RF Exposure Evaluation Report

Product Name : Communication Module
Model No. : LBEQ6ZZ1BN
FCC ID : 2AZKT71099000WIFI

Applicant : Waymo LLC
Address : 1600 Amphitheatre Parkway Mountain View, CA 94043 United States.

Date of Receipt : Nov. 09, 2020
Date of Declaration : Nov. 08, 2021
Report No. : 20B0272R-E3082100013
Report Version : V1.0

Issued Date: Nov. 08, 2021
Report No.: 20B0272R-E3082100013

Product Name	Communication Module	
Applicant	Waymo LLC	
Address	1600 Amphitheatre Parkway Mountain View, CA 94043 United States.	
Manufacturer	Tech-com (Shanghai) Computer Co. Ltd	
Model No.	LBEQ6ZZ1BN	
FCC ID.	2AZKT71099000WIFI	
Trade Name	Waymo	
Applicable Standard	KDB 447498 D01 v06	☒ Minimum test separation distance ≥ 20 cm ☐ For low power devices
Test Result	Complied	

Documented By : Joanne Lin
(Senior Adm. Specialist / Joanne Lin)

Tested By : Jack Hsu
(Senior Engineer / Jack Hsu)

Approved By :
(Director / Vincent Lin)

Revision History

Report No.	Version	Description	Issued Date
20B0272R-E3082100013	V1.0	Initial issue of report.	2021-11-08

1. GENERAL INFORMATION

1.1. EUT Description

Product Name	Communication Module
Trade Name	Waymo
Model No.	LBEQ6ZZ1BN
FCC ID.	2AZKT71099000WIFI
Contain FCC ID	2AX2UAR7592V1, WWAN module*2
Frequency Range	802.11b/g/n-20MHz: 2412-2462MHz 802.11a/n-20MHz: 5180-5320MHz, 5500-5700MHz, 5720MHz, 5745-5825MHz 802.11n-40MHz: 5190-5310MHz, 5510-5670MHz, 5710MHz, 5755-5795MHz 802.11ac-80MHz: 5210-5290MHz, 5530-5690MHz, 5775MHz Bluetooth: 2402-2480MHz
Number of Channels	802.11b/g/n-20MHz: 11 802.11a/n-20MHz: 25, 802.11n-40MHz: 12, 802.11ac-80MHz: 6 Bluetooth V4.0: 40CH
Data Speed	802.11b: 1-11Mbps, 802.11g: 6-54Mbps, 802.11n: up to 144.4Mbps 802.11a: 6 - 54Mbps 802.11n: up to 300Mbps 802.11ac-80MHz: up to 866.7Mbps
Channel separation	802.11b/g/n: 5MHz Bluetooth: 2MHz
Type of Modulation	802.11b: DSSS (DBPSK, DQPSK, CCK) 802.11g/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11a/n/ac: OFDM, BPSK, QPSK, 16QAM, 64QAM, 256QAM Bluetooth V4.0: GFSK (1Mbps)
Antenna Type	PCB Antenna / Patch Antenna / Monopole Antenna
Channel Control	Auto
Antenna Gain	Refer to the table “Antenna List”

Antenna List (WLAN Antenna)

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	Quanta	N/A	PCB Antenna	2.88dBi for 2.4GHz 3.03dBi for 5GHz

Antenna List (BLE Antenna #1)

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	Inpaq	WIFI00BP-LA-00-B	Patch Antenna	2.7dBi for 2.4 GHz

Antenna List (BLE Antenna #2)

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	Inpaq	WIFI00BP-LA-01-B	Patch Antenna	1.9dBi for 2.4 GHz

Antenna List (BLE Antenna #3)

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	Inpaq	WIFI00BP-LA-02-B	Patch Antenna	2.6dBi for 2.4 GHz

Antenna List (LTE Antenna)

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	Inpaq	LTE1 (module1 TX) (Primary A) (with filter)	Monopole Antenna	2.62dBi for B2 3.50dBi for B4 0.78dBi for B5 2.31dBi for B13 1.28dBi for B12/B17
2	Inpaq	LTE2 (module1 RX) (Secondary A)	Monopole Antenna	1.11dBi for B2 2.12dBi for B4 0.97dBi for B5 2.02dBi for B13 1.53dBi for B12/B17
3	Inpaq	LTE3 (module2 TX) (Primary B) (with filter)	Monopole Antenna	1.34dBi for B2 2.22dBi for B4 0.76dBi for B5 1.35dBi for B13 1.39dBi for B12/B17
4	Inpaq	LTE4 (module2 RX) (Secondary B)	Monopole Antenna	3.10dBi for B2 3.34dBi for B4 0.43dBi for B5 2.40dBi for B13 1.58dBi for B12/B17

2. RF Exposure Evaluation

2.1. Standard Applicable

According to KDB 447498 D01 (7.1), A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits.

2.2. Limits

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (Minutes)
(A) Limits for Occupational/ Control Exposures				
300-1500	--	--	F/300	6
1500-100,000	--	--	5	6
(B) Limits for General Population/ Uncontrolled Exposures				
300-1500	--	--	F/1500	6
1500-100,000	--	--	1	30

F= Frequency in MHz

Friis Formula

Friis transmission formula: $Pd = (Pout*G)/(4*pi*r^2)$

Where

Pd = power density in mW/cm^2

Pout = output power to antenna in mW

G = gain of antenna in linear scale

Pi = 3.1416

R = distance between observation point and center of the radiator in cm

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0

2.3. Test Result of RF Exposure Evaluation

Product : Communication Module
Test Item : RF Exposure Evaluation

BLE#1 2.4G Peak Gain: 2.7dBi

Band	Frequency (MHz)	Conducted maximum Peak Power (dBm)	Worst Case Duty Cycle (%)	Output Power to Antenna (mW)	Power Density at R = 20 cm (mW/cm^2)	Limit (mW/cm^2)	Pass/Fail
2.4G	2440	2.59	34.02	5.337	0.0020	1	Pass

BLE#2 2.4G Peak Gain: 1.9dBi

Band	Frequency (MHz)	Conducted maximum Peak Power (dBm)	Worst Case Duty Cycle (%)	Output Power to Antenna (mW)	Power Density at R = 20 cm (mW/cm^2)	Limit (mW/cm^2)	Pass/Fail
2.4G	2440	2.52	34.02	5.251	0.0016	1	Pass

BLE#3 2.4G Peak Gain: 2.6dBi

Band	Frequency (MHz)	Conducted maximum Peak Power (dBm)	Worst Case Duty Cycle (%)	Output Power to Antenna (mW)	Power Density at R = 20 cm (mW/cm^2)	Limit (mW/cm^2)	Pass/Fail
2.4G	2440	2.95	34.02	5.798	0.0021	1	Pass

Note: The Maximum conducted output power is refer to report No.: 20B0272R-E3032110113 from the DEKRA.

WLAN 2.4G Peak Gain: 2.88dBi

Band	Frequency (MHz)	Conducted maximum Peak Power (dBm)	Worst Case Duty Cycle (%)	Output Power to Antenna (mW)	Power Density at R = 20 cm (mW/cm^2)	Limit (mW/cm^2)	Pass/Fail
2.4G	2417	24.12	97.43	265.037	0.1023	1	Pass

Note: The Maximum conducted output power is refer to report No.: 20B0272R-E3032110109 from the DEKRA.

WLAN 5G Peak Gain: 3.03dBi

Band	Frequency (MHz)	Conducted maximum Peak Power (dBm)	Worst Case Duty Cycle (%)	Output Power to Antenna (mW)	Power Density at R = 20 cm (mW/cm^2)	Limit (mW/cm^2)	Pass/Fail
5G	5260	15.61	91.75	39.664	0.0159	1	Pass

Note: The Maximum conducted output power is refer to report No.: 20B0272R-E3032110125 from the DEKRA.

WWAN module#1 Peak Gain: B2 2.62 dBi; B4 3.5 dBi; B5 0.78 dBi; B13 2.31Bi; B12/B17 1.28 dBi

WWAN	Band	Frequency (MHz)	Conducted Peak Power (pre tune-up) (dBm)	Duty Cycle (%)	Conducted Average Power (dBm)	Output Power to Antenna (mW)	Power Density at R = 20 cm (mW/cm2)	Limit (mW/cm2)	Pass/Fail
GSM	850	824-849	33	25	26.98	498.8	0.118760	0.55	Pass
PCS	1900	1850-1910	29	50	25.99	397.2	0.144444	1.00	Pass
WCDMA	2	1850-1910	25.7	100	25.70	371.5	0.135123	1.00	Pass
WCDMA	4	1710-1755	25.7	100	25.70	371.5	0.165474	1.00	Pass
WCDMA	5	824-849	25.7	100	25.70	371.5	0.088457	0.55	Pass
2	2	1850-1910	25.2	100	25.20	331.1	0.120429	1.00	Pass
4	4	1710-1755	25.2	100	25.20	331.1	0.133768	1.00	Pass
5	5	824-849	25.2	100	25.20	331.1	0.065155	0.55	Pass
12	12	699-716	25.2	100	25.20	331.1	0.066886	0.47	Pass
13	13	777-787	25.2	100	25.20	331.1	0.077870	0.52	Pass
17	17	704-716	25.2	100	25.20	331.1	0.056612	0.47	Pass

WWAN module#2 Peak Gain: B2 1.34 dBi; B4 2.22 dBi; B5 0.76 dBi; B13 1.35Bi; B12/B17 1.39 dBi

WWAN	Band	Frequency (MHz)	Conducted Peak Power (pre tune-up) (dBm)	Duty Cycle (%)	Conducted Average Power (dBm)	Output Power to Antenna (mW)	Power Density at R = 20 cm (mW/cm2)	Limit (mW/cm2)	Pass/Fail
GSM	850	824-849	33	25	26.98	498.8	0.118214	0.55	Pass
PCS	1900	1850-1910	29	50	25.99	397.2	0.107572	1.00	Pass
WCDMA	2	1850-1910	25.7	100	25.70	371.5	0.100631	1.00	Pass
WCDMA	4	1710-1755	25.7	100	25.70	371.5	0.123234	1.00	Pass
WCDMA	5	824-849	25.7	100	25.70	371.5	0.088050	0.55	Pass
2	2	1850-1910	25.2	100	25.20	331.1	0.089687	1.00	Pass
4	4	1710-1755	25.2	100	25.20	331.1	0.099621	1.00	Pass
5	5	824-849	25.2	100	25.20	331.1	0.064855	0.55	Pass
12	12	699-716	25.2	100	25.20	331.1	0.068602	0.47	Pass
13	13	777-787	25.2	100	25.20	331.1	0.062426	0.52	Pass
17	17	704-716	25.2	100	25.20	331.1	0.058064	0.47	Pass

Note: The conducted output power is refer to Original RF Exposure Report for FCC ID: 2AX2UAR7592V1.

2.4. Calculations for Multi-Transsmitter

Mode	Power Density at R = 20 cm	Limit (mW/cm2)	Radio	Total	Radio Limit	Pass/Fail
BLE#1	0.0020	1	0.0020	0.54	1	Pass
BLE#2	0.0016	1	0.0016			
BLE#3	0.0021	1	0.0021			
WLAN	0.1023	1	0.1023			
WWAN#1	0.118760	0.55	0.2162			
WWAN#2	0.118214	0.55	0.2152			