

RADIO TEST REPORT

Product	:	SYNCUP PETS
Model Name	:	TMUS-SUP-1
FCC ID	:	2ASXC-TMO-NBT-01
Test Regulation	:	FCC 47 CFR Part 24, Subpart E
Received Date	:	May 2, 2019
Test Date	:	May 6, 2019 ~ May 31, 2019
Issued Date	:	Aug. 26, 2019
Applicant	:	T-mobile Usa, Inc. 12920 Se 38th Street, Bellevue, Washington, United States, 98006
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan



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REVISION HISTORY

Original Test Report No.: 4789004574-US-R2-V0

Rev.	Test report No.	Date	Page revised	Contents
Original	4789004574-US-R2-V0	Aug. 26, 2019	-	Initial issue



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1. Attestation of Test Results

APPLICANT:	T-mobile Usa, Inc. 12920 Se 38 th Street, Bellevue, Washington, United States, 98006
MANUFACTURER	CyberTAN Technology Inc. No. 99, Park Avenue III Science-based Industrial Park Hsinchu Taiwan 308
EUT DESCRIPTION:	SYNCUP PETS
BRAND:	T-Mobile
MODEL:	TMUS-SUP-1
SAMPLE STAGE:	Engineering sample
DATE of TESTED:	May 6, 2019 ~ May 31, 2019

APPLICABLE STANDARDS	
STANDARD	Test Results
FCC 47 CFR PART 24	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:

lee

Evelyn Lee Project Handler Date : Aug. 26, 2019

Approved and Authorized By:

Stanley Wu Date : Aug. 26, 2019 Senior Project Engineer

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2. Summary of Test Results

LTE 2				
FCC Clause	Test Items	Result		
§ 2.1046 § 24.232	RF Output Power	PASS		
§ 24.232 (d)	Peak-to-Average Power Ratio	PASS		
§ 2.1049 § 24.238 (b)	Occupied Bandwidth	PASS		
§ 2.1055 § 24.235	Frequency Stability	PASS		
§ 24.238 (a)	Band Edge Measurements	PASS		
§ 2.1051 § 24.238	Spurious Emissions at Antenna Terminal	PASS		
§ 2.1053 § 24.238	Radiated Spurious Emission	PASS		

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3. Test Methodology and Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB 971168 D01 Power Meas License Digital Systems v03r01, ANSI C63.26-2015 and ANSI/TIA-603-E.

4. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.		
Address	Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan		
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398. The full scope of accreditation can be viewed at http://accreditation.taftw.org.tw/taf/public/basic/viewApplyItems.action?unitNo=3398		



5. Measurement Uncertainty

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor k=2.

Test Item	Measurement Frequency Range	K	U(dB)
RF Output Power	30MHz ~ 40GHz	2	0.7dB
Effective Radiated Power	30MHz ~ 1GHz	2	5.6dB
Equivalent Isotropic Radiated Power	1GHz ~ 18GHz	2	4.2dB
Peak-to-Average Power Ratio	30MHz ~ 40GHz	2	3.10%
Occupied Bandwidth	30MHz ~ 40GHz	2	3.10%
Spurious Emissions at Antenna Terminal	30MHz ~ 40GHz	2	1.1dB
Frequency Stability	30MHz ~ 40GHz	2	299Hz
	30MHz ~ 1GHz	2	5.6dB
Radiated Spurious Emission	1GHz ~ 18GHz	2	4.2dB
	18GHz ~ 40GHz	2	4.4dB



6. Equipment under Test

6.1. Description of EUT

Product	SYNCUP PETS	
Brand Name	T-Mobile	
Model Name	TMUS-SUP-1	
Normal Voltage	5Vdc (adapter or host equipment) 3.7Vdc for battery	
Voltage Operation Range	3.33~4.07Vdc	
Hardware Version	V01	
Software Version	0.31.10.14	

Note :

1. The EUT contains following accessory devices.

Product	Brand	Model	Description
PSU Adapter	PHIHONG	AN05A-050E	I/P: 100-240Vac, 50-60Hz, 0.2A O/P: 5.0 Vdc, 1.0A
Battery	Joules Miles	GWB001-A1	3.7 Vdc, 430 mAh
Charging Dock	CyberTAN	N/A	N/A
Collar mount	CyberTAN	N/A	N/A
USB Cable	N/A	N/A	1 meter shielded cable without core
Bands	CyberTAN	N/A	N/A

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



6.2. Technical Information

Frequency Bands	■ LTE Band 2	1850 MHz to 1910 MHz (Uplink) 1930 MHz to 1990 MHz (Downlink)
Sub-carrier spacing	15 kHz / 3.75kHz	
Modulation Mode	QPSK / BPSK	

Note 1: Accordance with manufacturer description, the product support both single tone and multi tone carrier for spacing 15 kHz , but just only support single tone carrier for 3.75 kHz spacing.

6.3. Emission Designator

Frequency Bands ■ LTE Band 2	Sub-carrier spacing 15 kHz	236KG7D
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6.4. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	22~25°C / 65~69%RH	3.7Vdc	May 6, 2019 ~ May 31, 2019	Howard Kao
Radiated Spurious Emission	966-2	23~25°C / 66~68%RH	120Vac / 60 Hz	May 6, 2019 ~ May 24, 2019	Will Chen

FCC Test Firm Registration Number: 498077

6.5. Description Of Available Antennas

Band	Antenna Type	Antenna Gain(dBi)
LTE Band 2	Internal	1.5

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual.

6.6. Test Mode Applicability and Tested Channel Detail

Pre-Scan has been conducted to determine the worst-case mode from all mode and data rates and positions and carrier tone size and modulations were investigated. Subsequently, only the worst case are reported.

The following testing in NB-IOT is set based on the maximum RF Output Power.

Radiated measurements are performed by rotating the EUT in two different orthogonal (XZ axis) test planes, the worst case was found when positioned as the table below.

Band	Axis		
LTE Band 2	X-plane		



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

LTE Band 2

Test item	Sub-c Spacing	arrier g (kHz)	Modulation		Test Channel			Tone	
	3.75	15	QPSK	BPSK	L	М	Н	1	100%
RF Output Power (Note 3)	V	V	V	V	V	V	V	V	V
Frequency Stability	-	V	V	-	v	-	v	-	V
Occupied Bandwidth (Note 4)	-	v	V	-	v	V	V	-	V
Band Edge (Note 3)	v	v	V	V	v	-	V	V	V
Peak to Average Ratio	v	V	v	v	v	V	V	v	-
Spurious Emissions at Antenna Terminal	V	V	V	V	v	V	V	v	-
Radiated Spurious Emissions	V	-	V	-	v	V	V	v	-

Note:

1. The mark "V" means that this configuration is chosen for testing.

2. The mark "-" means that this configuration is not testing.

 Accordance with manufacturer description, the product support multi tone carrier and single tone carrier when operating in spacing 15 kHz, but only support single tone carrier when operating in 3.75 kHz spacing.

4. Since only when operating in QPSK of spacing 15 kHz could use with full Tone carrier, therefore, for emission bandwidth test only with operating in QPSK of spacing 15 kHz.



7. Test Equipment

Test Equipment List								
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval			
Spectrum Analyzer	Keysight	N9010A	MY56070827	Nov. 8, 2018	1 year			
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	Nov. 8, 2018	1 year			
Loop Antenna	ETS lindgren	6502	00213440	Dec. 11, 2018	1 year			
Trilog- Broadband Antenna with 5dB Attenuator	Schwarzbeck	VULB 9168 & N-6-05	774 & AT- N0538	Jan. 14, 2019	1 year			
Trilog- Broadband Antenna with 5dB Attenuator	Trilog- Broadband ntenna with B Attenuator		773 & AT- N0539	Jan. 14, 2019	1 year			
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	Jan. 25, 2019	1 year			
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01686	Jan. 16, 2019	1 year			
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	Jan.16, 2019	1 year			
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	759	Nov. 13, 2018	1 year			
Preamplifier (30- 1000 MHz)	EMCI	EMC330E	980405	Jan. 30, 2019	1 year			
Preamplifier (1- 18 GHz)	EMCI	EMC051835BE	980406	Jan. 29, 2019	1 year			
Preamplifier (18- 40GHz)	EMCI	EMC184040SE E	980426	May. 8, 2019	1 year			
Signal Generator	Keysight	N5173B	MY53271122	Jan. 14,2019	1 year			
RF Cable (9 KHz~18 GHz) UltraPhase & EMC Instrument		A1K50- UP0358- A1K50- 1500&EMC106 -NM-SM- 2500/7000	170111- 4&170219/170 102	Jan. 29,2019	1 year			
RF Cable (18 GHz~40 GHz) UltraPhase		K1K50- UP0264- K1K50- 2500/2500/600	170214- 2/170214- 6/170111-1	Jan. 29,2019	1 year			

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Test Equipment List							
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval		
Spectrum Analyzer	Keysight	N9010A	MY56070834	Nov. 8, 2018	1 year		
Wideband Radio Communication Tester	Rohde & Schwarz	CMW500	161254	Dec. 5, 2018	1 year		
Temperature &Humidity Test Chamber	GIANT FORCE	GTH-150- 40-CP-AR	MAA1701-010	Apr. 3, 2019	1 year		

UL Software						
Description Name Version						
Radiated measurement	AUDIX_E3	9.0				



8. Description of Test Setup

Support Equipment

Item	Equipment	Brand Name	Model Name	S/N
N/A	N/A	N/A	N/A	N/A

Setup Diagram for Test





9.1. RF Output Power

Requirements

Mobile / Portable station are limited to 2 watts e.i.r.p.

Test procedure

The EUT makes a call to the communication simulator. The communication simulator station system controlled a EUT to export maximum conducted RF output power under transmission mode and specific channel frequency.

The relevant equation for determining the ERP or EIRP from the conducted RF output power measured using the guidance provided above is:

ERP or EIRP =
$$P_{Meas} + GT - LC$$

where:

ERP or EIRP = effective radiated power or equivalent isotropically radiated power, respectively (expressed in the same units as P_{Meas} , typically dBW or dBm); P_{Meas} = measured transmitter output power or PSD, in dBm or dBW; G_T = gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP); L_C = signal attenuation in the connecting cable between the transmitter and antenna, in dB

<u>Test Setup</u>



The loss between RF output port of the EUT and the input port of the tester has been taken into consideration.

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Conducted Output Power (dBm)

				QPSK			BPSK			
Band	Sub- carrier Spacing	Ntones	Tone@	Low Ch 18601	Mid Ch 18900	High Ch 19199	Low Ch 18601	Mid Ch 18900	High Ch 19199	
				1850.1 MHz	1880.0 MHz	1909.9 MHz	1850.1 MHz	1880.0 MHz	1909.9 MHz	
2	15 kHz	1	0	22.80	22.85	22.78	22.67	23.01	22.72	
		1	11	22.67	22.73	22.65	22.67	22.88	22.66	
	2		12	0	20.61	20.67	20.57			
	2 75 l-Uz	1	0	23.07	23.09	22.30	23.04	22.97	22.85	
	3./5 KHZ	1	47	23.12	23.08	22.25	23.07	23.05	22.70	

E.I.R.P (dBm)

	Mode		QPSK		BPSK		
Band	Channel	Low CH	Mid CH	High CH	Low CH	Mid CH	High CH
		18601	18900	19199	18601	18900	19199
	Frequency	1850.1	1880	1909.9	1850.1	1880	1909.9
		MHz	MHz	MHz	MHz	MHz	MHz
	Conducted power(dBm)	23.12	23.09	22.78	23.07	23.05	22.85
2	Conducted power (Watts)	0.21	0.20	0.19	0.20	0.20	0.19
2	E.I.R.P (dBm)	24.62	24.59	24.28	24.57	24.55	24.35
	E.I.R.P (Watts)	0.29	0.29	0.27	0.29	0.29	0.27



9.2. Peak to Average Power Ratio

Requirements

In measuring transmissions in this band using an average power technique, the peak to-average ratio (PAR) of the transmission may not exceed 13 dB.

Test procedure

- 1. Set resolution/measurement bandwidth \geq signal's occupied bandwidth;
- 2. Set the number of counts to a value that stabilizes the measured CCDF curve;
- 3. Record the maximum PAPR level associated with a probability of 0.1 %.

Test Setup



The loss between RF output port of the EUT and the input port of the tester has been taken into consideration.

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LTE Band 2

Sub-carrier	Channal	Peak to Average Ratio (dB)		Sub-carrier	Channal	Peak to Average Ratio (dB)	
spacing	Channel	QPSK	BPSK	spacing		QPSK	BPSK
	18601	1.69	1.81	3.75kHz	18601	1.76	2.03
15 kHz	18900	1.65	1.78		18900	1.73	2.00
	19199	1.64	1.76		19199	1.70	1.99



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9.3. Occupied Bandwidth

Test procedure

The EUT makes a call to the communication simulator. All measurements were done at low, middle and high operational frequency range. The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency. Use OBW measurement function of Spectrum analyzer to measure 99 % occupied bandwidth.

Test Setup



The loss between RF output port of the EUT and the input port of the tester has been taken into consideration.

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LTE Band 2

Sub-Carrier	Channel	annel 99 % Occupied Bandwidth (kHz)		Channel	26dB Bandwidth (kHz)
Spacing		QPSK	Spacing		QPSK
	18601	179.57		18601	236.50
15 kHz	18900	179.50	15 kHz	18900	236.10
	19199	178.72		19199	235.80



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9.4. Frequency Stability

Requirements

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

Test procedure

- 1. Device is placed at the oven room. The oven room could control the temperatures and humidity. Power warm up is at least 15 min and power applied should perform before recording frequency error.
- 2. EUT is connected the external power supply to control the DC input power. The test voltage range is from minimum to maximum working voltage. Each step shall be record the frequency error rate.
- 3. The temperature range step is 10 degrees in this test items. All temperature levels shall be hold the $\pm 0.5^{\circ}$ C during the measurement testing. The each temperature step shall be at least 0.5 hours, consider the EUT could be test under the stability condition.

Note: The frequency error was recorded frequency error from the communication simulator.

Test Setup



The loss between RF output port of the EUT and the input port of the tester has been taken into consideration.

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LTE Band 2

	Sub-carrier spacing: 15 kHz					
Voltago Tomp		Low C	hannel	High Channel		
(V)	(°C)	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)	
$\mathbf{V}_{\mathrm{nom}}$		1850.100006	0.003	1909.900015	0.008	
\mathbf{V}_{\min}	T_{nom}	1850.100007	0.004	1909.900014	0.007	
V_{max}		1850.100007	0.004	1909.900014	0.007	

Sub-carrier spacing: 15 kHz						
	Tomp	Low C	hannel	High Channel		
	(°C)	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)	
	-30	1850.100013	0.007	1909.900016	0.008	
	-20	1850.100014	0.008	1909.900014	0.007	
Voltage	-10	1850.100012	0.007	1909.900012	0.006	
(V)	0	1850.100016	0.008	1909.900010	0.005	
	10	1850.100020	0.011	1909.900013	0.007	
	20	1850.100007	0.004	1909.900014	0.007	
	30	1850.100022	0.012	1909.900015	0.008	
	40	1850.100016	0.009	1909.900019	0.010	
	50	1850.100021	0.011	1909.900018	0.009	



9.5. Band Edge Measurements

Requirements

Power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P) dB$. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

Test procedure

- 1. All measurements were done at low and high operational frequency range.
- 2. For full tone sub-carrier, the center frequency of spectrum is the band edge frequency and span is 1 MHz, RBW of the spectrum is 2 kHz and VBW of the spectrum is 10 kHz.
- For 1 tone sub-carrier, the center frequency of spectrum is the band edge frequency and span is 1 MHz, RBW of the spectrum is 200 Hz and VBW of the spectrum is 1 kHz.
 (1 tone bandwidth = Full tones bandwidth / 12 is about 180 kHz/12 = 15kHz, and since RBW should be use greater than or equal to 1% of OBW, using 200 Hz is enough to cover 1% of demand in this case.)
- 4. Record the max trace plot into the test report.

Test Setup



The loss between RF output port of the EUT and the input port of the tester has been taken into consideration.

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LTE Band 2





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9.6. Spurious Emissions at Antenna Terminal

Requirements

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P) dB$. The emission limit equal to -13 dBm.

Test procedure

- 1. The EUT was connected to Spectrum Analyzer and Communication Simulator via power Splitter. All measurements were done at low, middle and high operational frequency range. The measurement is carried out using a spectrum analyzer.
- 2. Sweep the whole frequency band through the range from 30MHz to the 10th harmonic of the carrier. 10 dB attenuation pad is connected with spectrum. RBW = 1 MHz and VBW = 3 MHz is used for conducted emission measurement.

Test Setup



The loss between RF output port of the EUT and the input port of the tester has been taken into consideration.

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LTE Band 2









9.7. Radiated Spurious Emission

Requirements

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P) dB$. The emission limit is equal to -13 dBm.

Test procedure

- 1. Substitution method is used for E.I.R.P measurement. In the semi-anechoic chamber, EUT placed on the 0.8 m height of Turn Table, rotated the table around 360 degrees to search the maximum radiation power and receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1 m to 4 m to find the maximum polar radiated power. The "Read Value" is the spectrum reading the maximum power value.
- 2. The substitution horn antenna is substituted for EUT at the same position and signals generator export the CW signal to the substitution antenna via a TX cable. Rotated the Turn Table and moved receiving antenna to find the maximum radiation power. Adjust output power level of S.G to get a Value of spectrum reading equal to "Read Value" of step a. Record the power level of S.G.

EIRP = Output power level of S.G - TX cable loss + Antenna gain of substitution horn.

E.R.P power can be calculated form E.I.R.P power by subtracting the gain of dipole, E.R.P power = E.I.P.R power - 2.15 dBi.

Note: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz/3 MHz.



Test Setup

<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the Setup Configurations



- Sweep the whole frequency band through the range from 30MHz to the 10th harmonic of the carrier.
- The spurious emissions within 30-1000MHz were found more than 20dB below the permissible value is not required to be report.

LTE Band 2

EUT Test Condition		Measurement Detail		
Sub-carrier spacing	3.75 kHz	Encauchay Dongo	Above 1 CUr	
Channel	Low Channel	Frequency Kange	Above I GHZ	

Frequency (MHz)	EIRP (dBm)	Limit (dBm)	Over Limit (dB)	SPA. Reading (dBm)	S.G. Value (dBm)	Correction Factor (dB)	Polarization (H/V)
3700.2	-40.42	-13	-27.42	-45.23	-51.20	10.78	Н
5550.3	-51.50	-13	-38.50	-59.66	-63.10	11.60	Н
3700.2	-49.21	-13	-36.21	-53.92	-59.99	10.78	V
5550.3	-50.12	-13	-37.12	-58.32	-61.72	11.60	V

Remarks:

- 1. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).
- 2. EIRP (dBm) = S.G Value (dBm) + Correction Factor (dB).
- 3. The other emission levels were very low against the limit.



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EUT Test Condition		Measurement Detail		
Sub-carrier spacing	3.75 kHz	Fuer success Demos	Above 1 CHr	
Channel	Middle Channel	Frequency Kange	Above I GHZ	

Frequency (MHz)	EIRP (dBm)	Limit (dBm)	Over Limit (dB)	SPA. Reading (dBm)	S.G. Value (dBm)	Correction Factor (dB)	Polarization (H/V)
3760	-49.09	-13	-36.09	-54.06	-59.82	10.73	Н
5640	-52.17	-13	-39.17	-60.46	-63.73	11.56	Н
3760	-48.75	-13	-35.75	-53.67	-59.48	10.73	V
5640	-50.52	-13	-37.52	-58.83	-62.08	11.56	V

Remarks:

1. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

2. EIRP (dBm) = S.G Value (dBm) + Correction Factor (dB).

3. The other emission levels were very low against the limit.



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EUT Test Condition		Measurement Detail		
Sub-carrier spacing	3.75 kHz	Fuer success Demos	Above 1 CHr	
Channel	High Channel	Frequency Kange	Above I GHz	

Frequency (MHz)	EIRP (dBm)	Limit (dBm)	Over Limit (dB)	SPA. Reading (dBm)	S.G. Value (dBm)	Correction Factor (dB)	Polarization (H/V)
3819.8	-46.79	-13	-33.79	-51.93	-57.42	10.63	Н
5729.7	-53.00	-13	-40.00	-61.42	-64.54	11.54	Н
7639.6	-49.74	-13	-36.74	-62.61	-58.88	9.15	Н
3819.8	-43.82	-13	-30.82	-48.94	-54.45	10.63	V
5729.7	-48.18	-13	-35.18	-56.60	-59.72	11.54	V
7639.6	-45.83	-13	-32.83	-59.26	-54.97	9.15	V

Remarks:

- 1. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).
- 2. EIRP (dBm) = S.G Value (dBm) + Correction Factor (dB).
- 3. The other emission levels were very low against the limit.