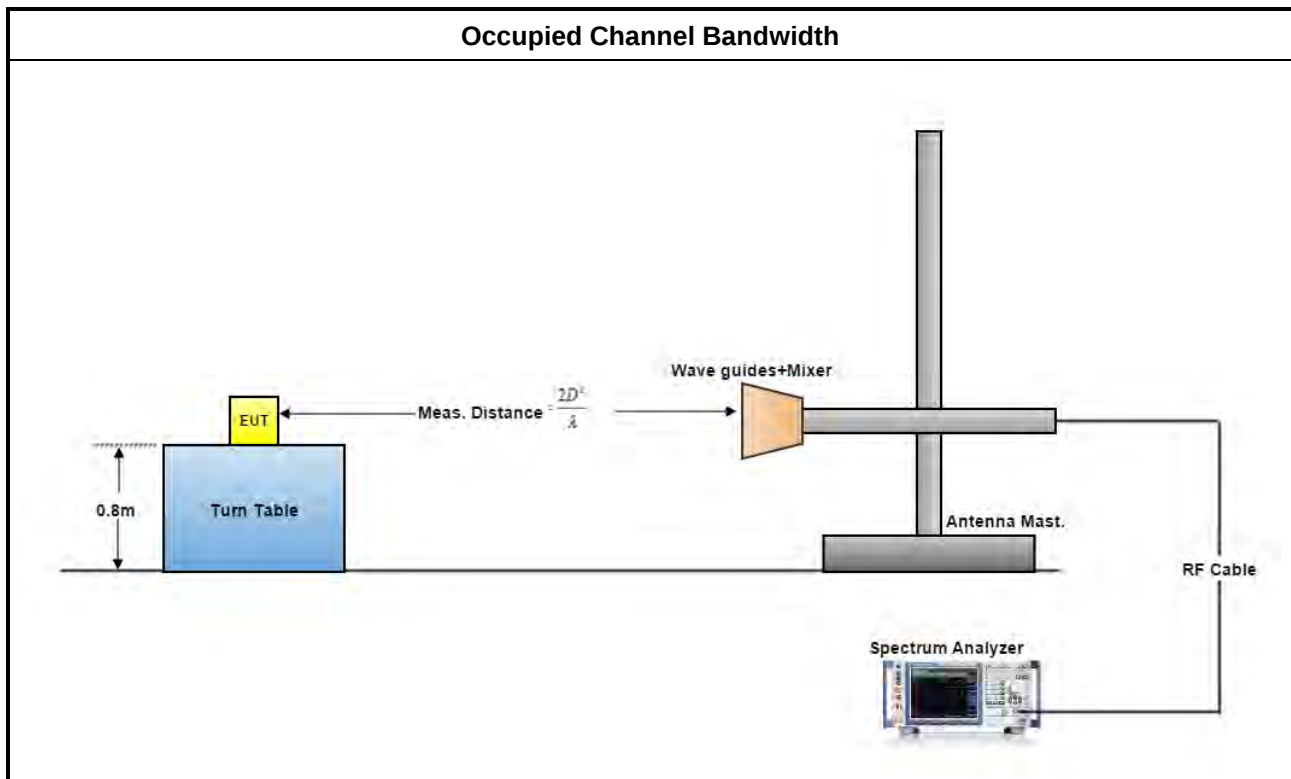
3.2.2 Measuring Instruments

Refer a measuring instruments list in this test report.

3.2.3 Test Procedures

Method of measurement: Refer as ANSI C63.10-2013, clauses 6.9.2.

3.2.4 Test Setup





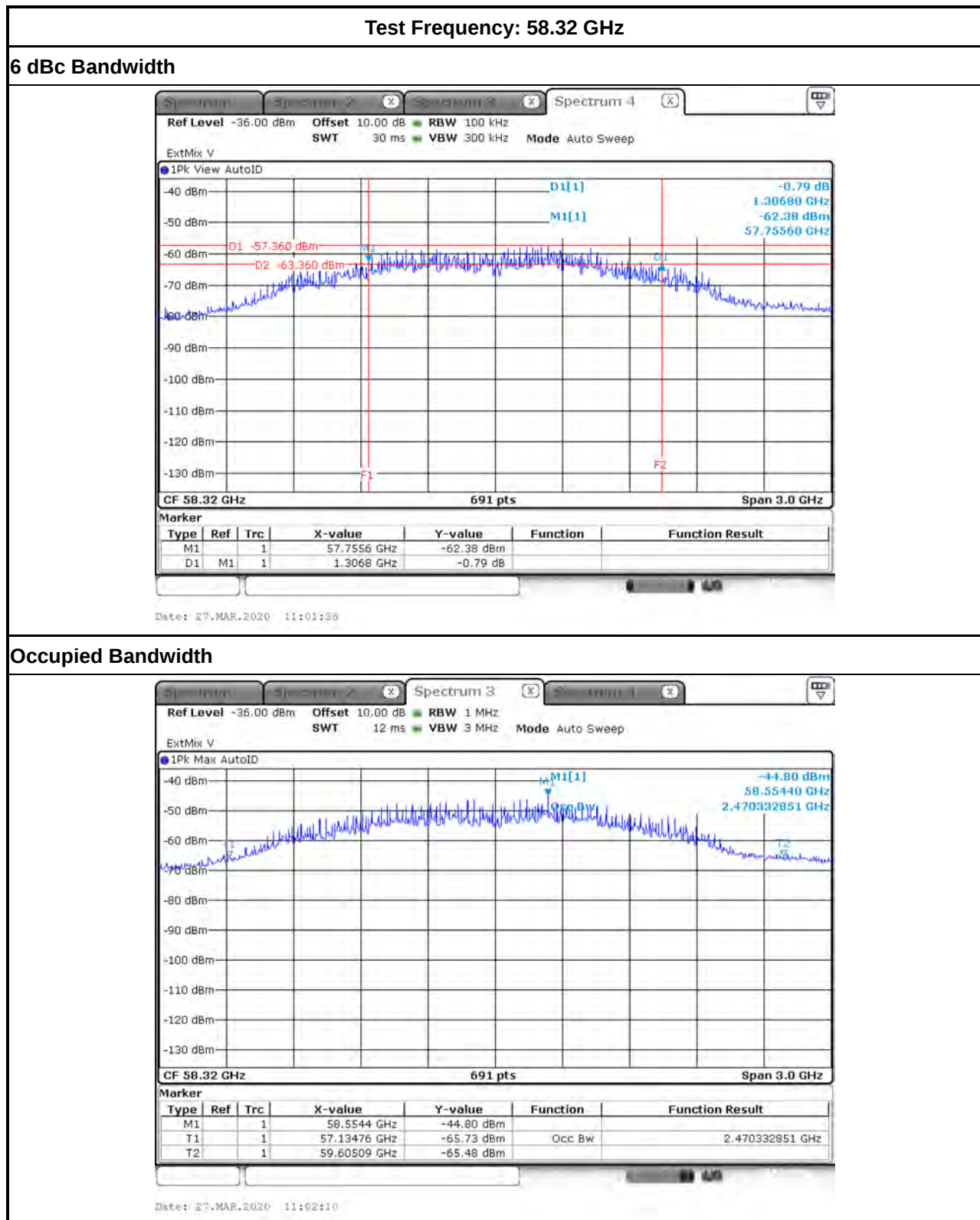
3.2.5 Test Result of Occupied Bandwidth

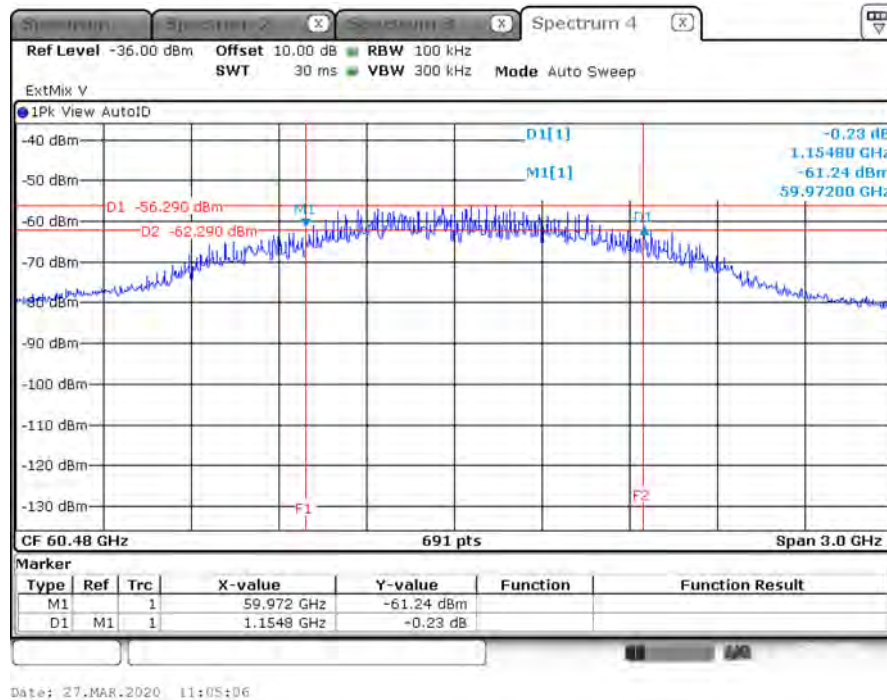
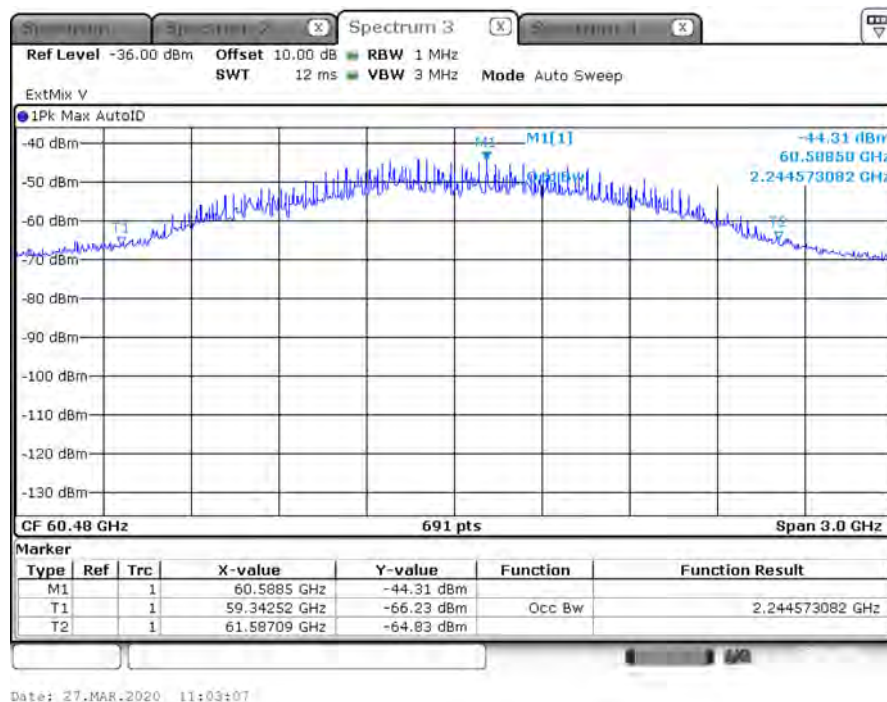
Test Conditions	see ANSI C63.10, clause 5.11
Test Setup	see ANSI C63.10, clause 6.9.2
NOTE: If equipment having different transmit operating modes (see test report clause 1.1.2), the measurements are uninfluenced by different transmit operating modes, may not need to be repeated for all the operating modes. Similar, if the equipment supports different modulations and/or data rates, the measurements described in ANSI C63.10, clause 5.11 may not need to be repeated for all these modulations and data rates. Simple comparison of engineering test across all operating modes, modulations and data rates may need to be performed to define the worse case combination to be used for the conformance testing. Refer as ANSI C63.10, clause 15, observe and record with plotted graphs or photographs the worst-case (i.e., widest) occupied bandwidth produced by these different modulation sources.	

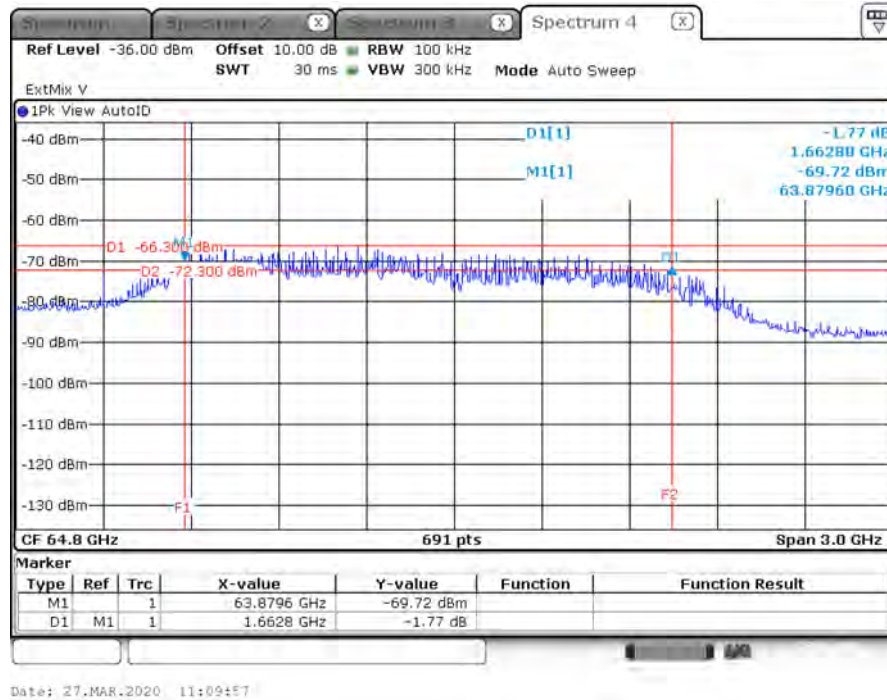
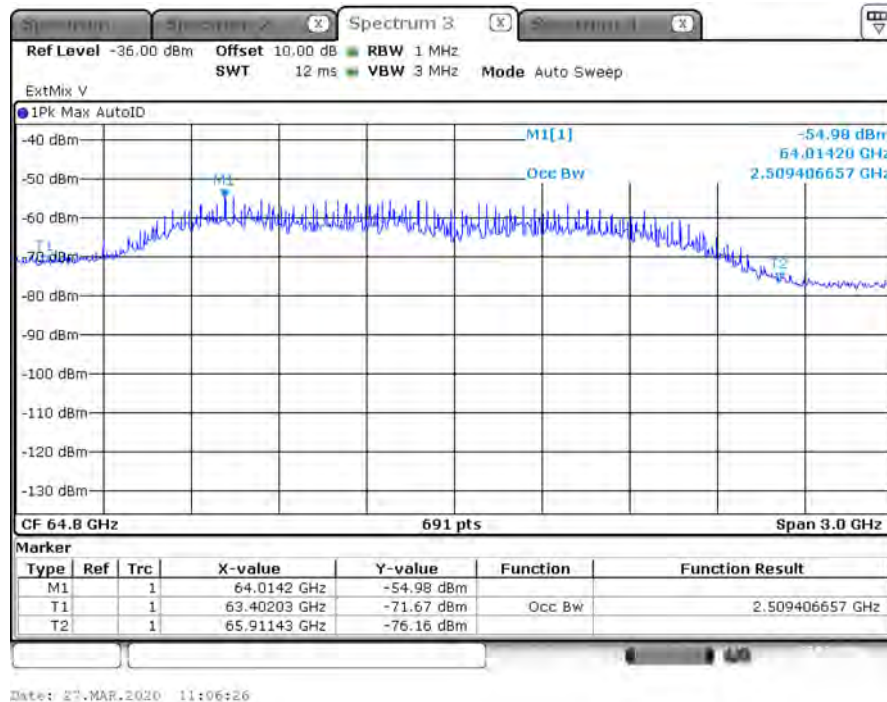
Test Results			
Test Freq. (GHz)	6 dBc Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	Limit (MHz)
58.32	1306.80	2470.33	N/A
60.48	1154.8	2244.57	N/A
64.80	1662.80	2509.41	N/A



3.2.5.1 Bandwidth Plots



**Test Frequency: 60.48 GHz****6 dBc Bandwidth****Occupied Bandwidth**

**Test Frequency: 64.80 GHz****6 dBc Bandwidth****Occupied Bandwidth**



3.3 EIRP Power

3.3.1 Limit of EIRP Power

EIRP Power Limit		
Use Condition	EIRP Average Power	EIRP Peak Power
Fixed field disturbance sensors at within the frequency band 61-61.5GHz	40 dBm	43 dBm
Fixed field disturbance sensors at outside of the band 61-61.5GHz	10 dBm	13 dBm
Except fixed field disturbance sensors at 61-61.5GHz	N/A	10 dBm
Except outdoor fixed Point to Point	40 dBm	43 dBm
Outdoor fixed Point to Point	82 dBm	85 dBm
Note: For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.		

NOTE: For the applicable limit, see FCC 15.255 (c)

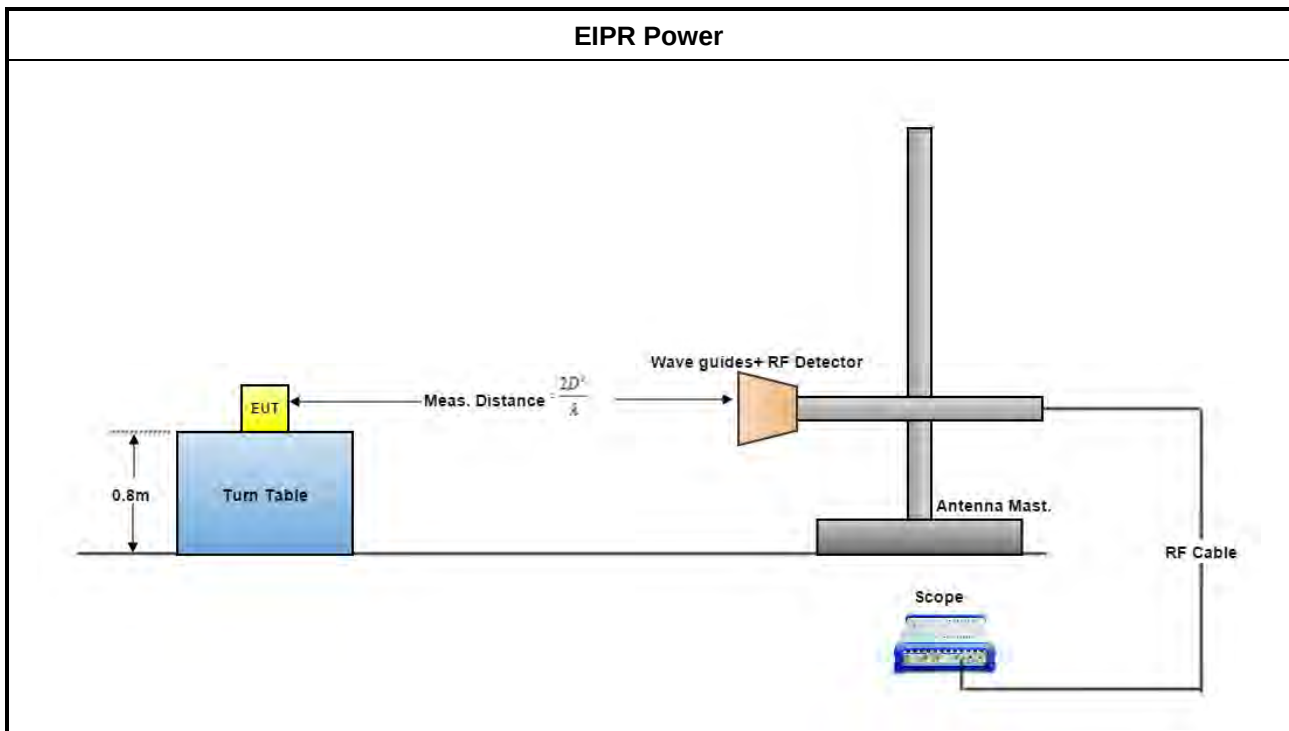
3.3.2 Measuring Instruments

Refer a measuring instruments list in this test report.

3.3.3 Test Procedures

Method of measurement: Refer as ANSI C63.10-2013 clause 9.3 & 9.5.

3.3.4 Test Setup



3.3.5 Test Result of EIRP Power

Test Conditions see ANSI C63.10, clause 5.11 & clause 9

Test Setup see ANSI C63.10, clause 9.11

NOTE: If the equipment supports different modulations and/or data rates, the measurements described in ANSI C63.10, clause 5.11 may not need to be repeated for all these modulations and data rates. Simple comparison of engineering test across all operating modes, modulations and data rates may need to be performed to define the worst case combination to be used for the conformance testing.

**3.3.5.1 Test Result of EIRP Power**

Test Distance				30m							
Test Results											
Test Freq. (GHz)	Rx Gain (dBi)	DSO (mV)		Power Measured (dBm)		E _{Meas} (dBuV/m)		EIRP (dBm)		EIRP Limit (dBm) (note 1)	
		Peak	AV	Peak	AV	Peak	AV	Peak	AV	Peak	AV
58.32	23.6	8.13	4.82	-27.12	-29.88	121.85	119.09	46.60	43.84	67	64
60.48	23.6	8.57	5.39	-26.85	-29.19	122.44	120.10	47.18	44.84	67	64
64.80	23.6	2.06	1.49	-34.76	-37.57	115.13	112.32	39.87	37.06	55	52
The measured power level is converted to EIRP using the Friis equation: For radiated emissions, calculate the field strength (E) in dBμV/meter. E = 126.8 – 20log(λ) + P - G where: E : is the field strength of the emission at the measurement distance, in dBμV/m P : is the power measured at the output of the test antenna, in dBm λ: is the wavelength of the emission under investigation [300/fMHz], in m G : is the gain of the test antenna, in dBi For radiated emissions, calculate the EIRP (dBm). If the measurement was performed in the far field, calculate the EIRP. EIRP = E-meas +20log(d-meas)-104.7 where: EIRP : is the equivalent isotopically 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 NOTE 1: For the applicable limit, see FCC 15.255 (c) NOTE 2: The comparison method which replaces EUT with a signal generator is used to find the correct conversion factor between “DSO(mV)” & “Power Measured(dBm)”.											



3.4 Peak Conducted Power

3.4.1 Limit of Peak Conducted Power

Peak Conducted Power Limit	
6dBc Bandwidth	Peak Conducted Power (note 1)
> 100MHz	500mW
≤ 100MHz	500mW x (BW/100) (see note 2)
NOTE 1: For the applicable limit, see FCC 15.255(c)	
NOTE 2: BW= 6dB bandwidth (measured at RBW 100kHz)	

3.4.2 Measuring Instruments

Refer a measuring instruments list in this test report.

3.4.3 Test Procedures

Method of measurement: Refer as ANSI C63.10-2013, clause 9.5

3.4.4 Test Result of Peak Conducted Power

Test Conditions	see ANSI C63.10, clause 5.11 & clause 9
Test Setup	see ANSI C63.10, clause 9.11
NOTE: If the equipment supports different modulations and/or data rates, the measurements described in ANSI C63.10, clause 5.11 may not need to be repeated for all these modulations and data rates. Simple comparison of engineering test across all operating modes, modulations and data rates may need to be performed to define the worst case combination to be used for the conformance testing.	

**3.4.4.1 Peak Conducted Power**

Test Results						
Test Freq. (GHz)	EIRP (dBm)	Max. Ant. Gain (dBi)	Peak Power (dBm) (note1)	Peak Power (mW)	6dBc BW (MHz) (note2)	Peak Power Limit (mW) (note3)
58.32	46.60	42	4.60	2.882	1306.80	500.00
60.48	47.18	42	5.18	3.298	1154.80	500.00
64.80	39.87	36	3.87	2.439	1662.80	500.00

NOTE 1: Because EUT used for the integral antenna without temporary RF connector provided. Therefore peak conducted power is equal to EIRP power subtract the antenna gain.

NOTE 2: For the 6dBc bandwidth, see test report clause 3.2.5.

NOTE 3: For the applicable limit, see FCC 15.255(c)

NOTE 4: For radiated emission measurements, calculate conducted transmitter output power P(cond)(dBm)

$P(\text{cond}) = \text{EIRP} - G(\text{dBi})$

where:

G(dBi) is gain of EUT antenna.



3.5 Transmitter Spurious Emissions

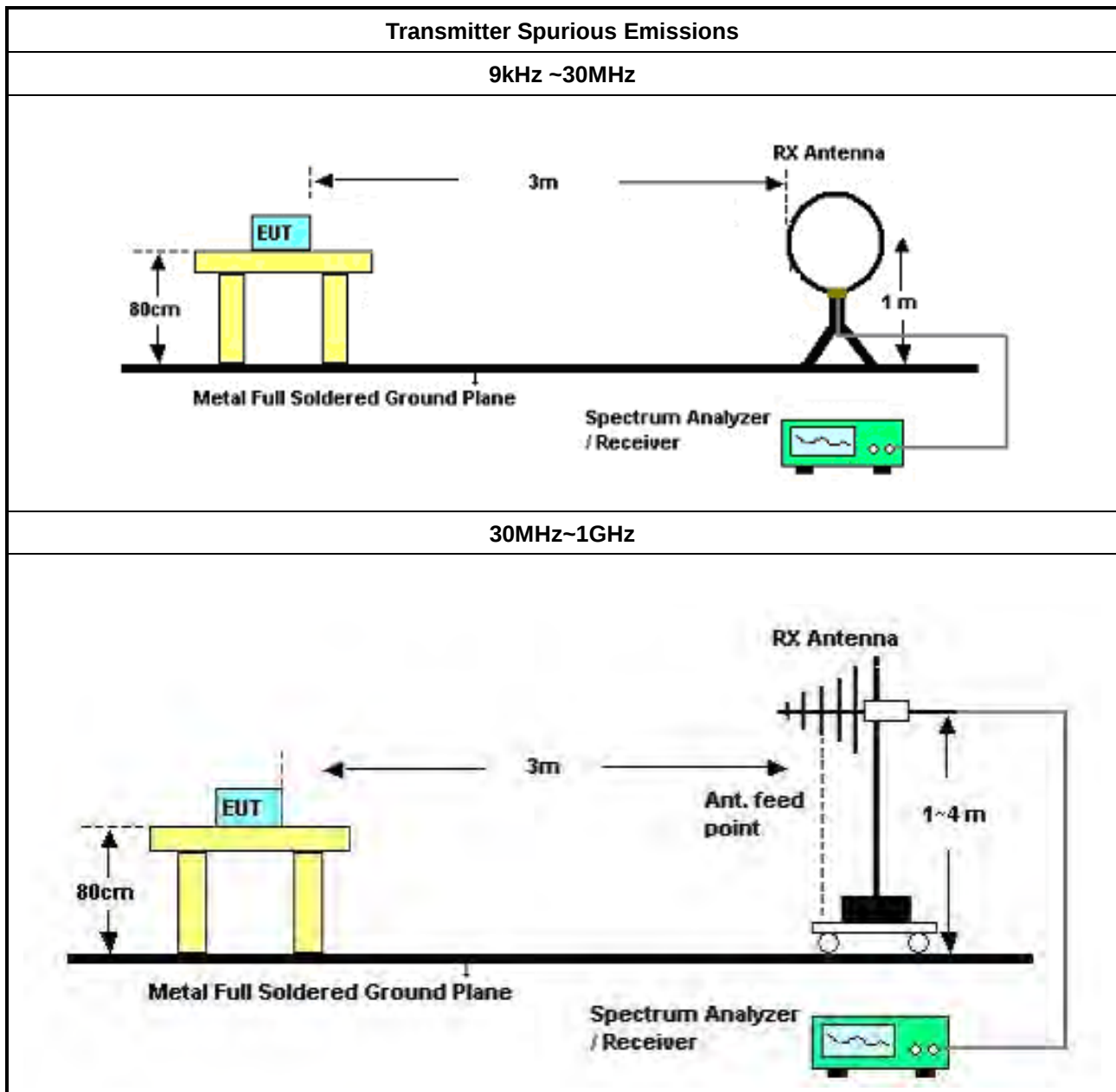
3.5.1 Limit of Transmitter Spurious Emissions

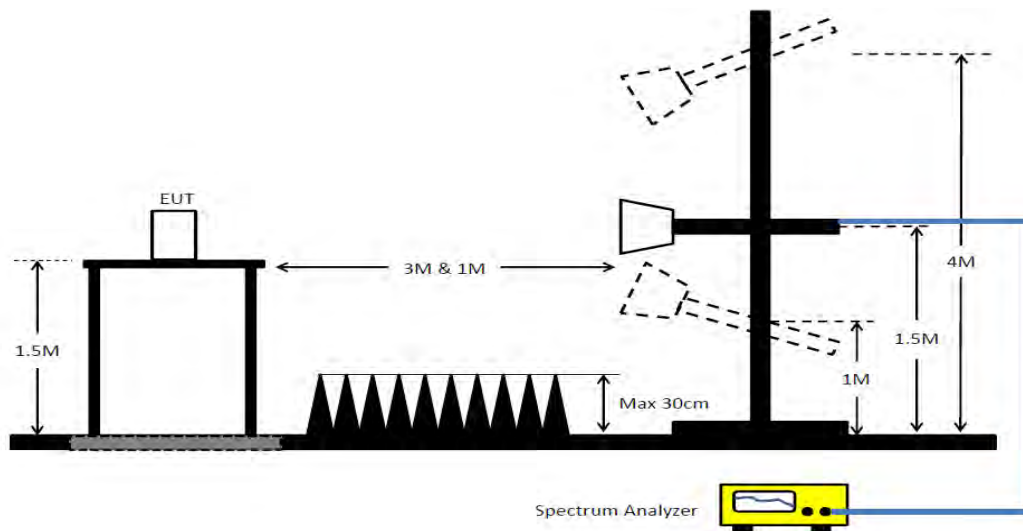
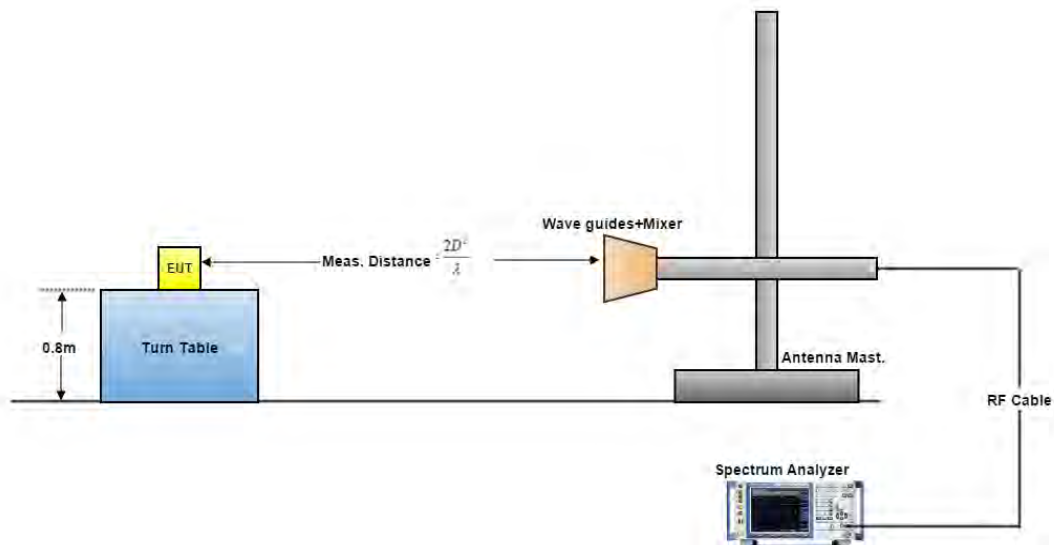
Frequency Range	Limit
Radiated emissions below 40 GHz	FCC 15.209
Radiated emissions above 40 GHz – 200GHz	90 pW/cm ² @ 3 m (Equivalent EIRP 102 µW, -9.91dBm)
NOTE 1: For the applicable limit, see FCC 15.255(d)	
NOTE 2: Spurious emissions shall not exceed the level of the fundamental emission.	

3.5.2 Test Procedures

Method of measurement: Refer as ANSI C63.10-2013, clause 9.12

3.5.3 Test Setup



1GHz~40GHz

Above 40GHz


A measuring distance of at 3 m shall be used for measurements at frequencies up to 15 GHz. For frequencies above 15 GHz, any suitable measuring distance may be used. The measurement distance is chosen up to far field distance, depending on the test system noise floor for detecting spurious emission signals. Then above 15 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade from spec. distance (3 m) to measurement distance. Distance extrapolation factor = $20 \log (\text{spec. distance [3 m]} / \text{measurement distance [N m]})$ (dB). The measurements described in ANSI C63.10, clause 7.8.6. If the emission cannot be detected at 1 m, reduce the RBW to increase system sensitivity. Note the value. If the emission still cannot be detected, move the horn closer to the EUT, noting the distance at which a measurement is made.



3.5.4 Test Result of Transmitter Spurious Emissions

Test Conditions	see ANSI C63.10, clause 5.11 & clause 9
Test Setup	see ANSI C63.10, clause 9.12 ~ 9.13
NOTE: If equipment having different channel plan and nominal channel bandwidth modes (see test report clause 1.1.1), the measurements are uninfluenced by different channel plan and nominal channel bandwidth modes, may not need to be repeated for all modes.	

3.5.5 Measurement Results Calculation

The measured Level is calculated using:

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor (if applicable) = Level.

3.5.5.1 Test Result of Transmitter Spurious Emissions (Below 30MHz)

There is a comparison data of both open-field test site and alternative test site - semi-Anechoic chamber according to KDB414788 Radiated Test Site, and the result came out very similar.

All amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

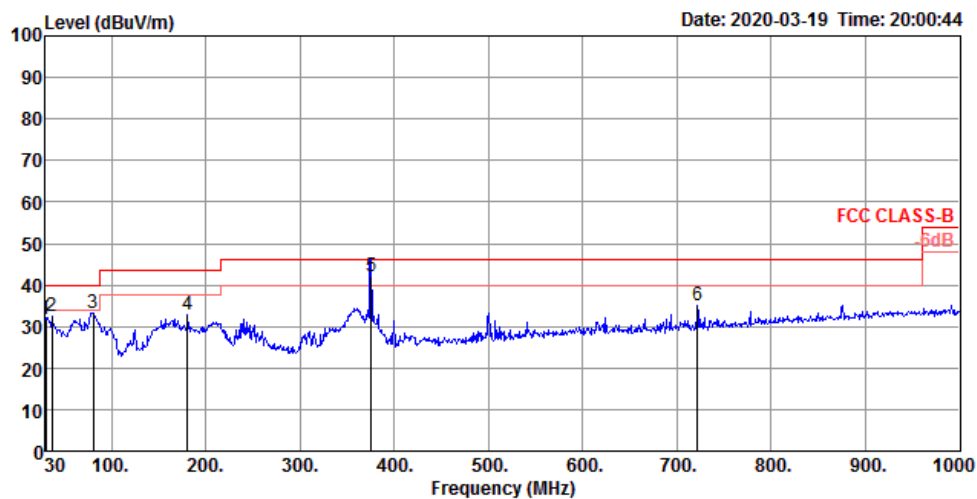
The radiated emissions were investigated from 9 kHz or the lowest frequency generated within the device, up to the 10 harmonic or 40 GHz, whichever is appropriate.



3.5.5.2 Test Result of Transmitter Spurious Emissions

Test Range	30 MHz – 1000 MHz	Test Distance	3 m
Test Configuration	CTX		

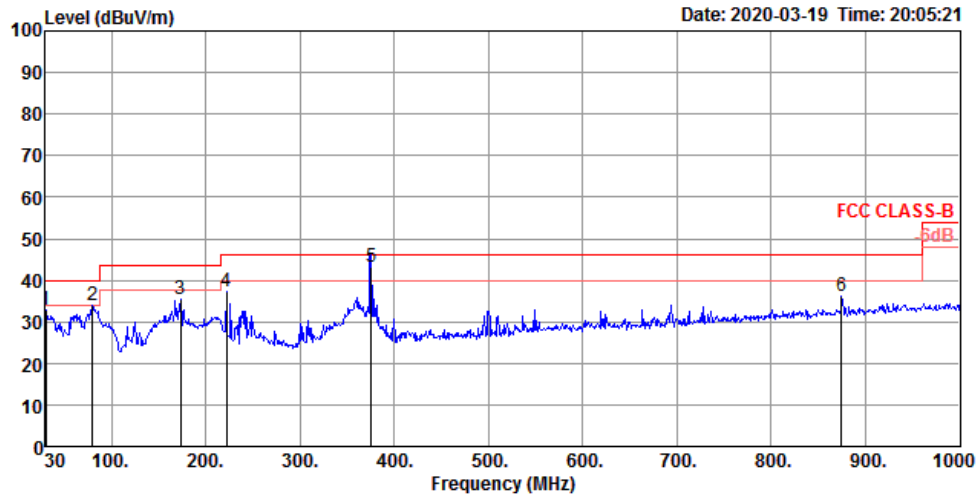
Vertical



	Freq	Level	Limit	Over	Read	Cable	Antenna	Preamp	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	30.00	31.73	40.00	-8.27	36.94	0.67	25.70	31.58	100	215	Peak	VERTICAL
2	36.79	32.41	40.00	-7.59	41.43	0.78	21.69	31.49	100	63	Peak	VERTICAL
3	80.44	33.36	40.00	-6.64	50.71	1.15	13.36	31.86	150	242	Peak	VERTICAL
4	180.35	32.96	43.50	-10.54	47.73	1.72	15.50	31.99	300	194	Peak	VERTICAL
5	375.32	42.07	46.00	-3.93	49.85	2.51	21.88	32.17	261	172	QP	VERTICAL
6	721.61	34.99	46.00	-11.01	38.00	3.54	25.87	32.42	300	239	Peak	VERTICAL



Horizontal



	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase	
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	30.00	32.87	40.00	-7.13	38.08	0.67	25.70	31.58	100	350	Peak	HORIZONTAL
2	79.47	34.10	40.00	-5.90	51.55	1.15	13.26	31.86	150	222	Peak	HORIZONTAL
3	173.56	35.24	43.50	-8.26	49.69	1.68	15.81	31.94	300	19	Peak	HORIZONTAL
4	222.06	37.26	46.00	-8.74	50.81	1.87	16.56	31.98	300	49	Peak	HORIZONTAL
5	375.32	42.99	46.00	-3.01	50.77	2.51	21.88	32.17	104	112	QP	HORIZONTAL
6	874.87	36.32	46.00	-9.68	37.30	3.92	27.50	32.40	100	166	Peak	HORIZONTAL

Note: Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.



Test Range	1 GHz – 18 GHz	Test Distance	3 m
Test Freq. (GHz)	58.32		

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	7289.48	50.98	74.00	-23.02	42.37	7.36	36.52	35.27	154	347	Peak	VERTICAL
2	7290.04	38.54	54.00	-15.46	29.93	7.36	36.52	35.27	154	347	Average	VERTICAL

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	7289.95	45.75	54.00	-8.25	37.14	7.36	36.52	35.27	164	356	Average	HORIZONTAL
2	7289.99	53.37	74.00	-20.63	44.76	7.36	36.52	35.27	164	356	Peak	HORIZONTAL

Note: Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.



Test Range	1 GHz – 18 GHz	Test Distance	3 m
Test Freq. (GHz)	60.48		

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg	
1	7560.18	38.07	54.00	-15.93	29.38	7.26	36.54	35.11	158	57 Average	VERTICAL
2	7562.43	51.39	74.00	-22.61	42.70	7.26	36.54	35.11	158	57 Peak	VERTICAL

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg	
1	7559.95	39.91	54.00	-14.09	31.22	7.26	36.54	35.11	170	358 Average	HORIZONTAL
2	7560.98	53.96	74.00	-20.04	45.27	7.26	36.54	35.11	170	358 Peak	HORIZONTAL

Note: Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.



Test Range	1 GHz – 18 GHz	Test Distance	3 m
Test Freq. (GHz)	64.80		

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg	
1	8099.59	51.82	74.00	-22.18	42.28	7.56	37.20	35.22	178	15 Peak	VERTICAL
2	8099.97	39.88	54.00	-14.12	30.34	7.56	37.20	35.22	178	15 Average	VERTICAL

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg	
1	8099.88	54.34	74.00	-19.66	44.80	7.56	37.20	35.22	166	354 Peak	HORIZONTAL
2	8099.98	46.74	54.00	-7.26	37.20	7.56	37.20	35.22	166	354 Average	HORIZONTAL

Note: Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.



Test Range	18 GHz – 40 GHz	Test Distance	1 m
Test Freq. (GHz)	58.32		

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	36830.54	70.61	83.54	-12.93	59.73	20.00	41.58	50.70	148	348	Peak	VERTICAL
2	36834.00	56.10	63.54	-7.44	45.22	20.00	41.58	50.70	148	348	Average	VERTICAL

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	36829.10	55.99	63.54	-7.55	45.11	20.00	41.58	50.70	151	19	Average	HORIZONTAL
2	36832.44	70.16	83.54	-13.38	59.28	20.00	41.58	50.70	151	19	Peak	HORIZONTAL

Note: Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.



Test Range	18 GHz – 40 GHz	Test Distance	1 m
Test Freq. (GHz)	60.48		

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg	
1	37096.11	70.31	83.54	-13.23	58.91	20.00	41.98	50.58	152	5 Peak	VERTICAL
2	37097.37	56.68	63.54	-6.86	45.28	20.00	41.98	50.58	152	5 Average	VERTICAL

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	CableAntenna Loss Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg	
1	37095.80	69.96	83.54	-13.58	58.56	20.00	41.98	50.58	149	355 Peak	HORIZONTAL
2	37097.07	56.51	63.54	-7.03	45.11	20.00	41.98	50.58	149	355 Average	HORIZONTAL

Note: Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.



Test Range	18 GHz – 40 GHz	Test Distance	1 m
Test Freq. (GHz)	64.80		

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	37092.77	70.13	83.54	-13.41	58.73	20.00	41.98	50.58	148	11	Peak	VERTICAL
2	37097.07	56.30	63.54	-7.24	44.90	20.00	41.98	50.58	148	11	Average	VERTICAL

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	cm	deg		
1	37097.49	56.19	63.54	-7.35	44.79	20.00	41.98	50.58	147	354	Average	HORIZONTAL
2	37098.67	69.49	83.54	-14.05	58.09	20.00	41.98	50.58	147	354	Peak	HORIZONTAL

Note: Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.



Test Range	40GHz – 200GHz
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Test Frequency (GHz)	Rx Antenna Gain (dBi)	Measurement Distance (m)	Read Worse Frequency (GHz)	Read Level (dBm)
58.32	23.6	30.00	56.79	-85.63
EIRP (dBm)	Specification Distance (m)	Power Density (pW/cm²)	Limit (pW/cm²)	Test Result
-12.16	3	53.7702	90.00	PASS

Test Frequency (GHz)	Rx Antenna Gain (dBi)	Measurement Distance (m)	Read Worse Frequency (GHz)	Read Level (dBm)
60.48	23.6	30.00	56.63	-90.69
EIRP (dBm)	Specification Distance (m)	Power Density (pW/cm²)	Limit (pW/cm²)	Test Result
-17.24	3	16.6748	90.00	PASS

Test Frequency (GHz)	Rx Antenna Gain (dBi)	Measurement Distance (m)	Read Worse Frequency (GHz)	Read Level (dBm)
64.80	23.6	30.00	56.70	-96.47
EIRP (dBm)	Specification Distance (m)	Power Density (pW/cm²)	Limit (pW/cm²)	Test Result
-23.01	3	4.4172	90.00	PASS

Note:

$EIRP = P_{rx} - G_{rx} + \text{Free Space Path Loss} = P_{rx} - G_{rx} + 20\log(4\pi d / \lambda)^2$

Which

$P_{rx} = \text{Read Level.}$

$G_{rx} = \text{Rx Antenna Gain.}$

A distance factor is offset and the formula is $20\log(D1/D2)$

Which

$D1 = \text{Specification Distance}$

$D2 = \text{Measurement Distance}$

3.6 Frequency Stability

3.6.1 Limit of Frequency Stability

Frequency Stability	Limit
Refer as FCC 15.255(f) and ANSI C63.10-2013, clause 9.14	within the frequency bands
Note: These measurements shall also be performed at normal and extreme test conditions.	

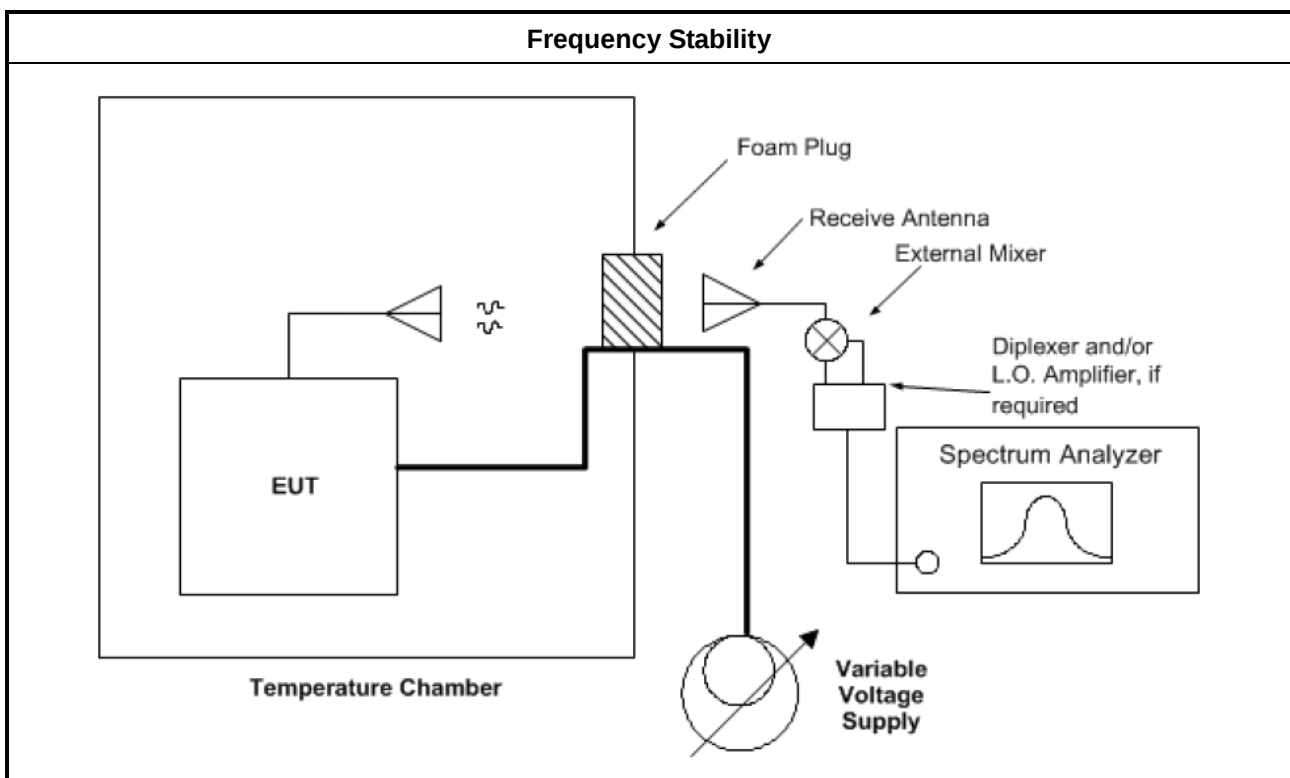
3.6.2 Measuring Instruments

Refer a measuring instruments list in this test report.

3.6.3 Test Procedures

Method of measurement: Refer as ANSI C63.10-2013, clauses 9.14.

3.6.4 Test Setup





3.6.5 Test Result of Frequency Stability

Test Conditions	see ANSI C63.10, clause 5.11 & clause 9
Test Setup	see ANSI C63.10, clause 9.14
NOTE: If equipment having different channel plan and nominal channel bandwidth modes (see test report clause 1.1.1), the measurements are uninfluenced by different channel plan and nominal channel bandwidth modes, may not need to be repeated for all modes.	

3.6.5.1 Frequency Stability with Respect to Ambient Temperature

Frequency Stability with Respect to Ambient Temperature			
Test Results			
Test Temp.erature (°C)	Measured Frequency (MHz)	Delta Frequency (kHz)	Limit (±kHz)
-40	60480.60	-470	Within band
-30	60480.68	-390	Within band
-20	60480.72	-350	Within band
-10	60480.88	-190	Within band
0	60480.92	-150	Within band
10	60480.92	-150	Within band
20	60481.07	Reference	Within band
30	60481.07	0	Within band
40	60480.92	-150	Within band
50	60480.92	-150	Within band
60	60480.88	-190	Within band
70	60480.80	-270	Within band
NOTE: The manufacturer's specified temperature range of -40 to 70°C.			

**3.6.5.2 Frequency Stability When Varying Supply Voltage**

Frequency Stability When Varying Supply Voltage			
Test Results			
Test Voltage: (Vdc)	Measured Frequency (MHz)	Delta Frequency (kHz)	Limit (±kHz)
20.4	60481.03	-40	Within band
24	60481.07	Reference	Within band
27.6	60480.92	-150	Within band
NOTE: For the applicable limit, see FCC 15.255(f).			



3.7 Operation Restriction and Group Installation

3.7.1 Limit of Operation Restriction and Group Installation

Item	Limit
Operation Restriction	Operation is not permitted for the following products: ♦ Equipment used on aircraft or satellites. (Refer as FCC 15.255 (a)) ♦ Field disturbance sensors, including vehicle radar systems, unless the field disturbance sensors are employed for fixed operation. (Refer as FCC 15.255 (a))
Group Installation	Operation is not permitted for the following products: ♦ External phase-locking (Refer as FCC 15.255 (h))

3.7.2 Result of Operation Restriction

Manufacturer declares that EUT will not be used on aircraft or satellites. Then user manual will include a statement to caution EUT is not permitted for use on aircraft or satellites. EUT is a wireless video area network (WVAN) for the connection of consumer electronic (CE) audio and video devices.

3.7.3 Result of Group Installation

The frequency, amplitude and phase of the transmit signal are set within the EUT. There are no external phase-locking inputs or any other means of combining two or more units together to realize a beam-forming array.

4 Test Equipment and Calibration Data

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date	Remark
LISN	Schwarzbeck	NSLK 8127	8127650	9kHz ~ 30MHz	Nov. 21, 2019	Nov. 20, 2020	Conduction (CO02-CB)
LISN	Schwarzbeck	NSLK 8127	8127478	9kHz ~ 30MHz	Oct. 30, 2019	Oct. 29, 2020	Conduction (CO02-CB)
EMI Receiver	Agilent	N9038A	My52260123	9kHz ~ 8.45GHz	Feb. 26, 2020	Feb. 25, 2021	Conduction (CO02-CB)
Pulse Limiter	Schwarzbeck	VTSD 9561F-N	00378	9kHz ~ 30MHz	Mar. 20, 2019	Mar. 19, 2020	Conduction (CO02-CB)
COND Cable	Woken	Cable	2	0.15MHz ~ 30MHz	Oct. 21, 2019	Oct. 20, 2020	Conduction (CO02-CB)
Software	Audix	E3	6.120210n	-	N.C.R.	N.C.R.	Conduction (CO02-CB)
Bilog Antenna with 6dB Attenuator	TESE & EMCI	CBL 6112D & N-6-06	35236 & AT-N0610	30MHz ~ 2GHz	Mar. 28, 2019	Mar. 27, 2020	Radiation (03CH05-CB)
Loop Antenna	Teseq	HLA 6120	24155	9kHz - 30 MHz	Mar. 29, 2019	Mar. 28, 2020	Radiation (03CH05-CB)
Horn Antenna	SCHWARZBECK	BBHA9120D	BBHA 9120D-1291	1GHz~18GHz	Oct. 05, 2019	Oct. 04, 2020	Radiation (03CH05-CB)
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170507	15GHz ~ 40GHz	Jun. 12, 2019	Jun. 11, 2020	Radiation (03CH05-CB)
Pre-Amplifier	EMCI	EMC330N	980331	20MHz ~ 3GHz	May 01, 2019	Apr. 30, 2020	Radiation (03CH05-CB)
Pre-Amplifier	EMCI	EMC12630SE	980287	1GHz ~ 26.5GHz	Apr. 16, 2019	Apr. 15, 2020	Radiation (03CH05-CB)
Pre-Amplifier	MITEQ	TTA1840-35-HG	1864479	18GHz ~ 40GHz	Jul. 03, 2019	Jul. 02, 2020	Radiation (03CH05-CB)
Spectrum Analyzer	R&S	FSP40	100304	9kHz ~ 40GHz	Aug. 15, 2019	Aug. 14, 2020	Radiation (03CH05-CB)
EMI Test Receiver	R&S	ESCS	826547/017	9kHz ~ 2.75GHz	May 15, 2019	May 14, 2020	Radiation (03CH05-CB)
RF Cable-low	Woken	RG402	LOW Cable-04+23	30MHz~1GHz	Oct. 07, 2019	Oct. 06, 2020	Radiation (03CH05-CB)
RF Cable-high	Woken	RG402	High Cable-28	1GHz~18GHz	Oct. 07, 2019	Oct. 06, 2020	Radiation (03CH05-CB)
RF Cable-high	Woken	RG402	High Cable-04+28	1GHz~18GHz	Oct. 07, 2019	Oct. 06, 2020	Radiation (03CH05-CB)
RF Cable-high	Woken	RG402	High Cable-40G#1	18GHz ~ 40 GHz	Jul. 24, 2019	Jul. 23, 2020	Radiation (03CH05-CB)
RF Cable-high	Woken	RG402	High Cable-40G#2	18GHz ~ 40 GHz	Jul. 24, 2019	Jul. 23, 2020	Radiation (03CH05-CB)
Mixer	OML	M19HWA	U91113-1	40 ~ 60 GHz	Oct. 01 2019	Sep. 30, 2020	Radiation (03CH05-CB)
Mixer	OML	M15HWA	V91113-1	50 ~ 75 GHz	Oct. 25 2019	Oct. 24, 2020	Radiation (03CH05-CB)



Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date	Remark
Mixer	OML	M12HWA	E91113-1	60 ~ 90 GHz	Oct. 25 2019	Oct. 24, 2020	Radiation (03CH05-CB)
Mixer	OML	M08HWA	F91113-1	90 ~ 140 GHz	Oct. 25 2019	Oct. 24, 2020	Radiation (03CH05-CB)
Mixer	OML	M05HW/A	G91113-1	140 ~ 220 GHz	Oct. 25 2019	Oct. 24, 2020	Radiation (03CH05-CB)
Detector	Millitech	DET-15-RPF W0	#A17807(067)	50 ~ 75 GHz	Dec. 12, 2019	Dec. 11, 2020	Radiation (03CH05-CB)
Pico Scope	Pico	Pico Scope 6402C	CX372/002	N/A	Jul. 07, 2019	Jul. 06, 2020	Radiation (03CH05-CB)
Standard Horn Antenna	Custom Microwave	M19RH	U91113-A	40 ~ 60 GHz	N.C.R	N.C.R	Radiation (03CH05-CB)
Standard Horn Antenna	Custom Microwave	M15RH	V91113-A	50 ~ 75 GHz	N.C.R	N.C.R	Radiation (03CH05-CB)
Standard Horn Antenna	Custom Microwave	M12RH	E91113-A	60 ~ 90 GHz	N.C.R	N.C.R	Radiation (03CH05-CB)
Standard Horn Antenna	Custom Microwave	M08RH	F91113-A	90 ~ 140 GHz	N.C.R	N.C.R	Radiation (03CH05-CB)
Standard Horn Antenna	Custom Microwave	M05RH	G91113-A	140 ~ 220 GHz	N.C.R	N.C.R	Radiation (03CH05-CB)
Temp. and Humidity Chamber	Gaint Force	GTH-408-40-CP-AR	MAA1410-011	-40~100 degree	Sep. 12, 2019	Sep. 11, 2020	Conducted (TH03-CB)

Note: Calibration Interval of instruments listed above is one year.

N.C.R. means Non-Calibration required.

5 Measurement Uncertainty

Test Items	Uncertainty	Remark
Conducted Emission (150kHz ~ 30MHz)	2.0 dB	Confidence levels of 95%
Radiated Emission (30MHz ~ 1,000MHz)	4.3 dB	Confidence levels of 95%
Radiated Emission (1GHz ~ 18GHz)	4.3 dB	Confidence levels of 95%
Radiated Emission (18GHz ~ 40GHz)	5.1 dB	Confidence levels of 95%
Radiated Emission (40GHz ~ 60GHz)	4.6 dB	Confidence levels of 95%
Radiated Emission (60GHz ~ 90GHz)	5.1 dB	Confidence levels of 95%
Radiated Emission (90GHz ~ 200GHz)	5.6 dB	Confidence levels of 95%
Temperature	1°C	Confidence levels of 95%