

TEST REPORT

Applicant: SG Wireless Limited
Address: Unit 4, 5/F, Sun Fung Industrial Building, 8 Ma Kok Street, Tsuen Wan, New Territories, Hong Kong
Equipment Type: F1 Smart Module
Model Name: SGW3501
Brand Name: SG Wireless
FCC ID: 2AS9406
Test Standard: 47 CFR Part 2.1091
KDB 447498 D04 v01
Sample Arrival Date: Sep. 27, 2024
Test Date: Oct. 05, 2024 - Nov. 05, 2024
Date of Issue: Dec. 02, 2024

ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

**Tested by:** Xu Rui**Checked by:** Liyao Zong**Approved by:** Tolan Tu

(Testing Director)

Revision History

<u>Version</u>	<u>Issue Date</u>	<u>Revisions Content</u>
<u>Rev. 01</u>	<u>Dec. 02, 2024</u>	<u>Initial Issue</u>

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1 GENERAL INFORMATION

1.1 Test Laboratory

Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Test Location

Name	Shenzhen BALUN Technology Co., Ltd.
Location	☐ Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
	☒ 1/F, Building B, Ganghongji High-tech Intelligent Industrial Park, No. 1008, Songbai Road, Yangguang Community, Xili Sub-district, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	SG Wireless Limited
Address	Unit 4, 5/F, Sun Fung Industrial Building, 8 Ma Kok Street, Tsuen Wan, New Territories, Hong Kong

2.2 Manufacturer Information

Manufacturer	SG Wireless Limited
Address	Unit 4, 5/F, Sun Fung Industrial Building, 8 Ma Kok Street, Tsuen Wan, New Territories, Hong Kong

2.3 General Description for Equipment under Test (EUT)

EUT Name	F1 Smart Module
Model Name Under Test	SGW3501
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	1.2.3
Software Version	B0.2.0b0
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.4 Technical Information

Network and Wireless connectivity	4G Network FDD LTE-M1 Band 2/4/5/12/13/14/17/18/19/25/26/66/71/85 FDD NB-IoT Band 2/4/5/12/13/14/17/18/19/25/26/66/71/85 Bluetooth (BLE) WIFI 802.11b, 802.11g, 802.11n(HT20/40) LoRa
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The requirement for the following technical information of the EUT was tested in this report:

Operating Mode	WWAN, Bluetooth, WIFI, LoRa		
Frequency Range	LTE-M1 Band 2	TX: 1850 ~ 1910 MHz	RX: 1930 ~ 1990 MHz
	LTE-M1 Band 4	TX: 1710 ~ 1755 MHz	RX: 2110 ~ 2155 MHz
	LTE-M1 Band 5	TX: 824 ~ 849 MHz	RX: 869 ~ 894 MHz
	LTE-M1 Band 12	TX: 699 ~ 716 MHz	RX: 729 ~ 746 MHz
	LTE-M1 Band 13	TX: 777 ~ 787 MHz	RX: 746 ~ 756 MHz
	LTE-M1 Band 14	TX: 788 ~ 798 MHz	RX: 758 ~ 768 MHz
	LTE-M1 Band 17	TX: 704 ~ 716 MHz	RX: 734 ~ 746 MHz

	LTE-M1 Band 18	TX: 815 ~ 830 MHz	RX: 860 ~ 875 MHz
	LTE-M1 Band 19	TX: 830 ~ 845 MHz	RX: 875 ~ 890 MHz
	LTE-M1 Band 25	TX: 1850 ~ 1915 MHz	RX: 1930 ~ 1995 MHz
	LTE-M1 Band 26	TX: 814 ~ 824 MHz	RX: 859 ~ 869 MHz
		TX: 824 ~ 849 MHz	RX: 869 ~ 894 MHz
	LTE-M1 Band 66	TX: 1710 ~ 1780 MHz	RX: 2110 ~ 2180 MHz
	LTE-M1 Band 71	TX: 663 ~ 698 MHz	RX: 617 ~ 652 MHz
	LTE-M1 Band 85	TX: 698 ~ 716 MHz	RX:728 ~ 746 MHz
	LTE-NB-IoT Band 2	TX: 1850 ~ 1910 MHz	RX: 1930 ~ 1990 MHz
	LTE-NB-IoT Band 4	TX: 1710 ~ 1755 MHz	RX: 2110 ~ 2155 MHz
	LTE-NB-IoT Band 5	TX: 824 ~ 849 MHz	RX: 869 ~ 894 MHz
	LTE-NB-IoT Band 12	TX: 699 ~ 716 MHz	RX: 729 ~ 746 MHz
	LTE-NB-IoT Band 13	TX: 777~ 787 MHz	RX: 746 ~ 756 MHz
	LTE-NB-IoT Band 14	TX: 788 ~ 798 MHz	RX: 758 ~ 768 MHz
	LTE-NB-IoT Band 17	TX: 704 ~ 716 MHz	RX: 734 ~ 746 MHz
	LTE-NB-IoT Band 18	TX: 815 ~ 830 MHz	RX: 860 ~ 875 MHz
	LTE-NB-IoT Band 19	TX: 830 ~ 845 MHz	RX: 875 ~ 890 MHz
	LTE-NB-IoT Band 25	TX: 1850 ~ 1915 MHz	RX: 1930 ~ 1995 MHz
	LTE-NB-IoT Band 26	TX: 814 ~ 824 MHz	RX: 859 ~ 869 MHz
		TX: 824 ~ 849 MHz	RX: 869 ~ 894 MHz
	LTE-NB-IoT Band 66	TX: 1710 ~ 1780 MHz	RX: 2110 ~ 2180 MHz
	LTE-NB-IoT Band 71	TX: 663 ~ 698 MHz	RX: 617 ~ 652 MHz
	LTE-NB-IoT Band 85	TX: 698 ~ 716 MHz	RX:728 ~ 746 MHz
	Bluetooth	2400 ~ 2483.5 MHz	
	802.11b/g	2400 ~ 2483.5 MHz	
	802.11n(HT20/HT40)	2400 ~ 2483.5 MHz	
	LoRa	902 ~928 MHz	
Antenna Type	WWAN: Monopole Antenna (External) Bluetooth: Monopole Antenna (External) WLAN: Monopole Antenna (External) LoRa: Monopole Antenna (External)		
Exposure Category	General Population/Uncontrolled Exposure		
Product Type	Mobile Device		

Note: LTE B18/19 is covered by B26, which has been proven to be the worst result. Therefore, the report only introduces the test data of B26.

3 SUMMARY OF TEST RESULT

3.1 Test Standards

No.	Identity	Document Title
1	KDB 447498 D04 v01	447498 D04 Interim General RF Exposure Guidance v01

3.2 Limit Standards

No.	Identity	Document Title
1	47 CFR Part 2.1091	Radiofrequency radiation exposure evaluation: mobile devices

4 DEVICE CATEGORY AND LEVELS LIMITS

Mobile Devices:

CFR Title 47 §2.1091(b)

For purposes of this section, a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.

FCC KDB 447498 D04 General RF Exposure Guidance v01 Limit

Evaluation of compliance with the exposure limits in § 1.1310 is necessary if the ERP of the device is greater than ERP_{20cm} in Formula (B.1) [repeated from § 2.1091(c)(1) and § 1.1307(b)(1)(i)(B)].

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases} \quad (\text{B.1})$$

If the ERP is not easily obtained, then the available maximum time-averaged power may be used (i. e., without consideration of ERP only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole.

SAR-based exemptions are constant at separation distances between 20 cm and 40 cm to avoid discontinuities in the threshold when transitioning between SAR-based and MPE-based exemption criteria at 40 cm, considering the importance of reflections.

The SAR-based exemption formula of § 1.1307(b)(3)(i)(B), repeated here as Formula (B.2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).

This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by Formula (B.2).

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases} \quad (\text{B. 2})$$

where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right)$$

and f is in GHz, d is the separation distance (cm), and $ERP_{20 \text{ cm}}$ is per Formula (B.1).
The example values shown in Table B.2 are for illustration only.

Table B.2—Example Power Thresholds (mW)

Frequency (MHz)	Distance (mm)										
		5	10	15	20	25	30	35	40	45	50
300		39	65	88	110	129	148	166	184	201	217
450		22	44	67	89	112	135	158	180	203	226
835		9	25	44	66	90	116	145	175	207	240
1900		3	12	26	44	66	92	122	157	195	236
2450		3	10	22	38	59	83	111	143	179	219
3600		2	8	18	32	49	71	96	125	158	195
5800		1	6	14	25	40	58	80	106	136	169

5 ASSESSMENT RESULT

5.1 Output Power

LTE-M1							
Mode	Band 2	Band 4	Band 5	Band 12	Band 13	Band 14	Band 17
Conducted Power (dBm)	21.00	20.82	21.39	21.37	21.17	21.13	21.20
Antenna Gain (dBi)	6.00	6.00	6.00	6.00	6.00	6.00	6.00
ERP/EIRP (dBm)	27.00	26.82	25.24	25.22	25.02	24.98	25.05
Note: This table listed the worst case power value, please refer to BL-SZ24A1042-501 report for more details.							

LTE-M1						
Mode	Band 25	Band 26 (part22)	Band 26 (part90)	Band 66	Band 71	Band 85
Conducted Power (dBm)	20.98	21.55	21.21	21.08	22.07	21.15
Antenna Gain (dBi)	6.00	6.00	6.00	6.00	6.00	6.00
ERP/EIRP (dBm)	26.98	25.40	25.06	27.08	25.92	25.00
Note: This table listed the worst case power value, please refer to BL-SZ24A1042-501 report for more details.						

LTE-NB-IoT							
Mode	Band 2	Band 4	Band 5	Band 12	Band 13	Band 14	Band 17
Conducted Power (dBm)	20.52	21.79	21.35	20.94	20.64	20.91	20.91
Antenna Gain (dBi)	6.00	6.00	6.00	6.00	6.00	6.00	6.00
ERP/EIRP (dBm)	26.52	27.79	25.20	24.79	24.49	24.76	24.76
Note: This table listed the worst case power value, please refer to BL-SZ24A1042-501 report for more details.							

LTE-NB-IoT						
Mode	Band 25	Band 26 (part22)	Band 26 (part90)	Band 66	Band 71	Band 85
Conducted Power (dBm)	20.50	21.31	20.96	14.50	21.31	21.00
Antenna Gain (dBi)	6.00	6.00	6.00	6.00	6.00	6.00
ERP/EIRP (dBm)	26.50	25.16	24.81	20.50	25.16	24.85
Note: This table listed the worst case power value, please refer to BL-SZ24A1042-501 report for more details.						

Mode	Bluetooth
Conducted Power (dBm)	17.91
Antenna Gain (dBi)	3.00
EIRP (dBm)	20.91
Note: This table listed the worst case power value, please refer to BL-SZ24A1042-601 report for more details.	

Mode	2.4G WIFI
Conducted Power (dBm)	16.39
Antenna Gain (dBi)	3.00
EIRP (dBm)	19.39
Note: This table listed the worst case power value, please refer to BL-SZ24A1042-602 report for more details.	

Mode	LoRa-1	LoRa-2
Conducted Power (dBm)	19.42	19.53
Antenna Gain (dBi)	2.00	2.00
ERP (dBm)	19.27	19.38
Note: This table listed the worst case power value, please refer to BL-SZ24A1042-603, BL-SZ24A1042-604 report for more details.		

5.2 Tune-up power

Mode	Conducted Power Range (dBm)	EIRP Range (dBm)	ERP Range (dBm)
LTE-M1 Band2	[20.00,22.00]	[26.00,28.00]	[23.85,25.85]
LTE-M1 Band4	[20.00,22.00]	[26.00,28.00]	[23.85,25.85]
LTE-M1 Band5	[20.00,22.00]	/	[23.85,25.85]
LTE-M1 Band12	[20.00,22.00]	/	[23.85,25.85]
LTE-M1 Band13	[20.00,22.00]	/	[23.85,25.85]
LTE-M1 Band14	[20.00,22.00]	/	[23.85,25.85]
LTE-M1 Band17	[20.00,22.00]	/	[23.85,25.85]
LTE-M1 Band25	[20.00,22.00]	[26.00,28.00]	[23.85,25.85]
LTE-M1 Band26(part22)	[21.00,23.00]	/	[24.85,26.85]
LTE-M1 Band26(part22)	[20.00,22.00]	/	[23.85,25.85]
LTE-M1 Band66	[20.00,22.00]	[26.00,28.00]	[23.85,25.85]
LTE-M1 Band71	[21.00,23.00]	/	[24.85,26.85]
LTE-M1 Band85	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band2	[19.00,21.00]	[26.00,28.00]	[23.85,25.85]
LTE-NB-IoT Band4	[21.00,23.00]	[27.00,29.00]	[24.85,26.85]
LTE-NB-IoT Band5	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band12	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band13	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band14	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band17	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band25	[19.00,21.00]	[25.00,27.00]	[22.85,24.85]
LTE-NB-IoT Band26(part22)	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band26(part22)	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band66	[13.00,15.00]	[19.00,21.00]	[16.85,18.85]
LTE-NB-IoT Band71	[20.00,22.00]	/	[23.85,25.85]
LTE-NB-IoT Band85	[20.00,22.00]	/	[23.85,25.85]
Bluetooth	[17.00,19.00]	[20.00,22.00]	[17.85, 19.85]
2.4G WIFI	[15.00, 17.00]	[18.00, 20.00]	[15.85,17.85]
LoRa-1	[18.00,20.00]	/	[17.85, 19.85]
LoRa-2	[18.00,20.00]	/	[17.85, 19.85]

Note1: ERP= EIRP -2.15dB.

Note2: According KDB 447498 D04, used the greater of maximum conducted power and ERP to compare with the threshold value Pth.

5.3 RF Exposure Evaluation Result

Evolution mode	Maximum power (dBm)	Maximum power (mw)	Distance (mm)	Threshold Power (mW)	Power / Limit	Verdict
LTE-M1 Band2	25.85	384.59	200	3060.00	0.126	Pass
LTE-M1 Band4	25.85	384.59	200	3060.00	0.126	Pass
LTE-M1 Band5	25.85	384.59	200	1731.96	0.222	Pass
LTE-M1 Band12	25.85	384.59	200	1460.64	0.263	Pass
LTE-M1 Band13	25.85	384.59	200	1605.48	0.240	Pass
LTE-M1 Band14	25.85	384.59	200	1627.92	0.236	Pass
LTE-M1 Band17	25.85	384.59	200	1460.64	0.263	Pass
LTE-M1 Band25	25.85	384.59	200	3060.00	0.126	Pass
LTE-M1 Band26(part22)	26.85	484.17	200	1731.96	0.280	Pass
LTE-M1 Band26(part22)	25.85	384.59	200	1680.96	0.229	Pass
LTE-M1 Band66	25.85	384.59	200	3060.00	0.126	Pass
LTE-M1 Band71	26.85	484.17	200	1423.92	0.340	Pass
LTE-M1 Band85	25.85	384.59	200	1460.64	0.263	Pass
LTE-NB-IoT Band2	25.85	384.59	200	3060.00	0.126	Pass
LTE-NB-IoT Band4	26.85	484.17	200	3060.00	0.158	Pass
LTE-NB-IoT Band5	25.85	384.59	200	1731.96	0.222	Pass
LTE-NB-IoT Band12	25.85	384.59	200	1460.64	0.263	Pass
LTE-NB-IoT Band13	25.85	384.59	200	1605.48	0.240	Pass
LTE-NB-IoT Band14	25.85	384.59	200	1627.92	0.236	Pass
LTE-NB-IoT Band17	25.85	384.59	200	1460.64	0.263	Pass
LTE-NB-IoT Band25	24.85	305.49	200	3060.00	0.100	Pass
LTE-NB-IoT Band26(part22)	25.85	384.59	200	1731.96	0.222	Pass
LTE-NB-IoT Band26(part22)	25.85	384.59	200	1680.96	0.229	Pass
LTE-NB-IoT Band66	18.85	76.74	200	3060.00	0.025	Pass
LTE-NB-IoT Band71	25.85	384.59	200	1423.92	0.270	Pass
LTE-NB-IoT Band85	25.85	384.59	200	1460.64	0.263	Pass
Bluetooth	19.85	96.61	200	3060.00	0.032	Pass
2.4G WIFI	17.85	60.95	200	3060.00	0.020	Pass
LoRa-1	19.85	96.61	200	1893.12	0.051	Pass
LoRa-2	19.85	96.61	200	1893.12	0.051	Pass

5.4 Collocated Power Calculation

Evolution mode	Frequency(MHz)	Power /Limit	$\Sigma(\text{Power / Limit})$ of WWAN + BT + Lora	Verdict
LTE-M1 Band71	663 ~ 698 MHz	0.340	0.423	Pass
Max. LoRa	902 ~ 928 MHz	0.051		
BT	2400 ~ 2483.5 MHz	0.032		

Evolution mode	Frequency(MHz)	Power /Limit	$\Sigma(\text{Power / Limit})$ of WWAN + WLAN + Lora	Verdict
LTE-M1 Band71	663 ~ 698 MHz	0.340	0.411	Pass
Max. LoRa	902 ~ 928 MHz	0.051		
WIFI	2400 ~ 2483.5 MHz	0.020		

Note:

- $\Sigma(\text{Power / Limit})$: This is a summation of [(power for each transmitter/ antenna included in the simultaneous transmission)/ (corresponding Power limit)], for WLAN 2.4GHz+LoRa+WWAN, BT+LoRa+WWAN
- Both of the 2.4GHz/BT/LoRa/WWAN can transmit simultaneously, the formula of calculated the Power is

$$CP1 / LP1 + CP2 / LP2 + \dots \text{etc.} < 1$$

CP = Calculation power
LP = Limit of power
- The worst-case situation is 0.423, which is less than "1". This confirmed that the device comply with FCC KDB 447498 D04 Power limit.
- The DUT work frequency range used is 2400 MHz ~ 2483.5 MHz, 663 MHz ~ 698 MHz and 902 MHz ~ 928 MHz the result close to the limit by the above formula, so we select worst case power to calculate the exclusion power threshold.

5.5 Conclusion

This EUT is deemed to comply with the reference level limits, therefore the basic restrictions are compliant with human exposure limits.

Statement

1. The laboratory guarantees the scientificity, accuracy and impartiality of the test, and is responsible for all the information in the report, except the information provided by the customer. The customer is responsible for the impact of the information provided on the validity of the results.
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