FCC Test Report

Report No.:	FCC_RF_SL18062902-FCB-011 Rev 1.0
FCC ID:	2AK7S-FBC2001
Product:	60GHz backhaul transmitter
Model:	FBC-2001
Received Date:	01/06/2020
Test Date:	01/06/2020 to 01/07/2020
Issued Date:	02/21/2020
Applicant:	FCL Tech, Inc
Address:	1601 Willow Road, Menlo Park, CA94025
Manufacturer:	FCL Tech, Inc.
Address:	1601 Willow Road, Menlo Park, CA94025
Issued By:	Bureau Veritas Consumer Products Services, Inc.
Test Lab Address:	775 Montague Expressway, Milpitas, CA 95035, USA
Test Location:	775 Montague Expressway, Milpitas, CA 95035, USA
FCC/ IC Test Site Number:	540430/4842D

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Release Control Record

Issue No.	Description	Date Issued
FCC_RF_SL18062902-FCB-011	Original	02/12/2020
FCC_RF_SL18062902-FCB-011 Rev 1.0	Updated per reviewer	02/21/2020

1 Certificate of Conformity

Product:	60GHz backhaul transmitter
Brand:	FCL Tech, Inc
Model:	FBC-2001
Series Model:	N/A
Sample Status:	Engineering Sample
Applicant:	FCL Tech, Inc
Test Date:	01/06/2020 – 01/07/2020
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.255) ANSI C63.10: 2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services, Inc. Milpitas Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : Gary Chou , **Date:** 02/12/2020

Gary Chou Test Engineer

Approved by : , **Date:** 02/12/2020

Chen Ge Engineering Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.255)			
FCC Clause	Test Item	Result	Remarks
15.207	AC Power Conducted Emission	PASS	Meet the requirement of limit.
15.255(e)	6dB Bandwidth	-	Reference only.
15.255 (c) & (e)	Output Power	PASS	Meet the requirement of limit.
15.255(d)	Spurious Emissions	PASS	Meet the requirement of limit.
15.255(f)	Frequency Stability	PASS	Meet the requirement of limit.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT:

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.51dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	3.73dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	4.64dB
	6GHz ~ 18GHz	4.82dB
	18GHz ~ 40GHz	4.91dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	60GHz backhaul transmitter
Brand	FCL Tech, Inc
Test Model	FBC-2001
Status of EUT	Engineering sample
Power Supply Rating	PoE 120V 60Hz Through RJ-45 Ethernet to EUT, and AC/DC Transformer 2.1A 120V 60Hz = +48V 3.9A
Modulation Type	16QAM, QPSK, BPSK
Modulation Technology	OFDM
Operating Frequency	58.32GHz ~ 64.80GHz
Output Power	43 dBm E.I.R.P
Antenna Type	Integrated(4 antenna)
Antenna Gain	28 dBi
Antenna Connector	NA
Accessory Device	NA
Data Cable Supplied	NA

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

LRP MODE							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	58.32GHz	2	60.48GHz	3	62.64GHz	4	64.80GHz

The power setting of EUT is 22 for all channels.
All data rate MCS1-MCS12 are verified, only worst case data (MCS9) is presented.

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO						DESCRIPTION
	PLC	BW	OP	FS	RE < 1G	RE ≥ 1G	
L	√	√	√	√	√	√	LRP Mode

Where **PLC:** Power Line Conducted Emission **BW:** 6dB Bandwidth
OP: Output Power **FS:** Frequency Stability
RE < 1G: Radiated Emission below 1GHz **RE ≥ 1G:** Radiated Emission above 1GHz

NOTE: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **X-plane**.

Power Line Conducted Emission Test:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE
L	4	1	OFDM	BPSK

6dB Bandwidth Test:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE
L	4	1, 2, 3, 4	OFDM	BPSK

Frequency stability test:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE
L	4	1	OFDM	QPSK

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE
L	4	1	OFDM	BPSK

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE
L	4	1, 2, 3, 4	OFDM	BPSK

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 65%RH	120Vac, 60Hz	Gary Chou
RE<1G	25deg. C, 65%RH	120Vac, 60Hz	Gary Chou
PLC	25deg. C, 68%RH	120Vac, 60Hz	Gary Chou
APCM	21deg. C, 60%RH	120Vac, 60Hz	Gary Chou

3.3 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	SwtichingPoE	Ubiquiti	GP-1540-150G	N/A	N/A	Not sold with EUT
B.	AC/DC Transformer	Mean Well	HEP-185-48A	RB5A058794	N/A	Not sold with EUT

ID	Description	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	Gigabit Ethernet port	4	<1	No	None	All Cables Loopbacked
2.	SFP+ port Fiber Optic	1	N/A	No	None	Loopbacked

3.4 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.255)
ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission Measurement

4.1.1 Limits of Radiated Emission Measurement

Spurious Emission	
Frequency Range	Average
Radiated emissions below 40GHz	Part 15.209
Between 40GHz and 200GHz	90pW/cm^2 (at 3 meter)
Note: The levels of the spurious emissions shall not exceed the level of the fundamental emission	

Emissions radiated outside of the specified bands, shall be according to the general radiated limits in 15.209 as following:

Frequencies (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.
4. Section 15.205 restricted bands of operation shall compliance with the limits in Section 15.209.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	08/28/2019	08/28/2020
Spectrum Analyzer KEYSIGHT	N9030B	MY57140374	07/22/2019	07/22/2020
Hybrid Antenna SUNAR	JB6	A111717	03/09/2019	03/09/2020
Horn Antenna ETS-Lindgren	3117	218554	11/06/2019	11/06/2020
Preamplifier RF-LAMBDA	RAMP00M50GA	17032300047	09/19/2019	09/19/2020
HORN ANTENNA (18-40GHZ) KEYSIGHT	SAS-574	579	07/27/2018	07/27/2020
HORN ANTENNA (40-60GHZ) OML,INC.	M19RH	1708-1101	08/11/2019	08/11/2020
40GHZ TO 60GHZ HARMONIC MIXER/ OML,INC.	M19HWA	170811-1	08/11/2019	08/11/2020
HORN ANTENNA (60-90GHZ) OML,INC.	M12RH	1708-1101	08/11/2019	08/11/2020
WAVEGUIDE HARMONIC MIXER(60GHZ-90GHZ)/ KEYSIGHT	M1970E	MY52230298	08/11/2019	08/11/2020
HORN ANTENNA (90-140GHZ) OML,INC.	M08RH	17081101	08/11/2019	08/11/2020
90GHZ TO 140GHZ HARMONIC MIXER OML,INC.	M08HWA	170811-1	08/11/2019	08/11/2020
HORN ANTENNA (140-220GHZ) OML,INC.	M05RH	17081101	08/ 11/2019	08/11/2020
140GHZ TO 220GHZ HARMONIC MIXER OML,INC.	M05HWA	170811-1	08/11/2019	08/11/2020

4.1.3 Test Procedures

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

For Radiated emission above 40GHz

a. Connect the test antenna covering the appropriate frequency range to a spectrum analyzer via an external mixer to the spectrum analyzer.

b. Set spectrum analyzer RBW = 1 MHz, VBW = 3 MHz, average detector.

c. Calculate the distance to the far field boundary and determine the maximum measurement distance.

d. Perform an exploratory search for emissions and determine the approximate direction at which each observed emission emanates from the EUT.

e. Exploratory measurements be made at a closer distance than the validated maximum measurement distance.

f. Perform a final measurement; begin with the test antenna at the approximate position where the maximum level occurred during the exploratory scan.

g. Slowly scan the test antenna around this position, slowly vary the test antenna polarization by rotating through at least 0° to 180°, and slowly vary the orientation of the test antenna to find the final position, polarization, and orientation at which the maximum level of the emission is observed.

h. Record the measured reading with the test antenna fixed at this maximized position, polarization, and orientation. Record the measurement distance.

i. Calculate the maximum field strength of the emission at the measurement distance and the adjusted/corrected power at the output of the test antenna.

j. Calculate the EIRP from the measured field strength and then convert to the linear.

k. Extrapolate the maximum measured field strength to the field strength at the distance specified by the limit, and then convert to the field strength in V/m.

l. Calculate the power density at the distance specified by the limit from the field strength at the distance specified by the limit.

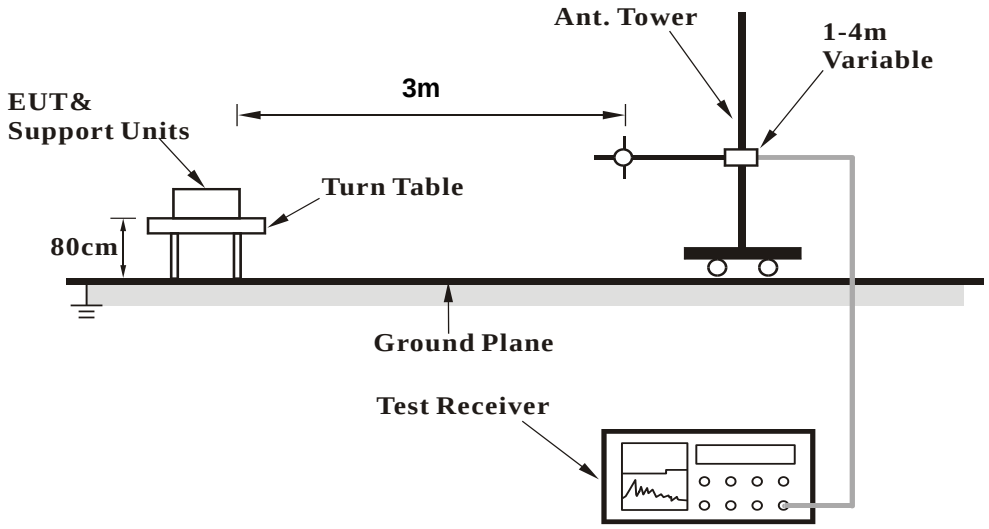
m. Repeat the preceding sequence for every emission observed in the frequency band under investigation.

4.1.4 Deviation from Test Standard

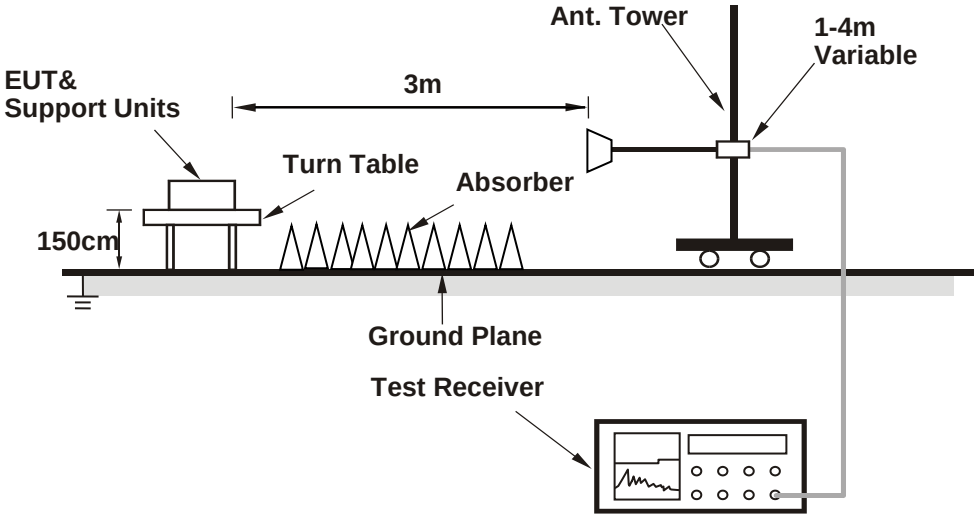
No deviation.

4.1.5 Test Setup

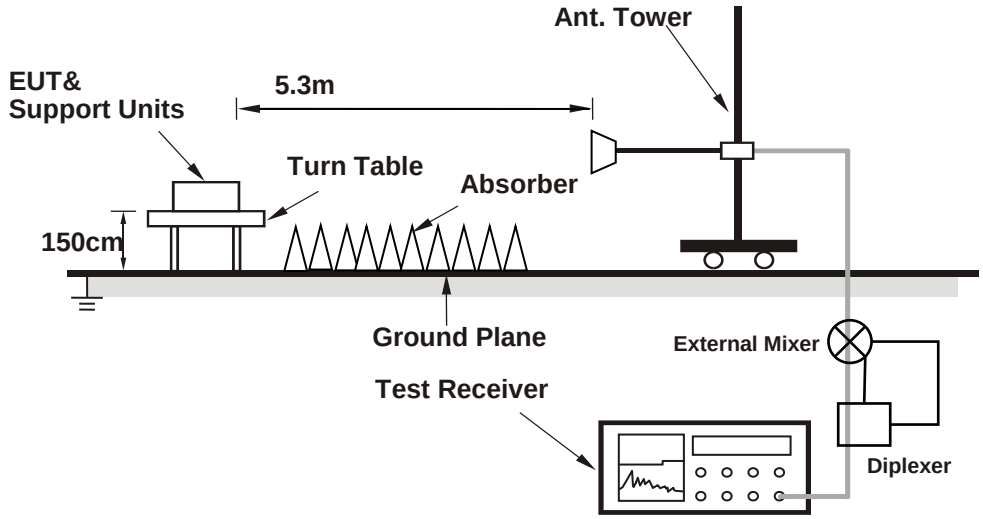
For Radiated emission 30MHz to 1GHz



For Radiated emission 1GHz to 40GHz



For Radiated emission above 40 GHz



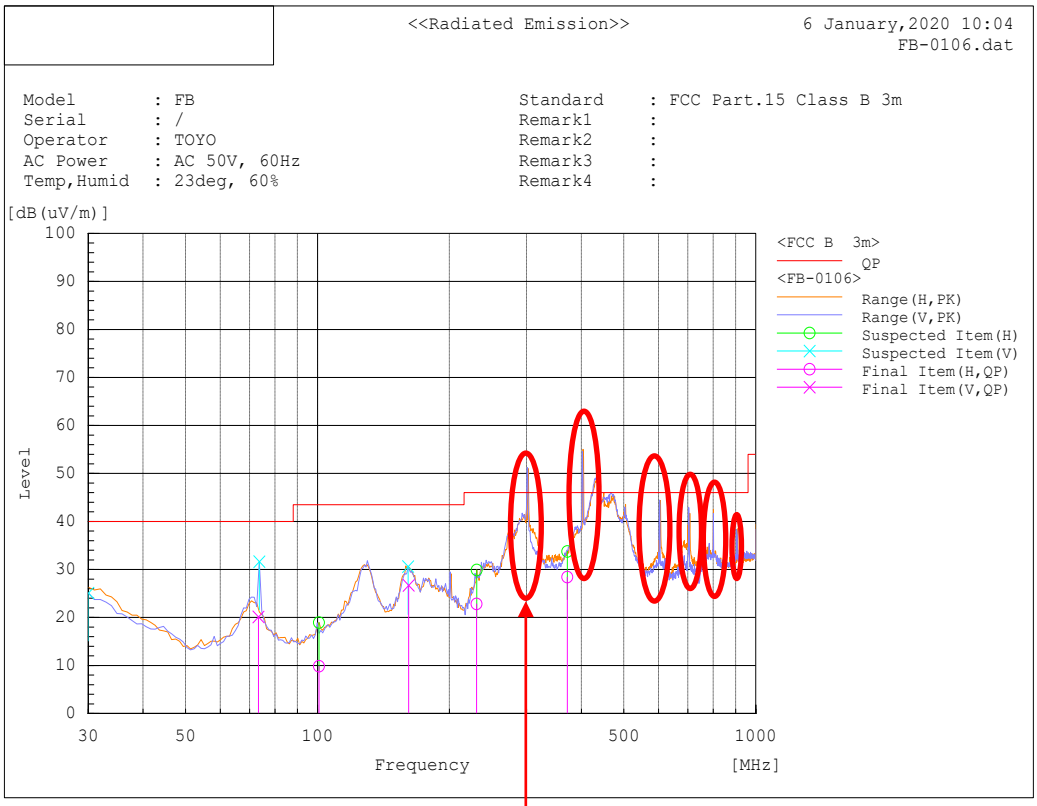
For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

4.1.7 Test Results

Below 1GHz Data:

CHANNEL	TX Channel 1	**DETECTOR FUNCTION**	Quasi-Peak (QP)
FREQUENCY RANGE	30MHz ~ 1GHz		



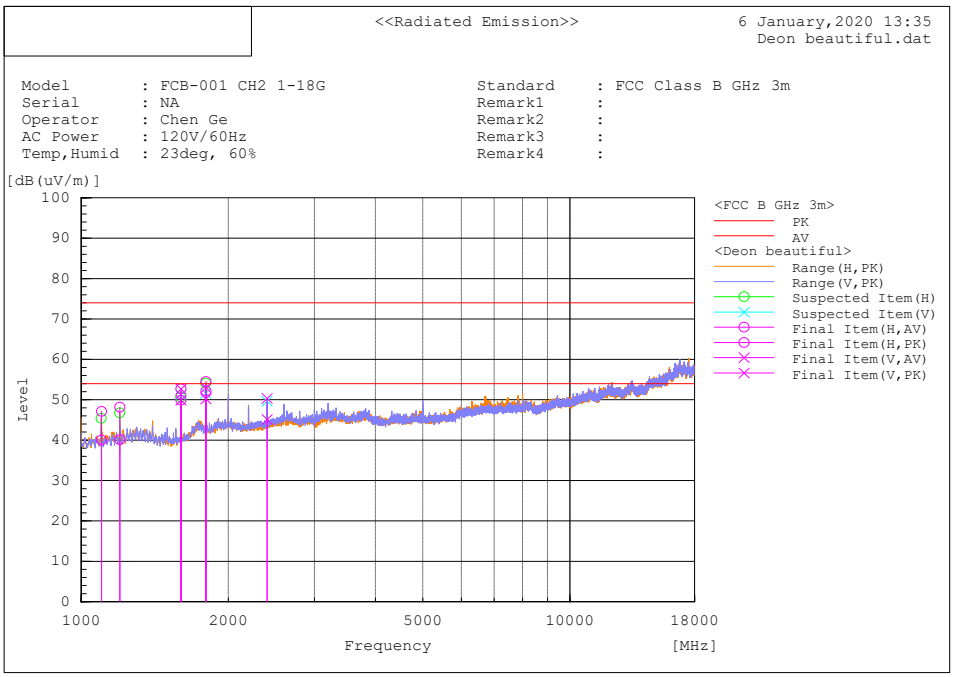
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m									
Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
73.342	V	6.8	13.3	20.1	40	-19.9	252	177.1	PASS
100.789	H	-6	15.8	9.8	43.5	-33.7	252	231.2	PASS
161.353	V	8.9	17.8	26.7	43.5	-16.8	152	275.2	PASS
230.711	H	5.5	17.3	22.8	46	-23.2	143	291.9	PASS
371.648	H	6.9	21.5	28.4	46	-17.6	290	238.4	PASS

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. Emissions in red circles are coming from unintentional radiator

Above 1GHz Data:

CHANNEL	TX Channel 1	**DETECTOR FUNCTION**	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 18GHz		

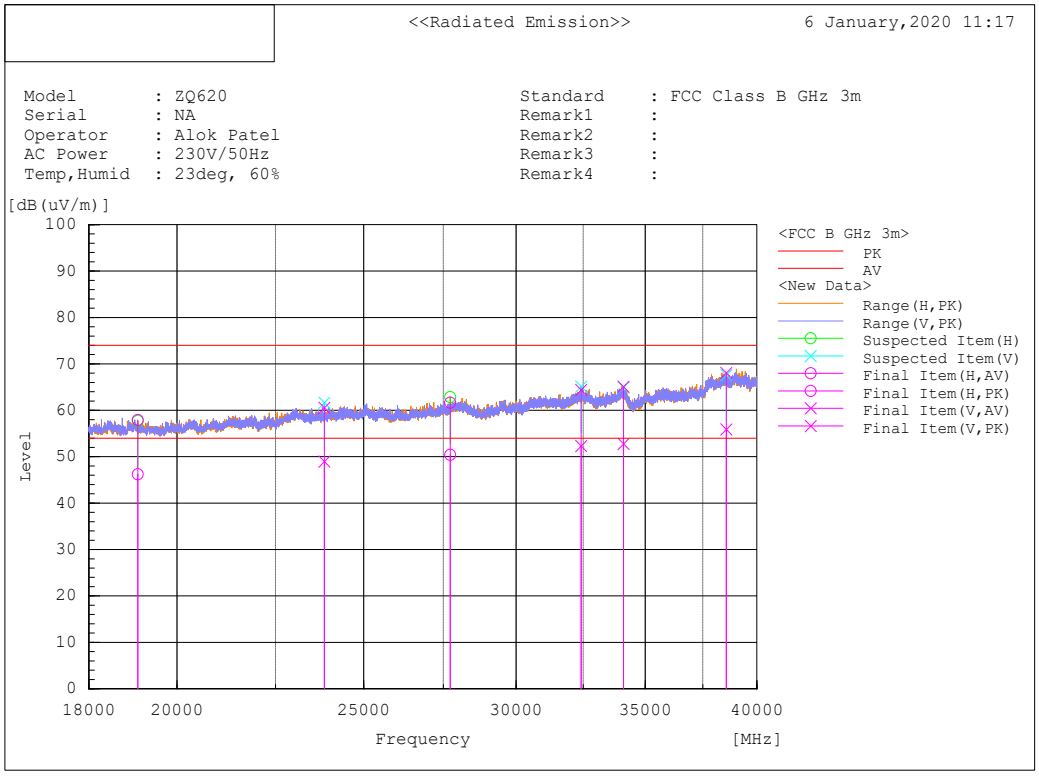


Antenna Polarity & Test Distance: Vertical and Horizontal at 3m													
Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1100.096	H	55.2	62.3	-15.2	40	47.1	54	74	-14	-26.9	162	68.8	PASS
1199.912	H	54.2	62.2	-14.1	40.1	48.1	54	74	-13.9	-25.9	208	291.1	PASS
1600.015	V	64.1	66.9	-14.2	49.9	52.7	54	74	-4.1	-21.3	253	258.7	PASS
1599.962	H	64.1	66.9	-14.2	49.9	52.7	54	74	-4.1	-21.3	177	229.2	PASS
1800.002	H	64	66.4	-11.9	52.1	54.5	54	74	-1.9	-19.5	162	220.4	PASS
1800.032	V	62.1	64.9	-11.9	50.2	53	54	74	-3.8	-21	291	178.7	PASS
2400.022	V	54.9	60.1	-9.8	45.1	50.3	54	74	-8.9	-23.7	238	145.9	PASS

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

CHANNEL	TX Channel 1	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	18GHz ~ 40GHz		



Antenna Polarity & Test Distance: Vertical and Horizontal at 3m													
Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
19084.63	H	33.9	45.6	12.3	46.2	57.9	54	74	-7.8	-16.1	132	209.4	PASS
23851.64	V	35.8	47.4	13.2	49	60.6	54	74	-5	-13.4	140	182.6	PASS
27724.8	H	36	47.2	14.4	50.4	61.6	54	74	-3.6	-12.4	359	251.2	PASS
32421.12	V	37.6	49.7	14.7	52.3	64.4	54	74	-1.7	-9.6	306	73	PASS
34107.02	V	35.8	48.1	17	52.8	65.1	54	74	-1.2	-8.9	201	178.8	PASS

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

CHANNEL	All Channels	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	40GHz ~ 200GHz		

Frequency (GHz)	Polarization (H/V)	E.I.R.P (dBm)	Reading (dBm]	Receiver antenna gain (dBi)	Power density (pW/cm^2)	Power density limit (pW/cm^2)
114.37	H	-19.59	-69.2	24	9.72	90
114.37	V	-19.19	-68.8	24	10.70	90
203	H	-20.6	-75.2	24	7.7	90
203	V	-21.2	-75.8	24	6.71	90

Note: All emissions above 40GHz are at noise floor level.
The measured power level is converted to EIRP using the equation:
EIRP = Raw Value - Receiver Antenna Gain + 20*log(4*3.1416*D/λ)
where:
D is the measurement distance
λ is the wavelength
*Measurements made at 1-meter distance.

4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 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 0.50MHz.

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date Of Calibration	Due Date Of Calibration
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	08/28/2019	08/28/2020
Transient Limiter ELECTRO-METRICS	EM-7600-5	106	12/31/2019	12/31/2020
LISN EMCO	3816/2NM	214372	01/14/2020	01/14/2021

4.2.3 Test Procedures

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 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.

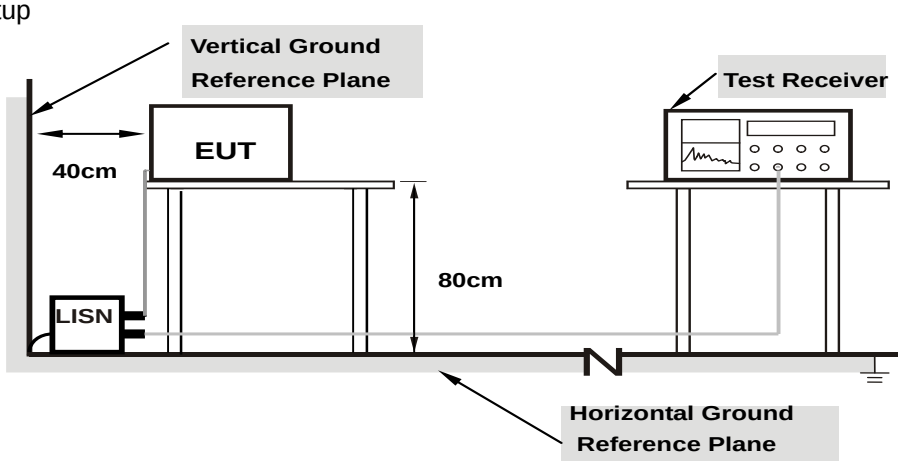
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup



Note: 1.Support units were connected to second LISN.

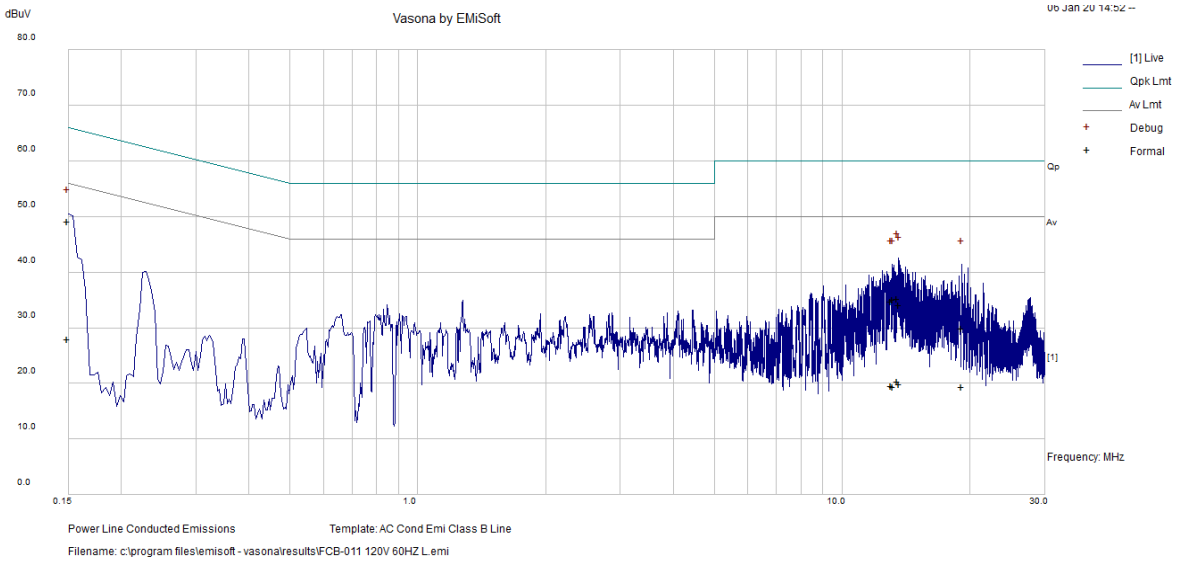
For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT Operating Conditions

Same as 4.1.6.

4.2.7 Test Results

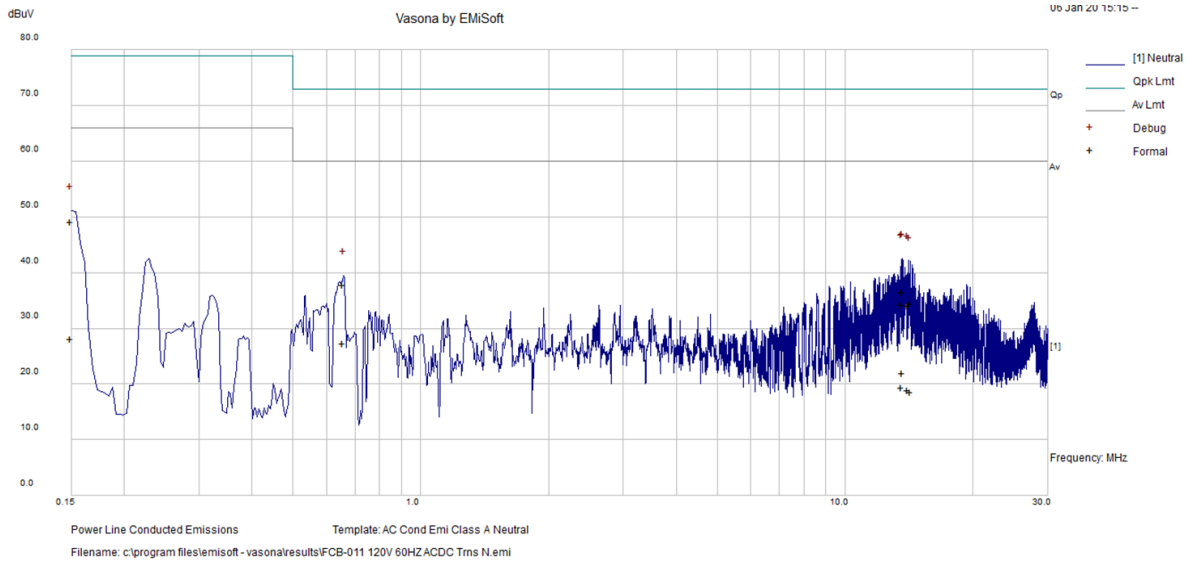
Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	21	Result:	☒ Pass
	Humidity (%):	42		
	Atmospheric(mbar):	1021		
Mains Power:	120Vac, 60Hz			
Tested by:	John Plotner			
Test Date:	01/06/2020			
Remarks	Live			



Live Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.15	41.93	7.11	0.05	49.09	Quasi Peak	Live	66	-16.91	Pass
13.56723	26.16	8.78	0.33	35.26	Quasi Peak	Live	60	-24.74	Pass
13.65076	25.08	8.78	0.33	34.19	Quasi Peak	Live	60	-25.81	Pass
19.16046	20.65	8.88	0.45	29.97	Quasi Peak	Live	60	-30.03	Pass
13.11054	25.63	8.77	0.31	34.71	Quasi Peak	Live	60	-25.29	Pass
13.20654	26.02	8.77	0.32	35.11	Quasi Peak	Live	60	-24.89	Pass
0.15	20.75	7.11	0.05	27.91	Average	Live	56	-28.09	Pass
13.56723	11.21	8.78	0.33	20.31	Average	Live	50	-29.69	Pass
13.65076	10.82	8.78	0.33	19.92	Average	Live	50	-30.08	Pass
19.16046	10.12	8.88	0.45	19.44	Average	Live	50	-30.56	Pass
13.11054	10.44	8.77	0.31	19.53	Average	Live	50	-30.47	Pass
13.20654	10.3	8.77	0.32	19.39	Average	Live	50	-30.61	Pass

Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	21	Result:	☒ Pass
	Humidity (%):	42		
	Atmospheric(mbar):	1021		
Mains Power:	120Vac, 60Hz			
Tested by:	John Plotner			
Test Date:	01/06/2020			
Remarks	Neutral			



Neutral Plot at 120Vac, 60Hz

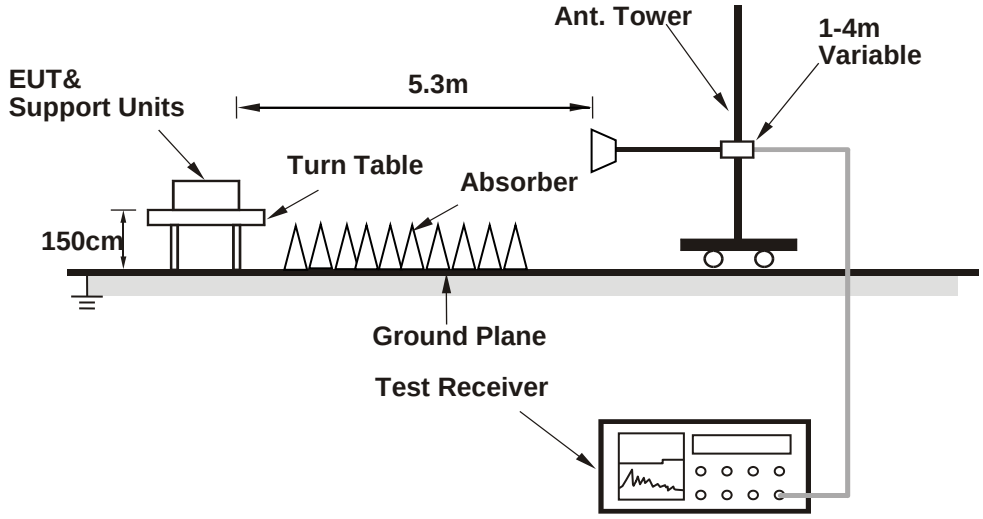
Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.15	41.97	7.11	0.04	49.13	Quasi Peak	Neutral	66	-16.87	Pass
0.655142	30.29	7.47	0.04	37.79	Quasi Peak	Neutral	56	-18.21	Pass
13.66257	27.41	8.78	0.33	36.52	Quasi Peak	Neutral	60	-23.48	Pass
13.58604	25.23	8.78	0.33	34.34	Quasi Peak	Neutral	60	-25.66	Pass
14.08417	24.92	8.79	0.34	34.04	Quasi Peak	Neutral	60	-25.96	Pass
14.25929	25.23	8.8	0.34	34.37	Quasi Peak	Neutral	60	-25.63	Pass
0.15	20.97	7.11	0.04	28.12	Average	Neutral	56	-27.88	Pass
0.655142	19.87	7.47	0.04	27.37	Average	Neutral	46	-18.63	Pass
13.66257	12.91	8.78	0.33	22.02	Average	Neutral	50	-27.98	Pass
13.58604	10.27	8.78	0.33	19.38	Average	Neutral	50	-30.62	Pass
14.08417	9.83	8.79	0.34	18.96	Average	Neutral	50	-31.04	Pass
14.25929	9.38	8.8	0.34	18.52	Average	Neutral	50	-31.48	Pass

4.3 6dB Bandwidth Measurement

4.3.1 Limits of 6dB Bandwidth Measurement

None: For reporting purposes only.

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

The spectrum analyzer and external mixer are set up to measure the radiated output of the transmitter.

4.3.5 Deviation fromTest Standard

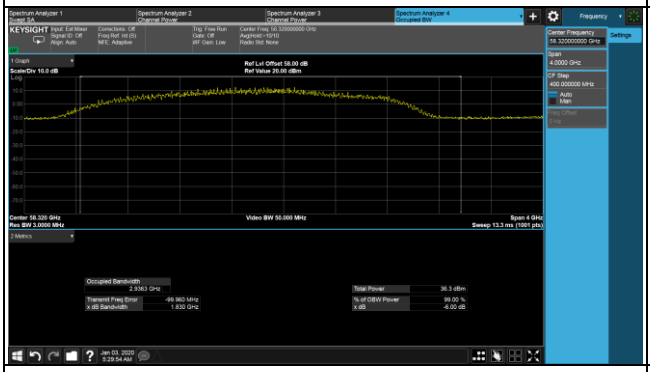
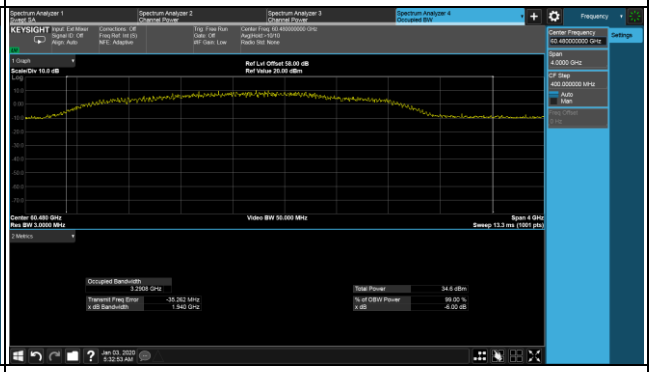
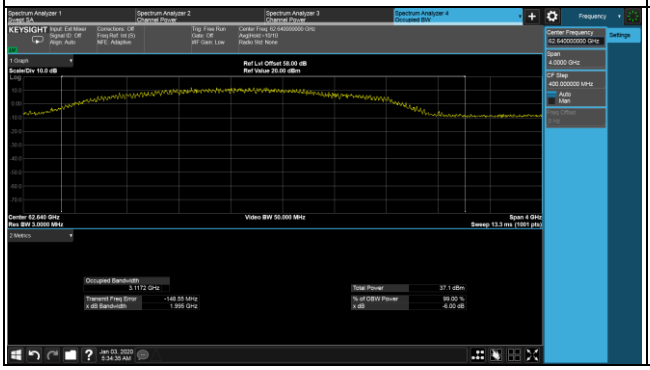
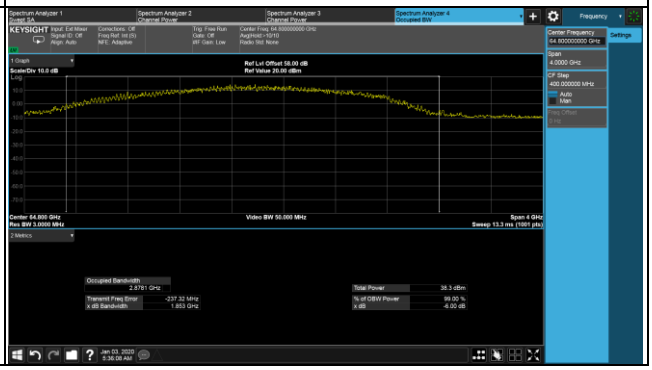
No deviation.

4.3.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 Test Result

Channel	Frequency (GHz)	6dB Bandwidth (GHz)
1	58.32	1.83
2	60.48	1.94
3	62.64	1.99
4	64.80	1.85

Spectrum Plot of Worst Value	
CH1	**CH2**
	
CH3	**CH4**
	

4.4 Output Power Measurement

4.4.1 Limits of Output Power Measurement

15.255 (c) & (e)

Output Power (EIRP)				
Applicaple	**Type**		**Peak Power**	**Average Power**
V	Within the 57-71 GHz band (Other than fixed field disturbance sensors and short-range devices)	Other than fixed point to point transmitters located outdoors	43dBm	40dBm
		Fixed point-to-point transmitters located outdoors	85dBm (*Note 1)	82dBm (*Note 2)
	Fixed field disturbance sensors (61-61.5GHz)	Occupy 500 MHz or less of bandwidth	43dBm (*Note 3)	40dBm (*Note 3)
	Fixed field disturbance sensors	Other than occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0-61.5 GHz	10dBm	-
	short-range devices for interactive motion sensing	-		

Note:
1. 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.
2. 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.
3. In addition, the average power of any emission outside of the 61.0-61.5 GHz band, measured during the transmit interval, but still within the 57-71 GHz band, shall not exceed 10 dBm,and the peak power of any emission shall not exceed 13 dBm.

Peak Output Power (Conducted Power)			
Applicaple	**Type**	**6dB Bandwidth**	**Maximum Conducted Power**
	Fixed field disturbance sensors (Exclude 61-61.5GHz)	-	≦ 0.1mW
V	Other	Other	500mW
V		Less than 100MHz	500mW x (B/100)

Note:
1. B is 6dB Bandwidth (measured with a 100kHz resolution bandwidth)
2. Peak transmitter output power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-64 GHz band and the has a video bandwidth of at least 10 MHz, or using an equivalent measurement method.
3. For purposes of demonstrating complained with this paragraph (e), corrections to the transmitter output power may be made due to the antenna and circuit loss.

Far field boundary calculations

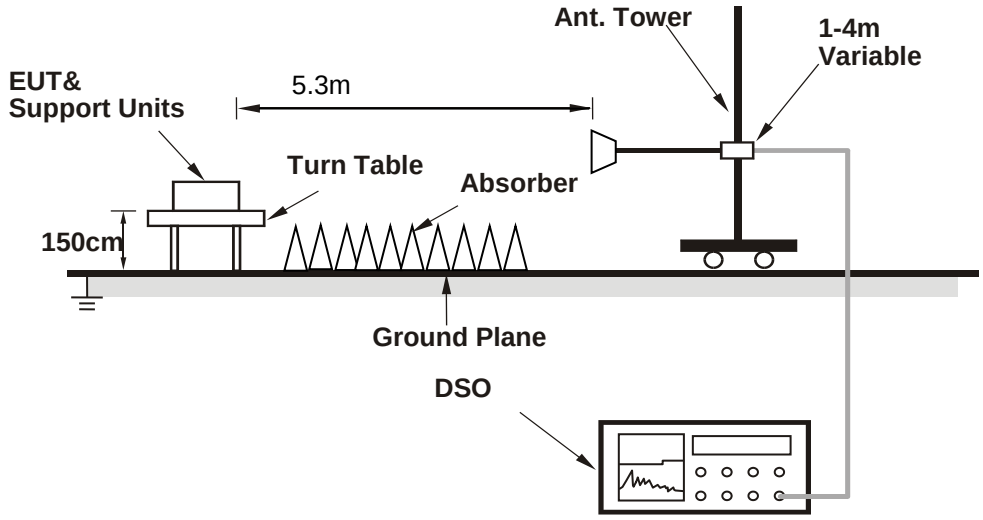
The far-field boundary is given as:
R = (2 * L ^ 2) / λ

Where,
L = Largest Antenna Dimension, including the reflector, in meters
λ = Wavelength in meters

Channel	Frequency (GHz)	L (m)	λ (m)	R (m)
1	58.32	0.11	0.0051	4.75
2	60.48	0.11	0.0050	4.84
3	62.64	0.11	0.0048	5.04
4	64.80	0.11	0.0046	5.26

Radiated power measurements are performed at 5.3 meters distance.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedures

a. Place the EUT in a continuous transmission mode.
b. For radiated emission measurements, attach a test receive antenna for the fundamental frequency band to the RF input of an RF detector or a downconverter with an RF detector at the output.
c. Connect the video output of the detector to the 50 ohm input of the DSO.
d. Place the test receive antenna in the main beam of the EUT at a distance which will provide a signal within the operating range of the RF detector.
e. Set the sampling rate of the DSO to the required value. Adjust the memory depth, the triggering and the sweep speed to obtain a display which is representative of the signal considering the type of modulation.
f. For radiated emission measurements, calculate the distance to the far field boundary of the fundamental emission using following equation

$$d_{farfield} = \frac{2D^2}{\lambda}$$

where:

D = largest dimension of the transmit antenna

λ = wavelength

g. Perform radiated emission measurements to keep maximize the received signal from the EUT in the far field.
h. Record the average and peak from the DSO and the measurement distance.
i. Disconnect the EUT fromthe RF input port of the instrumentation system.
j. Connect a mm-wave source to the RF input port of the instrumentation system via a waveguide variable attenuator. The mm-wave source is unmodulated.
k. Using substitution measurement.
l. Measure and note the power.
m. For conducted power measurements, calculate the conducted power using following equation

P_{cond} = EIRP-G_{dBi}

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Conditions

The EUT is 5m away from the measurement antenna.

4.4.7 Test Results

E.I.R.P

Channel	Frequency (GHz)	EIRP Peak (dBm)	EIRP Avg Raw (dBm)	Duty Cycle	Duty Cycle Factor	EIRP Avg Corrected (dBm)	EIRP Limit Peak (dBm)	EIRP Limit Avg (dBm)	Pass /Fail
1	58.32	42.59	29.32	50%	3.01	32.33	43	40	Pass
2	60.48	42.98	29.50	50%	3.01	32.51	43	40	Pass
3	62.64	42.21	28.86	50%	3.01	31.87	43	40	Pass
4	64.80	27.50	15.10	50%	3.01	18.11	43	40	Pass

Conducted Power

Channel	Frequency (GHz)	EIRP Peak (dBm)	Antenna Gain (dBi)	Conducted Power (dBm)	Conducted Power Peak (dBm)	Pass /Fail
1	58.32	42.59	28	14.59	27	Pass
2	60.48	42.98	28	14.98	27	Pass
3	62.64	42.21	28	14.21	27	Pass
4	64.80	27.50	28	-0.50	27	Pass

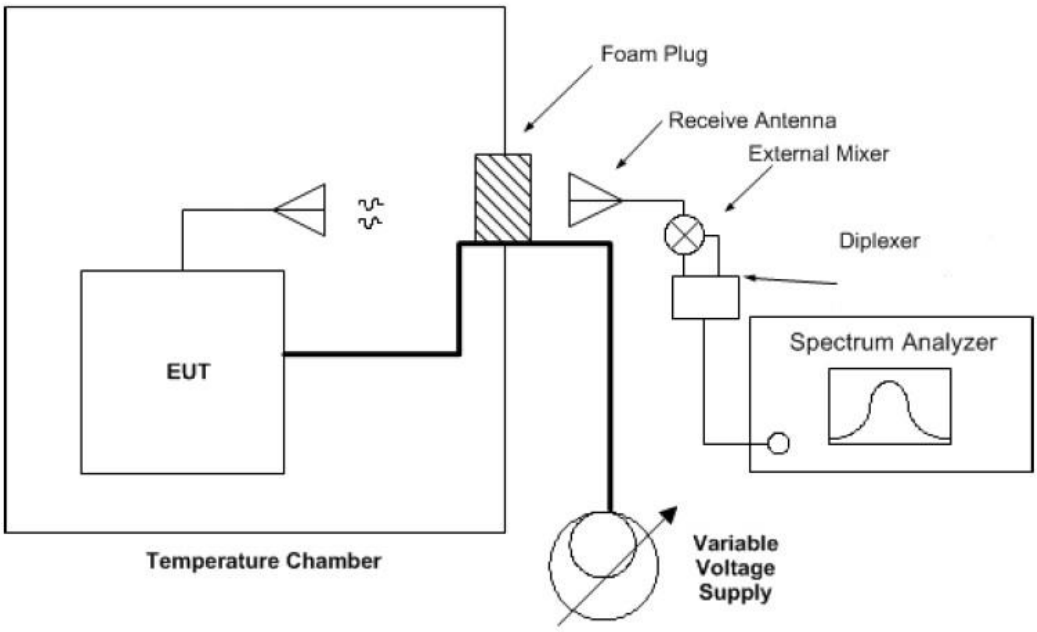
Note: 500mW = 27dBm.

4.5 Frequency Stability Measurement

4.5.1 Limits of Conducted Out of Band Emission Measurement

15.255(f) 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.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

a. Arrange EUT and test equipment as above setup configuration.
b. With the EUT at ambient temperature and voltage source set to the EUT nominal operating voltage (100%), record the spectrum mask of the EUT emission on the spectrum analyzer.
c. Vary EUT power supply between 85% and 115% of nominal, and record the frequency excursion of the EUT emission mask.
d. Set the power supply to 100% nominal setting, and raise EUT operating temperature to 50 °C. Record the frequency excursion of the EUT emission mask.
e. Repeat step d) at each 10 °C increment down to −20 °C

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 EUT Operating Condition

Same as Item 4.3.6

4.5.7 Test Results

Frequency Stability Versus Temp.			
Operating Frequency: 60480 MHz			
TEMP. (℃)	**Power Supply (Vdc)**	**Measured Frequency (MHz)**	**Pass/Fail**
-40	50	**60480.12**	**Pass**
-30	50	**60480.10**	**Pass**
-20	50	**60480.09**	**Pass**
-10	50	**60480.00**	**Pass**
0	50	**60480.00**	**Pass**
10	50	**60480.00**	**Pass**
20	50	**60480.00**	**Pass**
30	50	**60480.02**	**Pass**
40	50	**60480.04**	**Pass**
50	50	**60480.02**	**Pass**
55	50	**60480.02**	**Pass**

Frequency Stability Versus Voltage			
Operating Frequency: 60480 MHz			
TEMP. (℃)	**Power Supply (Vdc)**	**Measured Frequency(MHz)**	**Pass/Fail**
25	44	**60480.00**	**Pass**
	48	**60480.00**	**Pass**
	57	**60480.00**	**Pass**

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information of the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

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The address and road map of all our labs can be found in our web site also.

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