Shenzhen CTA Testing Technology Co., Ltd.
Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, China

RF Exposure evaluation

Report Reference No.....:	**CTA24052402905**
FCC ID. .....:	**2AJH3-AV14K**
Compiled by (position+printed name+signature) . :	File administrators Jinghua Xiao
Supervised by (position+printed name+signature) . :	Test Engineer Lushan Kong
Approved by (position+printed name+signature) . :	Manager Eric Wang
Date of issue .....:	Mar. 13, 2024
Representative Laboratory Name.:	**Shenzhen CTA Testing Technology Co., Ltd.**
Address .....:	Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, China
Applicant's name.....:	**Dune HD (HK) Limited**
Address .....:	10th Floor, Shun On Commercial Building, 112-114 Des Voeux Road, Central, Hong Kong
Test specification .....**:**	
Standard.....:	**47CFR §1.1310 Basis and purpose** **47CFR §2.1091 Radiofrequency radiation exposure evaluation: mobile devices** **KDB447498 D01 General RF Exposure Guidance v06**
TRF Originator.....:	Shenzhen Global Test Service Co.,Ltd.
Master TRF .....:	Dated 2014-12

Test item description .....:	set-top box
Trade Mark.....:	N/A
Manufacturer .....:	Dune HD (HK) Limited
Model/Type reference .....:	AV1 4K
Listed Models .....:	N/A
Modulation Type.....:	IEEE 802.11a/802.11b/802.11g/802.11n/802.11ac GFSK, π/4-DQPSK, 8-DPSK
Operation Frequency.....:	From 2402MHz to 2480MHz, 5180MHz to 5240MHz, 5745MHz to 5825MHz
Hardware Version .....:	N/A
Software Version.....:	N/A
Rating .....:	DC 5.0V/2.0A by Adapter
Result .....:	**PASS**

T E S T R E P O R T

Test Report No. :	**CTA24052402905**	Mar. 13, 2024 Date of issue

Equipment under Test	:	set-top box
Model /Type	:	AV1 4K
Listed model	:	N/A
Applicant	:	**Dune HD (HK) Limited**
Address	:	10th Floor, Shun On Commercial Building, 112-114 Des Voeux Road, Central, Hong Kong
Manufacturer	:	**Dune HD (HK) Limited**
Address	:	10th Floor, Shun On Commercial Building, 112-114 Des Voeux Road, Central, Hong Kong

Test Result:	**PASS**

Contents

1. SUMMARY

1.1 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

●	/	Length (m) :	/
		Shield :	/
		Detachable :	/

1.2 Product Description

Product Name:	set-top box
Trade Mark:	N/A
Model/Type reference:	AV1 4K
List Model:	N/A
Model Declaration	N/A
Power supply:	DC 5.0V/2.0A by Adapter
Hardware Version	N/A
Software Version	N/A
Sample ID	CTA240524029-S0001-1# & CTA240524029-S0001-2#
Bluetooth	
Frequency Range	2402MHz ~ 2480MHz
Channel Number	79 channels for Bluetooth (DSS) 40 channels for Bluetooth (DTS)
Channel Spacing	1MHz for Bluetooth (DSS) 2MHz for Bluetooth (DTS)
Modulation Type	GFSK, π/4-DQPSK, 8-DPSK for Bluetooth (DSS) GFSK for Bluetooth (DTS)
2.4GWLAN	
WLAN Operation frequency	IEEE 802.11b: 2412-2462MHz IEEE 802.11g: 2412-2462MHz IEEE 802.11n HT20: 2412-2462MHz IEEE 802.11n HT40:2422-2452MHz
WLAN Modulation Type	IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT20: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT40: OFDM (64QAM, 16QAM, QPSK, BPSK)
Channel number:	11 Channel for IEEE 802.11b/g/n(HT20) 7 Channel for IEEE 802.11n (HT40)
Channel separation:	5MHz
WIFI(5.2G/5.8G Band)	
Frequency Range	5180-5240MHz, 5745MHz to 5825MHz
Channel Number	4 Channels for 20MHz bandwidth(5180-5240MHz) 5 channels for 20MHz bandwidth(5745-5825MHz) 2 channels for 40MHz bandwidth(5190~5230MHz) 2 channels for 40MHz bandwidth(5755~5795MHz) 1 channels for 80MHz bandwidth(5210MHz) 1 channels for 80MHz bandwidth(5775MHz)
Modulation Type	IEEE 802.11a: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT20: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT40: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac VHT20: OFDM (256QAM,64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac VHT40: OFDM (256QAM,64QAM, 16QAM, QPSK, BPSK) IEEE 802.11ac VHT80: OFDM (256QAM,64QAM, 16QAM, QPSK, BPSK)
Antenna Description	Two Internal antenna respectively. WLAN not support 2*2MIMO technology. ANT0 used for BT TX/RX, 2.00 dBi(Max.) for 2.4GWLAN; ANT1 used for WIFI TX/RX, 2.00 dBi(Max.) for BT and 2.00dBi (Max.) for

	5GWLAN;

2. TEST ENVIRONMENT

2.1 Address of the test laboratory

Shenzhen CTA Testing Technology Co., Ltd.
Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, China

2.2 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:
FCC-Registration No.: 517856 Designation Number: CN1318
Shenzhen CTA Testing Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.
A2LA-Lab Cert. No.: 6534.01
Shenzhen CTA Testing Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.
The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.

2.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	950-1050mbar

2.4 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2 " and is documented in the Shenzhen CTA Testing Technology Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.
Hereafter the best measurement capability for Shenzhen CTA Testing Technology Co., Ltd. :

Test Items	Measurement Uncertainty	Notes
Transmitter power conducted	0.57 dB	(1)

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

3. METHOD OF MEASUREMENT

3.1 Applicable Standard

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.
According to §1.1310 and §2.1091 RF exposure is calculated.
KDB447498 D01 General RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

3.2 Requirement

Systems operating under the provisions of FCC 47 CFR section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.
In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.
In accordance with KDB447498 D01 General RF Exposure Guidance v06 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

3.3 Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	6
3.0 – 30	1842/f	4.89/f	$(900/f^2)$*	6
30 – 300	61.4	0.163	1.0	6
300 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 30	824/f	2.19/f	$(180/f^2)$*	30
30 – 300	27.5	0.073	0.2	30
300 – 1500	/	/	f/1500	30
1500 – 100,000	/	/	1.0	30

F=frequency in MHz
*=Plane-wave equivalent power density

3.4 MPE Calculation Method

Predication of MPE limit at a given distance
Equation from page 18 of OET Bulletin 65, Edition 97-01

$S=PG/4\pi R^2$
Where: S=power density
P=power input to antenna
G=power gain of the antenna in the direction of interest relative to an isotropic radiator
R=distance to the center of radiation of the antenna

As declared by the Applicant, the EUT transmits with the maximum soure-baed Duty Cycle of 100%-see the User manual, and the EUT is a wireless device used in a mobile application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum mobile separation distance, r =20cm, as well as the gain of the used antenna is 2.00dBi for BT&WLAN, and the power drift from Turn-up Procedure provide by manufacturer as following states, the RF power density can be obtained.

3.5 Antenna Information

AV1 4K can only use antennas certificated as follows provided by manufacturer;

Internal Identification	Antenna Identification in Internal photos	Antenna type and antenna number	Operate frequency band	Maximum antenna gain
Antenna 0	BT ANT0	Internal Antenna	2.4 – 2.5 GHz	2.00dBi (Max.) for 2.4G band
Antenna 1	WLAN ANT1	Internal Antenna	2.4 – 2.5 GHz 5.0 – 6.0 GHz	2.00dBi (Max.) for 2.4G band 2.00dBi (Max.) for 5G band

4. Conducted Power Results

Bluetooth

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	8.74
	39	2441	10.32
	78	2480	10.92
π/4DQPSK	0	2402	8.92
	39	2441	9.81
	78	2480	10.51
8-DPSK	0	2402	9.01
	39	2440	9.85
	78	2480	10.47
GFSK(BT LE)	0	2402	-3.92
	19	2440	-2.02
	39	2480	-1.93

2.4GWLAN

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
802.11b	01	2412	17.79
	06	2437	18.24
	11	2462	18.14
802.11g	01	2412	22.19
	06	2437	22.38
	11	2462	22.30
802.11n(HT20)	01	2412	21.83
	06	2437	21.11
	11	2462	21.13
802.11n(HT40)	03	2412	21.44
	06	2437	19.86
	9	2462	20.12

5.2GWLAN

Mode	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)
802.11a	36	5180	12.79
	40	5200	13.36
	48	5240	14.10
802.11n20	36	5180	12.74
	40	5200	13.24
	48	5240	14.06
802.11n40	38	5190	12.70
	46	5230	13.68
802.11ac20	36	5180	12.93
	40	5200	13.46
	48	5240	13.99
802.11ac40	38	5190	12.87
	46	5230	12.92
802.11ac80	42	5210	13.39

5.8GWLAN

Mode	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)
802.11a	149	5745	13.96
	157	5785	13.16
	165	5825	12.30
802.11n20	149	5745	12.22
	157	5785	12.85
	165	5825	12.31
802.11n40	151	5755	12.48
	159	5795	12.49
802.11ac20	149	5745	12.21
	157	5785	12.71
	165	5825	12.34
802.11ac40	151	5755	12.47
	159	5795	12.55
802.11ac80	155	5775	12.59

5. Manufacturing Tolerance

Bluetooth

GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	8.00	10.00	10.00
Tolerance ±(dB)	1.0	1.0	1.0
π/4DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	8.00	9.00	10.00
Tolerance ±(dB)	1.0	1.0	1.0
8-DPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	9.00	9.00	10.00
Tolerance ±(dB)	1.0	1.0	1.0
GFSK BT LE (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	-3.00	-2.00	-1.00
Tolerance ±(dB)	1.0	1.0	1.0

2.4GWLAN

IEEE 802.11b (Peak)			
Channel	Channel 01	Channel 06	Channel 11
Target (dBm)	17.00	18.00	18.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11g (Peak)			
Channel	Channel 01	Channel 06	Channel 11
Target (dBm)	22.00	22.00	22.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Peak)			
Channel	Channel 01	Channel 06	Channel 11
Target (dBm)	21.00	21.00	21.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Peak)			
Channel	Channel 03	Channel 06	Channel 09
Target (dBm)	21.00	19.00	20.00
Tolerance ±(dB)	1.0	1.0	1.0

5.2GWLAN

IEEE 802.11a (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	12.00	13.00	14.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	12.00	13.00	14.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n VHT40 (Average)			
Channel	Channel 38	Channel 46	/
Target (dBm)	12.00	13.00	/
Tolerance ±(dB)	1.0	1.0	/
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	12.00	13.00	13.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 38	Channel 46	/
Target (dBm)	12.00	12.00	/
Tolerance ±(dB)	1.0	1.0	/
IEEE 802.11ac VHT80 (Average)			
Channel	Channel 42	/	/
Target (dBm)	13.00	/	/
Tolerance ±(dB)	1.0	/	/

5.8GWLAN

IEEE 802.11a (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	13.00	13.00	12.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	12.00	12.00	12.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n VHT40 (Average)			
Channel	Channel 151	Channel 159	/
Target (dBm)	12.00	12.00	/
Tolerance ±(dB)	1.0	1.0	/
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	12.00	12.00	12.00
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 151	Channel 159	/
Target (dBm)	12.00	12.00	/
Tolerance ±(dB)	1.0	1.0	/
IEEE 802.11ac VHT80 (Average)			
Channel	Channel 155	/	/
Target (dBm)	12.00	/	/
Tolerance ±(dB)	1.0	/	/

6. Measurement Results

6.1 Standalone MPE Evaluation

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, r =20cm, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

BT

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
GFSK	11.00	12.5893	2.00	1.5849	0.0040	1.0000
π/4DQPSK	11.00	12.5893	2.00	1.5849	0.0040	1.0000
8-DPSK	11.00	12.5893	2.00	1.5849	0.0040	1.0000
GFSK(BT LE)	0.00	1.0000	2.00	1.5849	0.0003	1.0000

2.4GWLAN

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
802.11b	19.00	79.4328	2.00	1.5849	0.0250	1.0000
802.11g	23.00	199.5262	2.00	1.5849	0.0629	1.0000
802.11n(HT20)	22.00	158.4893	2.00	1.5849	0.0500	1.0000
802.11n(HT40)	22.00	158.4893	2.00	1.5849	0.0500	1.0000

5.2GWLAN

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
802.11a	15.00	31.6228	2.00	1.5849	0.0100	1.0000
802.11n20	15.00	31.6228	2.00	1.5849	0.0100	1.0000
802.11n40	14.00	25.1189	2.00	1.5849	0.0079	1.0000
802.11ac20	14.00	25.1189	2.00	1.5849	0.0079	1.0000
802.11ac40	13.00	19.9526	2.00	1.5849	0.0063	1.0000
802.11ac80	14.00	25.1189	2.00	1.5849	0.0079	1.0000

5.8GWLAN

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MP20 Limits (mW/cm^2)
	dBm	mW				
802.11a	14.00	25.1189	2.00	1.5849	0.0079	1.0000
802.11n20	13.00	19.9526	2.00	1.5849	0.0063	1.0000
802.11n40	13.00	19.9526	2.00	1.5849	0.0063	1.0000
802.11ac20	13.00	19.9526	2.00	1.5849	0.0063	1.0000
802.11ac40	13.00	19.9526	2.00	1.5849	0.0063	1.0000
802.11ac80	13.00	19.9526	2.00	1.5849	0.0063	1.0000

Remark:

1. Output power including tune-up tolerance;

2. MPE evaluate distance is 20cm from user manual provide by manufacturer;

3. According to ANSI C63.10: 2020 Clause 6.4.4.2, $E_{0.2m} = E_{3m} + 40 \log (3/0.2)$;

6.2 Simultaneous Transmission MPE

The sample support one Bluetooth & WLAN modular and one Bluetooth antenna,and one 2.4GWLAN antennas, WLAN not support MIMO, Not Need consider simultaneous transmission ;

According to KDB447498 D01 General RF Exposure Guidance v06 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
∑ of MPE ratios ≤ 1.0

6.2.1 Summary simultaneous transmission information

Modulation Type	Work Frequency Band	Transmit Antenna		Antenna 0, Antenna 1 Synchronization transmits
		Antenna 0	Antenna 1	
BT	2.4GHz	Yes	No	No
WLAN	2.4GHz	No	Yes	No
WLAN	5GHz	No	Yes	No
		Antenna 0	Antenna 1	2.4GHzWLAN + 5GHzWLAN Synchronization transmits
WLAN	2.4GHz	No	Yes	No
WLAN	5GHz	No	Yes	No

6.2.2 Summary simultaneous transmission results

Maximum Simultaneous transmission MPE Ratios for **2.4GWLAN, BT.**

Maximum MPE ratio 2.4GWLAN	Maximum MPE ratio BT	∑MPE ratios	Limit	Results
0.0629	0.0040	0.0669	1.0	PASS

7. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure and SAR Exclusion Threshold per KDB447498 D01 General RF Exposure Guidance v06.

.....End of Report.....