

Maximum Permissible Exposure Report

1 PRODUCT INFORMATION

EUT	: Set Top Box
Model Number	: ROBERTS-3PATH
Model Declaration	: N/A
Test Model	: ROBERTS-3PATH
Power Supply	: Input:DC 12V
Hardware version	: SO288LA
Software version	: V1.0

2 EVALUATION METHOD

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 KDB447498D01 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 modelled 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 LIMIT

3.1 Refer evaluation method

ANSI C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

FCC KDB publication 447498 D01 General 1 RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

FCC CFR 47 part1 1.1310: Radiofrequency radiation exposure limits.

FCC CFR 47 part2 2.1091: Radiofrequency radiation exposure evaluation: mobile devices

3.2 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

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

5 ANTENNA INFORMATION

Antenna Gain and type refer to Antenna specification

6 CONDUCTED POWER

2.4G Band:
Bluetooth(BDR+EDR)

Test Mode	Antenna	Frequency[MHz]	Result[dBm]
DH5	Ant1	2402	1.72
DH5	Ant1	2441	1.46
DH5	Ant1	2480	-0.33
2DH5	Ant1	2402	1.30
2DH5	Ant1	2441	1.20
2DH5	Ant1	2480	-0.26
3DH5	Ant1	2402	-5.13
3DH5	Ant1	2441	-5.44
3DH5	Ant1	2480	-6.90

Bluetooth(BLE)

TestMode	Antenna	Frequency[MHz]	Result[dBm]
BLE_1M	Ant1	2402	1.33
BLE_1M	Ant1	2440	0.60
BLE_1M	Ant1	2480	-0.46

WiFi 2.4GHz Band

Test Mode	Antenna	Frequency[MHz]	Result [dBm]
11B	Ant2	2412	10.25
11B	Ant1	2412	0.52
11B	Ant1	2437	1.53
11B	Ant2	2437	6.66
11B	Ant1	2462	1.66
11B	Ant2	2462	9.68
11G	Ant1	2412	2.36
11G	Ant2	2412	10.14
11G	Ant1	2437	2.61
11G	Ant2	2437	9.73
11G	Ant1	2462	3.76
11G	Ant2	2462	9.40
11N20MIMO	Ant1	2412	2.76
11N20MIMO	Ant2	2412	10.06
11N20MIMO	total	2412	10.80
11N20MIMO	Ant2	2437	9.80
11N20MIMO	total	2437	10.19
11N20MIMO	Ant1	2437	3.84
11N20MIMO	Ant2	2462	9.24
11N20MIMO	total	2462	9.62
11N20MIMO	Ant1	2462	4.23
11N40MIMO	Ant2	2422	10.28
11N40MIMO	total	2422	10.70
11N40MIMO	Ant1	2422	3.20
11N40MIMO	Ant2	2437	10.00
11N40MIMO	total	2437	10.43
11N40MIMO	Ant1	2437	3.90
11N40MIMO	Ant1	2452	4.20
11N40MIMO	Ant2	2452	9.82
11N40MIMO	total	2452	10.87

5G Band
UNII-1 Band

Test Mode	Antenna	Frequency[MHz]	Result [dBm]
11A	Ant1	5180	-5.78
11A	Ant2	5180	11.56
11A	Ant1	5200	-6.67
11A	Ant2	5200	11.10
11A	Ant1	5240	-5.75
11A	Ant2	5240	12.15
11N20MIMO	Ant1	5180	-5.86
11N20MIMO	Ant2	5180	11.64
11N20MIMO	total	5180	11.72
11N20MIMO	Ant1	5200	-6.79
11N20MIMO	Ant2	5200	11.05
11N20MIMO	total	5200	11.12
11N20MIMO	Ant1	5240	-5.95
11N20MIMO	Ant2	5240	12.29
11N20MIMO	total	5240	12.35
11N40MIMO	Ant1	5190	-6.59
11N40MIMO	Ant2	5190	11.11
11N40MIMO	total	5190	11.18
11N40MIMO	Ant1	5230	-6.18
11N40MIMO	Ant2	5230	11.64
11N40MIMO	total	5230	11.71
11AC20MIMO	Ant1	5180	-7.96
11AC20MIMO	Ant2	5180	9.64
11AC20MIMO	total	5180	9.71
11AC20MIMO	Ant1	5200	-8.51
11AC20MIMO	Ant2	5200	9.50
11AC20MIMO	total	5200	9.57
11AC20MIMO	Ant1	5240	-7.48
11AC20MIMO	Ant2	5240	10.55
11AC20MIMO	total	5240	10.62
11AC40MIMO	Ant1	5190	-7.06
11AC40MIMO	Ant2	5190	9.35
11AC40MIMO	total	5190	9.45
11AC40MIMO	Ant1	5230	-5.55
11AC40MIMO	Ant2	5230	9.91
11AC40MIMO	total	5230	10.03
11AC80MIMO	Ant1	5210	-6.05
11AC80MIMO	Ant2	5210	9.07
11AC80MIMO	total	5210	9.20

UNII-3 Band

Test Mode	Antenna	Frequency[MHz]	Result [dBm]
11A	Ant1	5745	-2.48
11A	Ant2	5745	5.20
11A	Ant1	5785	-2.67
11A	Ant2	5785	4.92
11A	Ant1	5825	-3.87
11A	Ant2	5825	5.56
11N20MIMO	Ant1	5745	-1.66
11N20MIMO	Ant2	5745	5.93
11N20MIMO	total	5745	6.63
11N20MIMO	Ant1	5785	-2.78
11N20MIMO	Ant2	5785	6.00
11N20MIMO	total	5785	6.54
11N20MIMO	Ant1	5825	-3.46
11N20MIMO	Ant2	5825	6.14
11N20MIMO	total	5825	6.59
11N40MIMO	Ant1	5755	-2.21
11N40MIMO	Ant2	5755	5.63
11N40MIMO	total	5755	6.29
11N40MIMO	Ant1	5795	-3.02
11N40MIMO	Ant2	5795	5.58
11N40MIMO	total	5795	6.14
11AC20MIMO	Ant1	5745	-0.81
11AC20MIMO	Ant2	5745	6.90
11AC20MIMO	total	5745	7.58
11AC20MIMO	Ant1	5785	-1.85
11AC20MIMO	Ant2	5785	6.90
11AC20MIMO	total	5785	7.44
11AC20MIMO	Ant1	5825	-2.28
11AC20MIMO	Ant2	5825	7.36
11AC20MIMO	total	5825	7.81
11AC40MIMO	Ant1	5755	-1.31
11AC40MIMO	Ant2	5755	6.53
11AC40MIMO	total	5755	7.19
11AC40MIMO	Ant1	5795	-3.23
11AC40MIMO	Ant2	5795	6.68
11AC40MIMO	total	5795	7.10
11AC80MIMO	Ant1	5775	-3.03
11AC80MIMO	Ant2	5775	6.20
11AC80MIMO	total	5775	6.69

7 MANUFACTURING TOLERANCE

Bluetooth(BDR+EDR)

GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	1.0	1.0	-1.0
Tolerance $\pm$ (dB)	1	1	1
$\pi/4$ -DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	1	0.5	-1
Tolerance $\pm$ (dB)	1	1	1
8-DPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	-5.5	-6	-7.5
Tolerance $\pm$ (dB)	1	1	1

Bluetooth(BLE)

GFSK(1Mbps) (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	1	0	-1
Tolerance $\pm$ (dB)	1	1	1

WiFi 2.4GHz Band – Antenna 1

IEEE 802.11b(Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10	1	1
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11g(Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	2	2	3.5
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20(Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	2.5	9.5	8.5
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT40(Average)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	10	9.5	3.5
Tolerance $\pm$ (dB)	1	1	1

WiFi 2.4GHz Band – Antenna 2

IEEE 802.11b (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	0	6	9
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11g (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	9.5	9	9
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20 (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	9.5	9.5	9
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT40(Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10	10	9.5
Tolerance $\pm$ (dB)	1	1	1

UNII-1 Band – Antenna 1

IEEE 802.11a (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	-6.5	-7	-6
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	-6.5	-7.5	-6.5
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT40 (Average)			
Channel	Channel 38	Channel 46	--
Target (dBm)	-7	-6.5	--
Tolerance $\pm$ (dB)	1	1	--
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	-8.5	-9	-8
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 38	Channel 46	--
Target (dBm)	-7.5	-6	--
Tolerance $\pm$ (dB)	1	1	--
IEEE 802.11ac VHT80 (Average)			
Channel	Channel 42	--	--
Target (dBm)	-6.5	--	--
Tolerance $\pm$ (dB)	1	--	--

UNII-1 Band – Antenna 2

IEEE 802.11a (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	11	10.5	11.5
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	11	10.5	12
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT40 (Average)			
Channel	Channel 38	Channel 46	--
Target (dBm)	10.5	11	--
Tolerance $\pm$ (dB)	1	1	--
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	9	9	10
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 38	Channel 46	--
Target (dBm)	9	9.5	--
Tolerance $\pm$ (dB)	1	1	--
IEEE 802.11ac VHT80 (Average)			
Channel	Channel 42	--	--
Target (dBm)	8.5	--	--
Tolerance $\pm$ (dB)	1	--	--

UNII-3 Band – Antenna 1

IEEE 802.11a (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	-3	-3	-4.5
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	-2	-3.5	-4
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT40 (Average)			
Channel	Channel 151	Channel 159	--
Target (dBm)	-2.5	-3.5	--
Tolerance $\pm$ (dB)	1	1	--
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	-1.5	-2.5	-3
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 151	Channel 159	--
Target (dBm)	-2	-3.5	--
Tolerance $\pm$ (dB)	1	1	--
IEEE 802.11ac VHT80 (Average)			
Channel	Channel 155	--	--
Target (dBm)	-3.5	--	--
Tolerance $\pm$ (dB)	1	--	--

UNII-3 Band – Antenna 2

IEEE 802.11a (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	4.5	4.5	5
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	5.5	5.5	5.5
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT40 (Average)			
Channel	Channel 151	Channel 159	--
Target (dBm)	5	5	--
Tolerance $\pm$ (dB)	1	1	--
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	6.5	6.5	7
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 151	Channel 159	--
Target (dBm)	6	6	--
Tolerance $\pm$ (dB)	1	1	--
IEEE 802.11ac VHT80 (Average)			
Channel	Channel 155	--	--
Target (dBm)	5.5	--	--
Tolerance $\pm$ (dB)	1	--	--

8 MEASUREMENT RESULTS

8.1 Standalone MPE

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, $r = 20\text{cm}$, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

Bluetooth(BDR+EDR)

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
GFSK	2.0	1.5849	2	1.5849	100%	0.0005	1.0000
$\pi/4$ -DQPSK	2.0	1.5849	2	1.5849	100%	0.0005	1.0000
8-DPSK	-4.5	0.3548	2	1.5849	100%	0.0001	1.0000

Bluetooth(BLE)

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
GFSK(1Mbps)	2.0	1.5849	2	1.5849	100%	0.0005	1.0000

WiFi 2.4GHz Band – Ant 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11b	11.0	12.5893	3.97	2.4946	100%	0.0063	1.0000
IEEE 802.11g	4.5	2.8184	3.97	2.4946	100%	0.0014	1.0000
IEEE 802.11n HT20	10.5	11.2202	3.97	2.4946	100%	0.0056	1.0000
IEEE 802.11n HT40	11.0	12.5893	3.97	2.4946	100%	0.0063	1.0000

WiFi 2.4GHz Band – Ant 2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11b	10.0	10.0000	3.9	2.4547	100%	0.0049	1.0000
IEEE 802.11g	10.5	11.2202	3.9	2.4547	100%	0.0055	1.0000
IEEE 802.11n HT20	10.5	11.2202	3.9	2.4547	100%	0.0055	1.0000
IEEE 802.11n HT40	11.0	12.5893	3.9	2.4547	100%	0.0062	1.0000

UNII-1 Band – Ant 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	-5.0	0.3162	3.67	2.3281	100%	0.0001	1.0000
IEEE 802.11n HT20	-5.5	0.2818	3.67	2.3281	100%	0.0001	1.0000
IEEE 802.11ac VHT20	-7.0	0.1995	3.67	2.3281	100%	0.0001	1.0000
IEEE 802.11n HT40	-5.5	0.2818	3.67	2.3281	100%	0.0001	1.0000
IEEE 802.11ac VHT40	-5.0	0.3162	3.67	2.3281	100%	0.0001	1.0000
IEEE 802.11ac VHT80	-5.5	0.2818	3.67	2.3281	100%	0.0001	1.0000

UNII-1 Band – Ant 2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	12.5	17.7828	3.71	2.3496	100%	0.0083	1.0000
IEEE 802.11n HT20	13.0	19.9526	3.71	2.3496	100%	0.0093	1.0000
IEEE 802.11ac VHT20	11.0	12.5893	3.71	2.3496	100%	0.0059	1.0000
IEEE 802.11n HT40	12.0	15.8489	3.71	2.3496	100%	0.0074	1.0000
IEEE 802.11ac VHT40	10.5	11.2202	3.71	2.3496	100%	0.0052	1.0000
IEEE 802.11ac VHT80	9.5	8.9125	3.71	2.3496	100%	0.0042	1.0000

UNII-3 Band – Ant 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	-2.0	0.6310	3.96	2.4889	100%	0.0003	1.0000
IEEE 802.11n HT20	-1.0	0.7943	3.96	2.4889	100%	0.0004	1.0000
IEEE 802.11ac VHT20	-0.5	0.8913	3.96	2.4889	100%	0.0004	1.0000
IEEE 802.11n HT40	-1.5	0.7079	3.96	2.4889	100%	0.0004	1.0000
IEEE 802.11ac VHT40	-1.0	0.7943	3.96	2.4889	100%	0.0004	1.0000
IEEE 802.11ac VHT80	-2.5	0.5623	3.96	2.4889	100%	0.0003	1.0000

UNII-3 Band – Ant 2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	6.0	3.9811	3.97	2.4946	100%	0.0020	1.0000
IEEE 802.11n HT20	6.5	4.4668	3.97	2.4946	100%	0.0022	1.0000
IEEE 802.11ac VHT20	8.0	6.3096	3.97	2.4946	100%	0.0031	1.0000
IEEE 802.11n HT40	6.0	3.9811	3.97	2.4946	100%	0.0020	1.0000
IEEE 802.11ac VHT40	7.0	5.0119	3.97	2.4946	100%	0.0025	1.0000
IEEE 802.11ac VHT80	6.5	4.4668	3.97	2.4946	100%	0.0022	1.0000

Remark:

1. Output power including tune-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer;

8.2 Simultaneous Transmission MPE

Bluetooth + Wi-Fi

Maximum MPE Ratio BT Ant.	Maximum MPE Ratio WIFI	Maximum MPE Ratio WIFI	Σ MPE	Limit	Results
0.0005	0.0063	0.0093	0.0161	1	PASS

Remark:

- 1. Output power including tune-up tolerance;*
- 2. MPE evaluate distance is 20cm from user manual provide by manufacturer;*

9 CONCLUSION

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

-----THE END OF REPORT-----