

RF Exposure Evaluation Report

Equipment : 802.11a/b/g/n/ac RTL8821CE Combo module
Brand Name : REALTEK
Model No. : RTL8821CE
FCC ID : TX2-RTL8821CE
Standard : 47 CFR Part 2.1091
Applicant : Realtek Semiconductor Corp.
No. 2, Innovation Road II, Hsinchu Science Park,
Hsinchu 300, Taiwan
Manufacturer : Realtek Semiconductor Corp.
No. 2, Innovation Road II, Hsinchu Science Park,
Hsinchu 300, Taiwan

The product sample received on Sep. 30, 2016 and completely tested on Nov. 29, 2016. We, SPORTON, would like to declare that the tested sample has been evaluated in accordance with 47 CFR Part 2.1091, and pass the limit.

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Cliff Chang
SPORTON INTERNATIONAL INC.





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REVISION HISTORY

[illegible]

1 General Description

1.1 EUT General Information

RF General Information			
Evaluation Mode	Frequency Range (MHz)	Operating Frequency (MHz)	Modulation Type
2.4GHz WLAN	2400-2483.5	2412-2472	802.11b: DSSS (DBPSK, DQPSK, CCK) 802.11g/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM)
5GHz WLAN	5150-5250 5250-5350 5470-5725 5725-5850	5180-5240 5260-5320 5500-5720 5745-5825	802.11a/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM)
Bluetooth	2400-2483.5	2402-2480	BR / EDR: FHSS (GFSK / $\pi/4$ -DQPSK / 8DPSK) LE: DSSS (GFSK)

1.2 Testing Location

Testing Location		
☐	HWA YA	ADD : No. 52, Hwa Ya 1st Rd., Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL : 886-3-327-3456 FAX : 886-3-327-0973
☒	JHUBEI	ADD : No.8, Lane 724, Bo-ai St., Jhubei City, HsinChu County 302, Taiwan, R.O.C. TEL : 886-3-656-9065 FAX : 886-3-656-9085

1.3 Table for class I change

This product is an extension of original one reported under Sporton project number: FA692918-03
Below is the table for the change of the product with respect to the original one.

Modifications	Performance Checking
Maximum Permissible Exposure	Maximum Permissible Exposure

Note: RF Exposure Evaluation of 5GHz Band 1, 2, 4 and 2.4GHz Band are based on original test report.

1.4 Antenna Information

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)	
					2.4GHz	5GHz
1	LYNwave	ALA110-222050-300011	PIFA Antenna	IPEX MHF4	3.5	5
2	PSA	RFDPA171320EMLB301	Dipole Antenna	IPEX MHF4	3.14	5

Note: 1. The EUT has two types of antenna and there are above only records higher gain of same type antenna.

2. For more information, refer to Appendix A. Antenna List.

3. There are four configurations for EUT.

4. Chain 1: Connect to Ant. 1 or Ant. 2, Chain 2: Connect to Ant. 1 or Ant. 2

EUT	Configuration	Antenna Chain	Description
EUT 1	Config.1 Diversity	2 chains	The EUT supports the antenna with TX/RX diversity function for WLAN and Bluetooth. (Ex. Assume chain 1 was selected to conduct transmitting function in WLAN, so chain 2 was selected in Bluetooth Mode. Vice versa.) WLAN 2.4GHz and Bluetooth will be transmitting from the different chains; WLAN 5GHz and Bluetooth will be transmitting from the same chain. WLAN function (1TX, 1RX) / Bluetooth function (1TX, 1RX) The EUT supports 1TX/1RX function, and it supports TX/RX diversity function. Both chain 1 and chain 2 could be used as transmitting/receiving antenna, but only one of them could transmit/receive at the same time.
EUT 2	Config.2 Fixed	2 chains	WLAN function (1TX, 1RX) / Bluetooth function (1TX, 1RX) Chain 2 is designated for WLAN (2.4GHz), Chain 1 is designated for WLAN (5GHz) and Bluetooth.
EUT 3	Config.3 Single	1 chain	WLAN function (1TX, 1RX) / Bluetooth function (1TX, 1RX) WLAN and BT share a common chain, where WLAN (2.4GHz) and BT couldn't transmit/receive at the same time, but WLAN (5GHz) and BT could transmit/receive at the same time.
EUT 4	Config.4 Single	1 chain	WLAN function (1TX, 1RX) / Bluetooth function (1TX, 1RX) WLAN and BT share a common chain, where WLAN (2.4GHz) and BT couldn't transmit/receive at the same time, but WLAN (5GHz) and BT could transmit/receive at the same time.

2 Maximum Permissible Exposure

2.1 Limit of Maximum Permissible Exposure

(A) Limits for Occupational / Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842 / f	4.89 / f	(900 / f)*	6
30-300	61.4	0.163	1.0	6
300-1500			F/300	6
1500-100,000			5	6

(B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

2.2 MPE Calculation Method

The MPE was calculated at 20 cm to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

$$E \text{ (V/m)} = \frac{\sqrt{30 \times P \times G}}{d} \quad \text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

E = Electric field (V/m)

P = RF output power (W)

G = EUT Antenna numeric gain (numeric)

d = Separation distance between radiator and human body (m)

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2}$$



2.3 Calculated Result and Limit

Exposure Environment: General Population / Uncontrolled Exposure

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	EIRP (W)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)
2.4G; 11G 2437 MHz	3.5	18.21	21.71	0.14825	20	0.02950	1
2.4G;BT-LE 2402 MHz	3.5	5.53	9.03	0.00800	20	0.00159	1
5.2G; 11a 5240 MHz	5	16.74	21.74	0.14928	20	0.02971	1
5.3G; 11a 5260 MHz	5	16.72	21.72	0.14859	20	0.02957	1
5.6G; 11a 5720 MHz	5	16.70	21.70	0.14791	20	0.02944	1
5.8G; 11ac20 5825 MHz	5	16.74	21.74	0.14928	20	0.02971	1

Simultaneous Transmission Analysis Mode: WLAN 2.4GHz+Bluetooth

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	EIRP (W)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Ratio (S/Limit)
2.4G; 11G 2437 MHz	3.5	18.21	21.71	0.14825	20	0.02950	1	0.02950
2.4G;BT-LE 2402 MHz	3.5	5.53	9.03	0.00800	20	0.00159	1	0.00159
							Sum Ratio	0.03109
							Ratio Limit	1

Simultaneous Transmission Analysis Mode: WLAN 5GHz+Bluetooth

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	EIRP (W)	Distance (cm)	S (mW/cm ²)	S Limit (mW/cm ²)	Ratio (S/Limit)
5.8G; 11ac20 5825 MHz	5	16.74	21.74	0.14928	20	0.02971	1	0.02971
2.4G;BT-LE 2402 MHz	3.5	5.53	9.03	0.00800	20	0.00159	1	0.00159
							Sum Ratio	0.03130
							Ratio Limit	1

Appendix A. Antenna List

1. Table for Filed Antenna

No.	Brand	Ant. Type	Con. Type	Peak Gain (dBi)		Model No.
				2.4GHz	5GHz	
01	LYNwave	PIFA	IPEX	3.5	5	ALA110-222050-300011
02	Walsin	DIPOLE	IPEX	3.14	5	RFDPA171320EMLB301
03	HONGLIN	PIFA	IPEX	1.58	1.21	DC33001FH00
04	LUXSHARE-ICT	PIFA	IPEX	-0.5	0.5	DC33001FC00
05	SPEEDWIRE	PIFA	IPEX	-0.97	1.93	DC33001FG00
06	HONGLIN	PIFA	IPEX	-0.78	-2.39	DC33001FF00
07	LUXSHARE-ICT	PIFA	IPEX	-0.3	-0.3	DC33001FD00
08	SPEEDWIRE	PIFA	IPEX	-0.98	2.78	DC33001FE00
09	Tongda	PIFA	IPEX	TX1: 0.02 TX2: -0.46	-0.20 -0.93	TX1: T-543-9021099-A TX2: T-543-9021099-A
10	LUXSHAR E-ICT	PIFA	IPEX	TX1: -3.90 TX2: -1.70	-1.20 -2.90	TX1: DC33001FY20 TX2: DC33001FY30
11	LUXSHAR E-ICT	PIFA	IPEX	TX1: -1.80 TX2: -1.40	-0.90 -2.50	TX1: DC33001FY00 TX2: DC33001FY10
12	LUXSHAR E-ICT	PIFA	IPEX	TX1: -3.30 TX2: -2.20	-1.30 -2.60	TX1: DC33001G000 TX2: DC33001G010
13	LUXSHAR E-ICT	PIFA	IPEX	TX1: -1.60 TX2: -1.30	-1.90 -0.90	TX1: DC33001G020 TX2: DC33001G030
14	LUXSHAR E-ICT	PIFA	IPEX	TX1: -5.10 TX2: -1.30	-3.10 -0.80	TX1: DC33001G310 TX2: DC33001G300
15	Smart Approach	PIFA	IPEX	TX1: 0.60 TX2: 0.32	0.43 2.15	TX1: SE-EQFFG-006 TX2: SE-EQFFG-006
16	Foxconn	PIFA	IPEX	TX1: 0.54 TX2: 1.43	0.64 2.20	TX1: ANTP2M1-CQA23-EH TX2: ANTP2M1-CQA23-EH
17	Foxconn	PIFA	IPEX	TX1: 0.15 TX2: 1.13	-0.30 -0.64	TX1: ANTP2M1-CQA22-EH TX2: ANTP2M1-CQA22-EH
18	INPAQ	PIFA	IPEX	TX1: 0.88 TX2: 0.51	3.05 2.57	TX1: DQ60PLBLB12 TX2: DQ60PLBLB12
19	LUXSHAR E-ICT	PIFA	IPEX	TX1: -4.50 TX2: -3.40	-0.50 -0.80	TX1: DC33001G320 TX2: DC33001G330
20	Smart Approach	PIFA	IPEX	TX1: -0.29 TX2: 0.46	1.02 1.12	TX1: SE-EQFFG-005 TX2: SE-EQFFG-005

21	INNOWAVE	PIFA	IPEX	TX1: 2.82 TX2: 2.72	2.08 2.96	TX1: S79-1805520-I73 TX2: S79-1805510-I73
22	Speedwire	PIFA	IPEX	TX1: -0.03 TX2: -1.31	-0.58 -0.03	TX1: DC33001G210 TX2: DC33001G200
23	Speedwire	PIFA	IPEX	TX1: -1.88 TX2: -4.51	-0.59 -0.33	TX1: DC33001FZ00 TX2: DC33001FZ10
24	Speedwire	PIFA	IPEX	TX1: -1.55 TX2: -3.99	0.38 1.78	TX1: DC33001FZ20 TX2: DC33001FZ30
25	Speedwire	PIFA	IPEX	TX1: -1.41 TX2: -2.16	0.09 0.13	TX1: DC33001G120 TX2: DC33001G130
26	Speedwire	PIFA	IPEX	TX1: -1.27 TX2: -2.02	0.08 0.42	TX1: DC33001G100 TX2: DC33001G110
27	Speedwire	PIFA	IPEX	TX1: -1.13 TX2: -0.17	-1.95 -0.52	TX1: DC33001G220 TX2: DC33001G230
28	High-Tek	PIFA	IPEX	TX1: 1.01 TX2: -1.19	2.90 1.06	TX1: DC33001RM00 TX2: DC33001RM10
29	Tongda	PIFA	IPEX	TX1: -2.05 TX2: -1.08	1.44 1.00	TX1: DC33001RN00 TX2: DC33001RN10
30	High-Tek	PIFA	IPEX	TX1: -0.86 TX2: -2.59	0.63 -0.21	TX1: 0ACCN014021N TX2: 0ACCN014021N
31	Smart Approach	PIFA	IPEX	TX1: 0.38 TX2: 1.43	0.73 2.91	TX1: SE-ECAL1-001 TX2: SE-ECAL1-001
32	LUXSHARE-ICT	PIFA	IPEX	TX1: -3.60 TX2: -2.00	-0.60 -2.90	TX1: LA22RF826-1H TX2: LA22RF825-1H
33	Speed	PIFA	IPEX	TX1: -1.46 TX2: -1.59	0.14 2.39	TX1: F.0G.JV-0048-003-00 TX2: F.0G.JV-0048-004-00
34	Amphenol	PIFA	IPEX	TX1: 1.68 TX2: 0.18	-0.71 -1.71	TX1: 6717-FA TX2: 6719-FB
35	Speed	PIFA	IPEX	TX1: 1.50 TX2: -0.12	0.38 -0.14	TX1: M.Z2.ZV-0001-001 TX2: M.Z2.ZV-0001-002
36	LUXSHARE-ICT	PIFA	IPEX	TX1: -1.40 TX2: -3.60	-0.20 -2.80	TX1: 025.900KY.0001 TX2: 025.900KZ.0001
37	WNC	PIFA	IPEX	TX1: -0.89 TX2: 0.38	0.63 -1.41	TX1: 025.900KY.0001 TX2: 025.900KZ.0001
38	Jieng-Tai	PIFA	IPEX	TX1: 1.93 TX2: 0.15	1.23 1.39	TX1: 7KYQUTAN000372 TX2: 7KYQUTAN000372

39	TONGDA	PIFA	IPEX	TX1: 0.76 TX2: 0.66	0.75 0.85	TX1: T-543-9051117-B TX2: T-543-9051117-B
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