

Test Report

Product: SP02 smart pen

Trade Mark: N/A

Model Number: SP02

FCC ID: 2BCFZ-SP02

Prepared for

Shenzhen ZUOMU Technology Co., Ltd.

A-402, Hengyu Industrial Park, Longgang District, Shenzhen 518116, China

Prepared by

Shenzhen HongBiao Certification& Testing Co., Ltd

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TEST RESULT CERTIFICATION

Applicant's Name..... : Shenzhen ZUOMU Technology Co., Ltd.
Address : A-402, Hengyu Industrial Park, Longgang District, Shenzhen
518116, China
Manufacturer's Name : Shenzhen ZUOMU Technology Co., Ltd.
Address : A-402, Hengyu Industrial Park, Longgang District, Shenzhen
518116, China

Product description

Product name : SP02 smart pen
Model Number : SP02
Standards : FCC Part 15.249
Test procedure..... : IEEE/ANSI C63.10-2020

This device described above has been tested by Shenzhen HongBiao Certification& Testing Co., Ltd and the test results show that the equipment under test (EUT) is in compliance with the EMC requirements. And it is applicable only to the tested sample identified in the report.

Date of Test

Date (s) of performance of tests..... : Aug. 04, 2023~ Sept. 11, 2023
Test Result..... : **Pass**

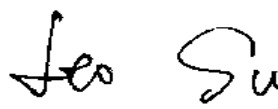
Testing Engineer :


(Z o e S u)

Technical Manager :


(G a r y L u)

Authorized Signatory :


(L e o S u)

[illegible]

1 General Description

1.1 Description of EUT

Product name:	SP02 smart pen
Model name:	SP02
Series Model:	SP02A, SP02B, SP02C
Different of series model:	Except for the model number, appearance of the pen tip, and software functions, the circuits and modules of all models are the same.
Operation frequency:	2443 MHz
Modulation type:	GFSK
Bit Rate of transmitter:	1 Mbps
Antenna type:	Ceramic Antenna
Antenna gain:	2dBi
Max. Field Strength:	74.26dBμV/m
Hardware version:	V5.0
Software version:	V4.0
Battery:	DC 3.7V, 130mAh
Power supply:	Input: DC 4.2V Output: DC 3.3V
Adapter information:	N/A

1.2 Test Mode

Test Mode	Channel	Frequency (MHz)
1	1	2443

1.3 Operation Channel list

Channel	Frequency (MHz)
1	2443

1.4 Test Setup

See photographs of the test setup in the report for the actual setup and connections between EUT and support equipment.

1.5 Ancillary Equipment

Equipment	Model	S/N	Manufacturer
/	/	/	/

2 Summary of Test Result

No.	Standard Section	Test Item	Result	Remark
1	FCC Part15.203	Antenna Requirement	Pass	
2	FCC Part15.207	AC power line conducted emission	N/A	
3	FCC Part15.249(d)	Radiated spurious emission	Pass	
4	FCC Part 15.215	20dB Bandwidth	Pass	

3 Test Facilities and Accreditations

3.1 Test Laboratory

Test Site	Shenzhen HongBiao Certification& Testing Co., Ltd
Test Site Location	Room 102, 201, Building 2, Yuanwanggu RFID Industrial Park, Tongguan Road, Tianliao Community, Yutang Street, Guangming District, Shenzhen, China
Telephone:	(86-755) 2998 9321
Fax:	(86-755) 2998 5110
FCC Registration No.:	CN1341
A2LA Certificate No.:	6765.01

3.2 Environmental Conditions

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

Temperature:	15°C~35°C
Relative Humidity:	20%~75%
Air Pressure:	98kPa~101kPa

3.3 Measurement Uncertainty

The reported uncertainty of measurement $y \pm U$, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95 %.

Measurement Frequency Range	U, (dB)	Note
RF frequency	2×10^{-5}	
RF power, conducted	± 0.57 dB	
Conducted emission(150kHz~30MHz)	± 2.5 dB	
Radiated emission(30MHz~1GHz)	± 4.2 dB	
Radiated emission (above 1GHz)	± 4.7 dB	
Temperature	± 1 degree	
Humidity	± 5 %	

3.4 Test Software

Software name	Manufacturer	Model	Version
EMI Measurement	Farad	EZ-EMC	V1.1.4.2
Conducted test system	MWRF-test	MTS 8310	V2.0.0

4 List of Test Equipment

Radiation emission							
Item	Equipment No.	Equipment name	Manufacturer	Model	Serial No.	Calibration date	Due date
1	HB-E001	Horn Antenna	Schwarzbeck	BBHA 9120D	02592	2022-04-02	2024-04-01
2	HB-E002	Biconical log-periodic composite antenna	Schwarzbeck	VULB 9168	01340	2022-04-06	2024-04-05
3	HB-E003	SHF-EHF Horn	Schwarzbeck	BBHA 91270	01193	2022-04-02	2024-04-01
4	HB-E004	Preamplifier	Noyetec	LAN-0910	NYCM1420101	2023-05-11	2024-05-10
5	HB-E005	Preamplifier	Noyetec	LAN-0118	NYCM1420102	2023-05-12	2024-05-11
6	HB-E006	Preamplifier	Noyetec	LAN-1840	NYCM1420103	2023-06-11	2024-06-10
7	HB-E007	EMI TEST RECEIVER	R&S	ESR7	102520	2023-05-12	2024-05-11
8	HB-E009	POSITINAL COTROLLE R	Noyetec	N/A	N/A	/	/
9	HB-E013	RF switch	Noyetec	NY-RF4	NY0CM1420204	/	/
10	HB-E066	Illuminance Tester	TASI	TA8121	N/A	2023-05-11	2024-05-10
11	HB-E075	Active loop antenna	Schwarzbeck	FMZB 1519B	1519B-245	2022-07-24	2024-07-23
Conduction emission							
Item	Equipment No.	Equipment name	Manufacturer	Model	Serial No.	Calibration date	Due date
1	HB-E014	4 Path V-LISN	Schwarzbeck	NNLK 8121	00770	2023-05-12	2024-05-11
2	HB-E015	Pulse Limiter	Schwarzbeck	VTSD 9561-F	00949	2023-05-12	2024-05-11
3	HB-E016	ZN23201	Noyetec	ZN23201	N/A	2023-05-11	2024-05-10
4	HB-E059	Attenuator	Xianghua	TS2-6-1	220215166	2023-05-12	2024-05-11
5	HB-E069	EMI TEST RECEIVER	R&S	ESCI	N/A	2023-05-12	2024-05-11
RF							
Item	Equipment No.	Equipment name	Manufacturer	Model	Serial No.	Calibration date	Due date
1	HB-E041	MXG AnaioG Signal Generator	Agilent	N5181A	MY47070421	2023-05-11	2024-05-10
2	HB-E042	WIDEBAND RADIO COMMUNICA	R&S	CMW500	132108	2023-05-11	2024-05-10

		TION TESTER					
3	HB-E043	MXG Anaio Signal Generator	Agilent	N5182A	US46240335	2023-05-11	2024-05-10
4	HB-E044	Signal& spectrum Analyzer	R&S	FSV3044	101264	2023-05-11	2024-05-10
5	HB-E045	RF Control Box	Noyetec	NY100-R FCB	N/A	/	/
6	HB-E058	Thermometer Clock Humidity Monitor	N/A	HTC-1	N/A	/	/

Note: the calibration interval of the above test instruments is 12&24 months and the calibrations are traceable to international system unit (SI).

5 Test Item And Results

5.1 Antenna Requirement

5.1.1 Standard Requirement

15.203 requirement: For intentional device, according to 15.203: an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device

5.1.2 Test Result

The antenna is a Ceramic antenna, which was permanently affixed to the device and un-replaced, complies with 15.203. In addition, the maximum antenna gain is 2dBi.

5.2 Conducted Emission

5.2.1 Limits

Limits – Class B		
Frequency (MHz)	Limit (dBμV)	
	Quasi-Peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

Note:

- the tighter limit applies at the band edges.
- the limit of "*" marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

5.2.2 Test Procedures

a) EUT Operating Conditions

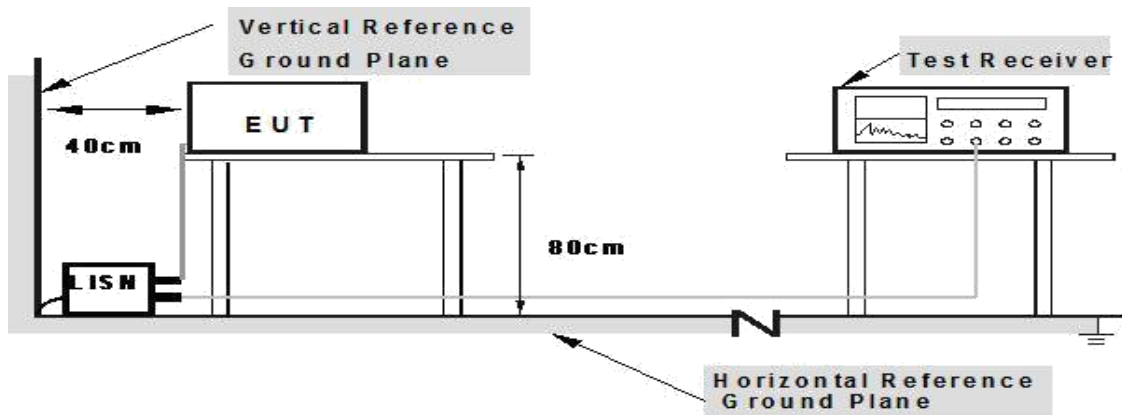
The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

b) The following table is the setting of the receiver

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

- The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipment powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
- I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
- LISN is at least 80 cm from nearest part of EUT chassis.
- For the actual test configuration, please refer to the related Item – photographs of the test setup.

5.2.3 Test Setup



5.2.4 Test Result

Note: The EUT is battery powered and does not emit while charging.

5.3 Radiated Emission

5.3.1 Limits

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequencies (MHz)	Field Strength (micровolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RB 120kHz for QP

FCC PART 15.249(a);

Except as provided in paragraph (a) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (μV/m)
902-928	50	500
2400-2483.5	50	500
5725-5875	50	500

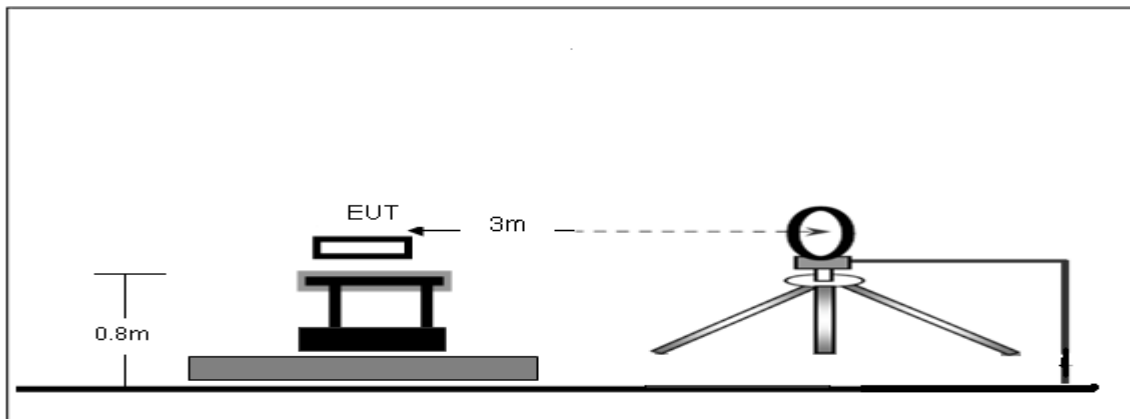
5.3.2 Test Procedures

- The EUT is placed on a turntable, which is 0.8m above ground plane for test frequency range below 1GHz, and 1.5m above ground plane for test frequency range above 1GHz.
- EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
- Use the following spectrum analyser settings:

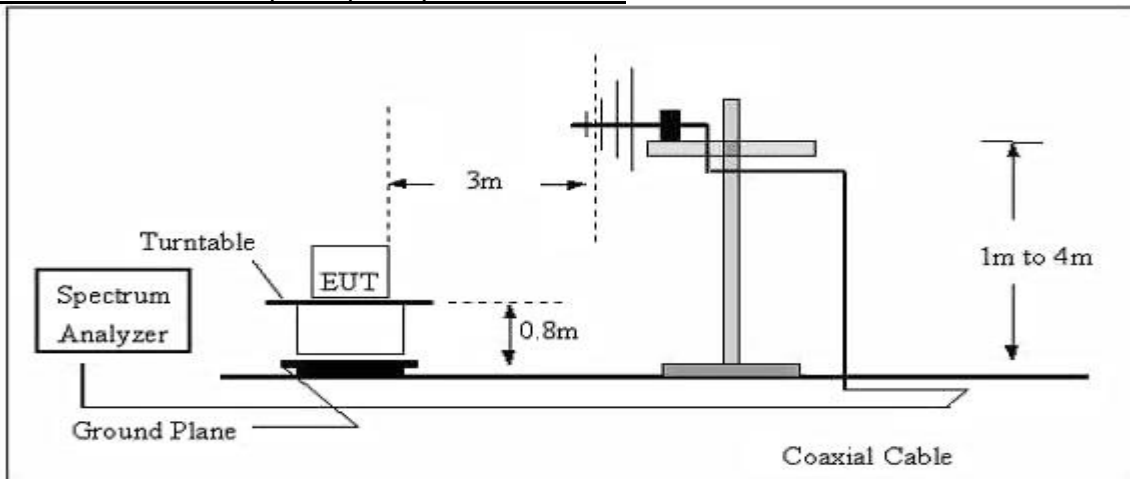
1. Span = wide enough to fully capture the emission being measured
 2. RBW = 1 MHz for $f \geq 1\text{GHz}$, 100 kHz for $f < 1\text{GHz}$
 3. VBW $\geq$ RBW, Sweep = auto
 4. Detector function = peak
 5. Trace = max hold
- d) Follow the guidelines in ANSI C63.4-2014 with respect to maximizing the emission by rotating the EUT, adjusting the measurement antenna height and polarization, etc. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, submit this data. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- e) The peak level, once corrected, must comply with the limit specified in Section 15.209. Set the RBW = 1MHz, VBW = 10Hz, Detector = PK for AV value, while maintaining all of the other instrument settings.
- f) For the actual test configuration, please refer to the related item – EUT test photos.

5.3.3 Test Setup

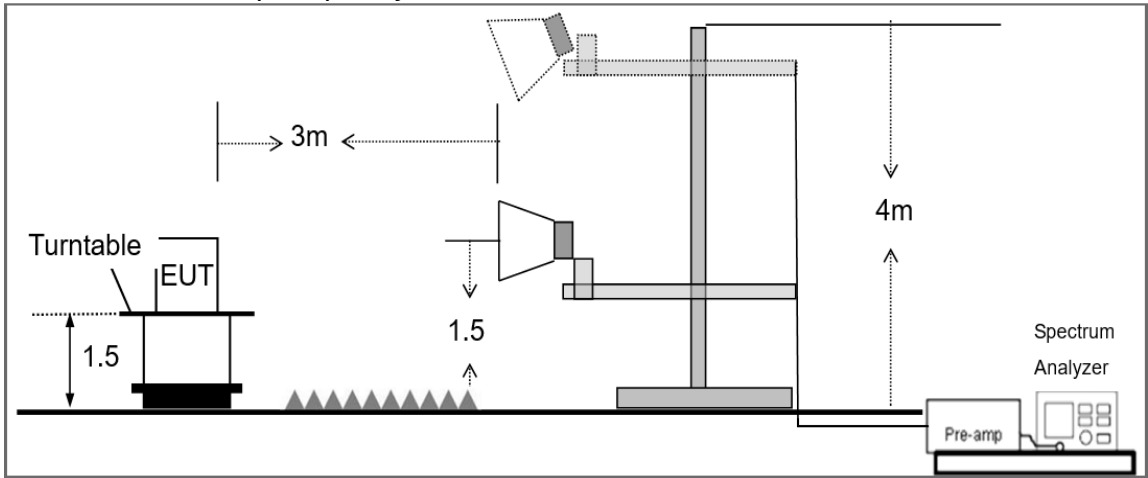
Radiated Emission Test-Up Frequency Below 30MHz



Radiated Emission Test-Up Frequency 30MHz~1GHz



Radiated emission test-up frequency above 1GHz



5.3.4 Test Result

Below 30MHz

EUT:	SP02 smart pen	Model Name:	SP02
Pressure:	1010 hPa	Test Voltage:	DC 3.7V
Test Mode:	TX	Polarization::	--

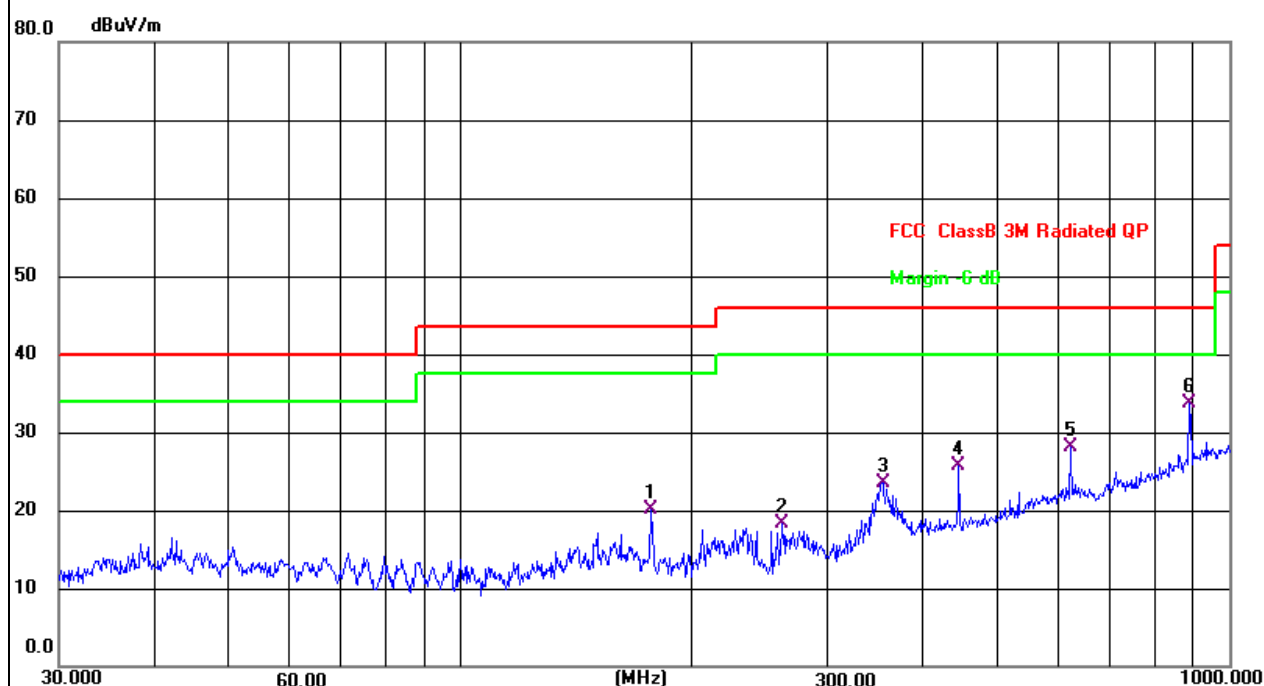
Freq.	Reading	Limit	Margin	State
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F
--	--	--	--	Pass
--	--	--	--	Pass

Note:

1. For 9kHz-30MHz, the amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
2. Distance extrapolation factor = $40 \log (\text{specific distance}/\text{test distance})(\text{dB})$;
3. Limit line = specific limits (dBuV) + distance extrapolation factor.

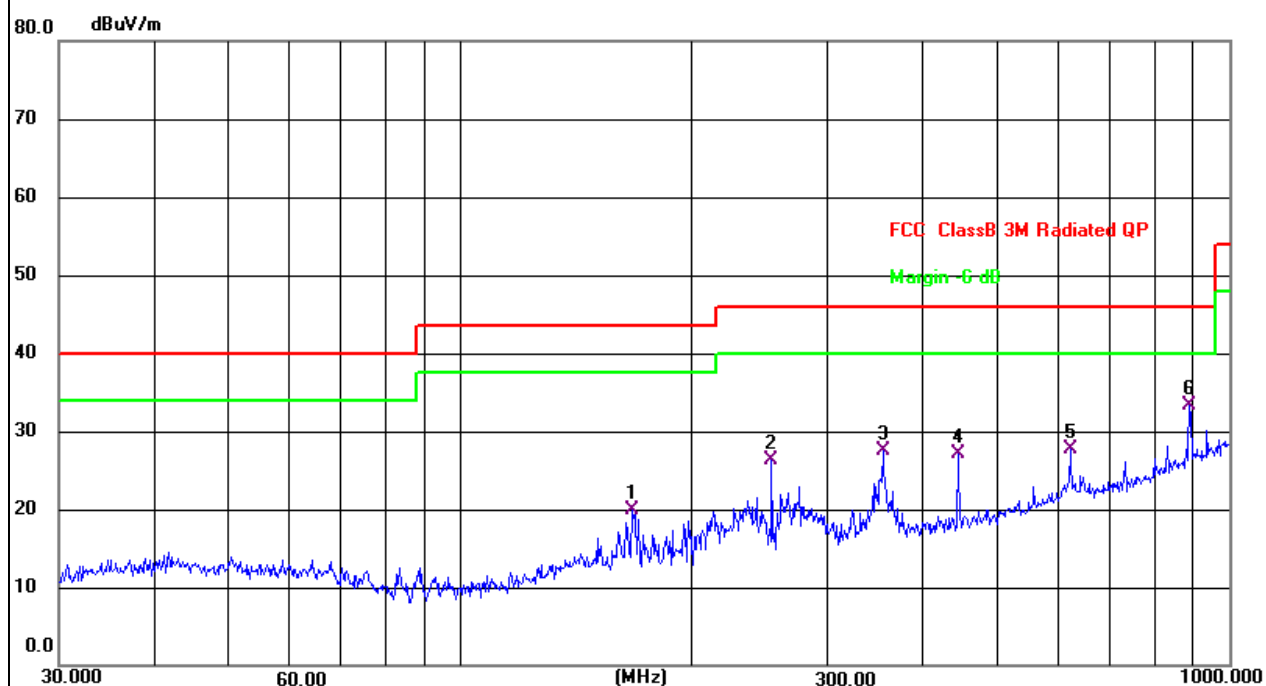
Frequency range (30MHz – 1GHz)

EUT:	SP02 smart pen	Model Name:	SP02
Test Mode:	Mode 1	Phase :	Vertical
Test Voltage:	DC 3.7V		



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	176.8878	34.94	-14.93	20.01	43.50	-23.49	QP
2	261.9753	32.68	-14.33	18.35	46.00	-27.65	QP
3	354.1831	35.10	-11.53	23.57	46.00	-22.43	QP
4	444.8514	34.65	-8.96	25.69	46.00	-20.31	QP
5	620.7096	32.72	-4.54	28.18	46.00	-17.82	QP
6 *	887.6099	32.85	0.81	33.66	46.00	-12.34	QP

EUT:	SP02 smart pen	Model Name:	SP02
Test Mode:	Mode 1	Phase :	Horizontal
Test Voltage:	DC 3.7V		



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	167.2368	34.07	-14.19	19.88	43.50	-23.62	QP
2	253.8367	40.97	-14.60	26.37	46.00	-19.63	QP
3	354.1831	39.08	-11.53	27.55	46.00	-18.45	QP
4	443.2943	36.09	-9.02	27.07	46.00	-18.93	QP
5	620.7096	32.26	-4.54	27.72	46.00	-18.28	QP
6 *	887.6099	32.44	0.81	33.25	46.00	-12.75	QP

5.3.5 Band edge—Field strength of fundamental

Frequency (MHz)	Ant. Polarization H / V	Emission level dBμV/m	Limits dBμV/m	Detector	Result
2443	H	74.26	114	PK	PASS
2443	H	66.21	94	AV	PASS
2443	V	63.54	114	PK	PASS
2443	V	52.36	94	AV	PASS

5.3.6 Band edge-radiated

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
GFSK – Low band-edge							
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
2310	49.59	-6.6	42.99	74	-31.01	Peak	V
2310	39.33	-6.6	32.73	54	-21.27	AVG	V
2390	49.28	-6.23	43.05	74	-30.95	Peak	V
2390	39.57	-6.23	33.34	54	-20.66	AVG	V
2310	49.40	-6.6	42.80	74	-31.20	Peak	H
2310	39.29	-6.6	32.69	54	-21.31	AVG	H
2390	49.21	-6.23	42.98	74	-31.02	Peak	H
2390	39.23	-6.23	33.00	54	-21.00	AVG	H
GFSK – High band-edge							
2483.5	51.19	-5.79	45.40	74	-28.60	Peak	V
2483.5	42.57	-5.79	36.78	54	-17.22	AVG	V
2500	51.11	-5.72	45.39	74	-28.61	Peak	V
2500	42.57	-5.72	36.85	54	-17.15	AVG	V
2483.5	51.11	-5.79	45.32	74	-28.68	Peak	H
2483.5	42.29	-5.79	36.50	54	-17.50	AVG	H
2500	51.60	-5.72	45.88	74	-28.12	Peak	H
2500	42.34	-5.72	36.62	54	-17.38	AVG	H

5.4 20dB and 99% Bandwidth

5.4.1 Limit

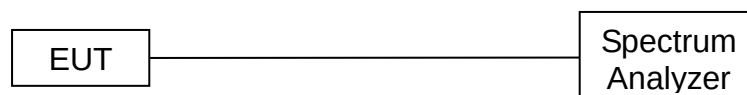
FCC §15.215(c)

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in § 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

5.4.2 Test Procedure

1. Use the following spectrum analyzer settings:
2. For 20 dB bandwidth
3. Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
4. RBW $\geq 1\%$ of the 20 dB bandwidth
5. VBW $\geq$ RBW
6. Sweep = auto
7. Detector function = peak
8. Trace = max hold
9. The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth and 99% occupied bandwidth of the emission

5.4.3 Test Setup

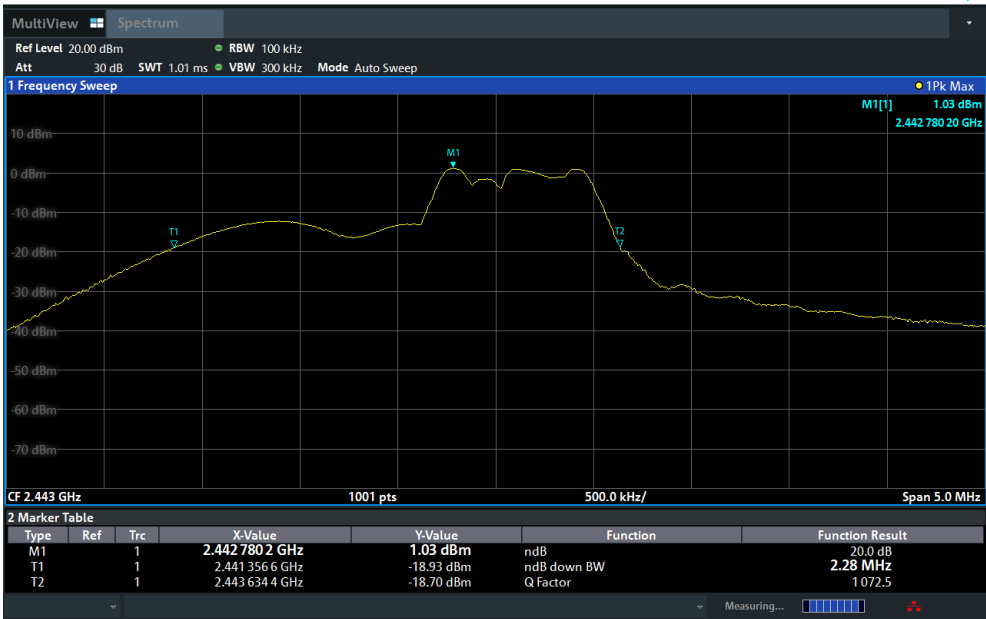


5.4.4 Test Results

Frequency (MHz)	20dB bandwidth (MHz)
2443	2.28

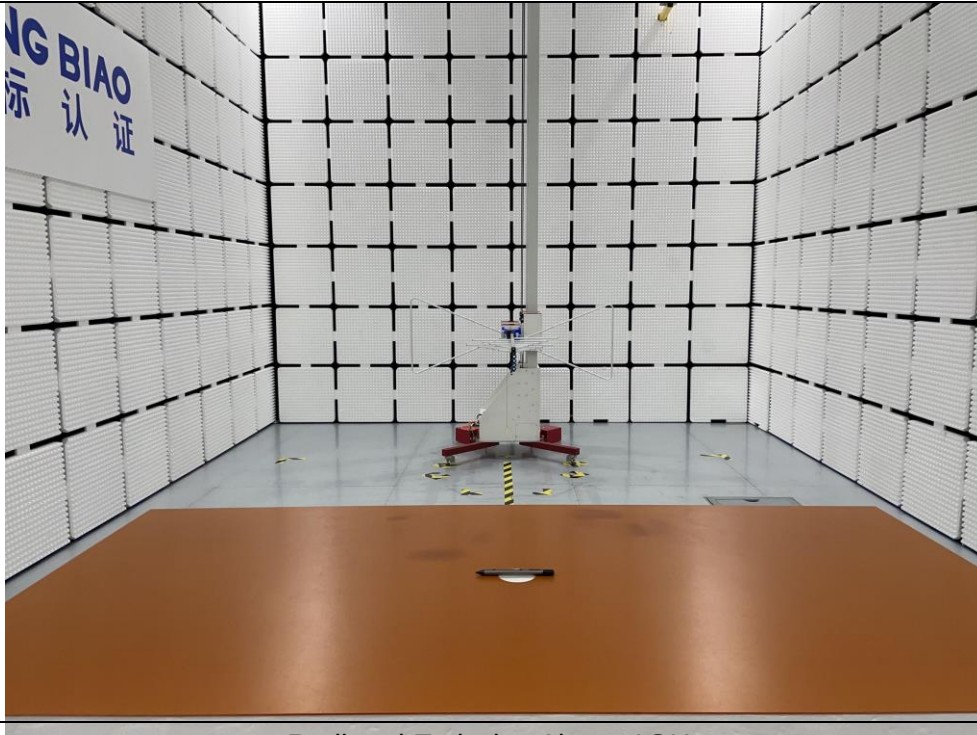
Test plots

2443MHz



6 Photographs of the Test Setup

Radiated Emission Below 1GHz



Radiated Emission Above 1GHz



7 Photographs of the EUT

Photo 1



Photo 2

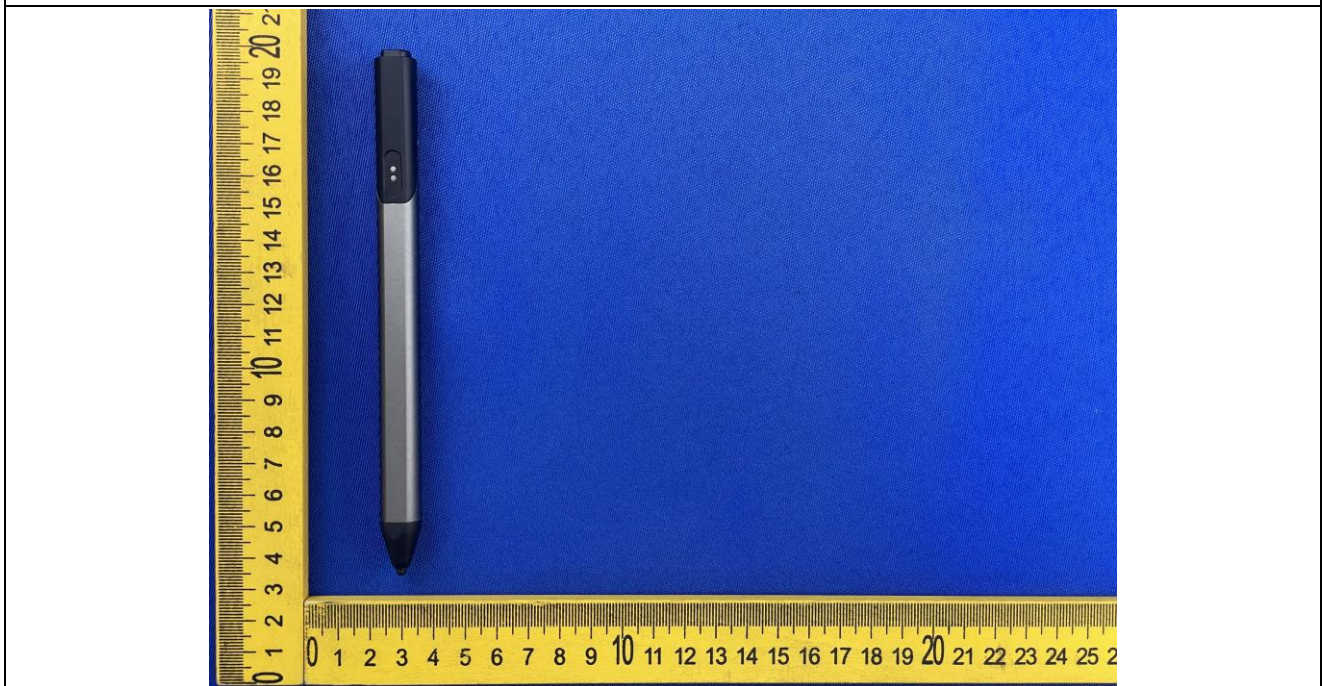


Photo 3



Photo 4



Photo 5

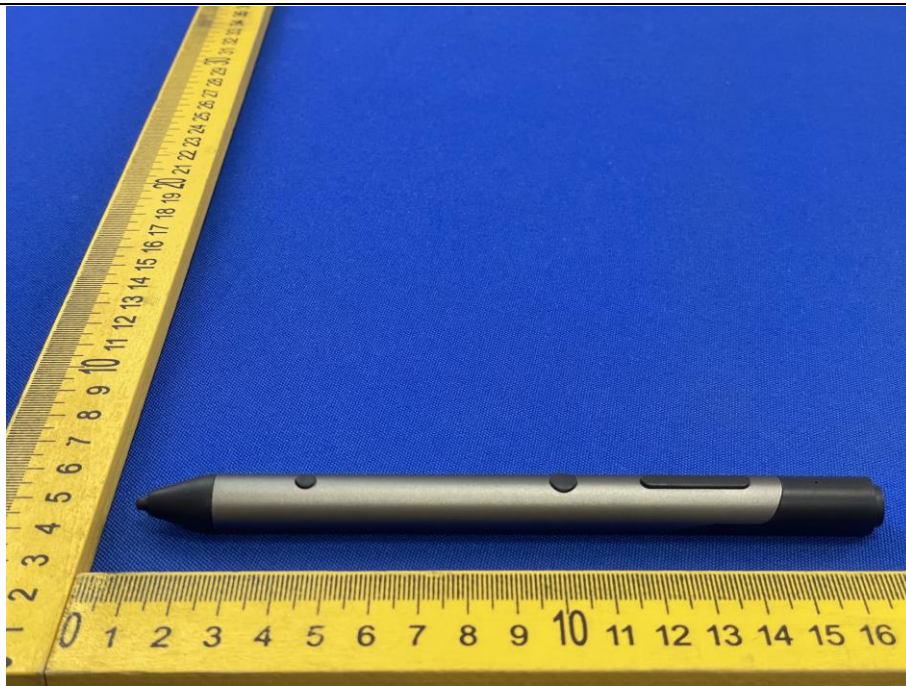


Photo 6



Photo 7

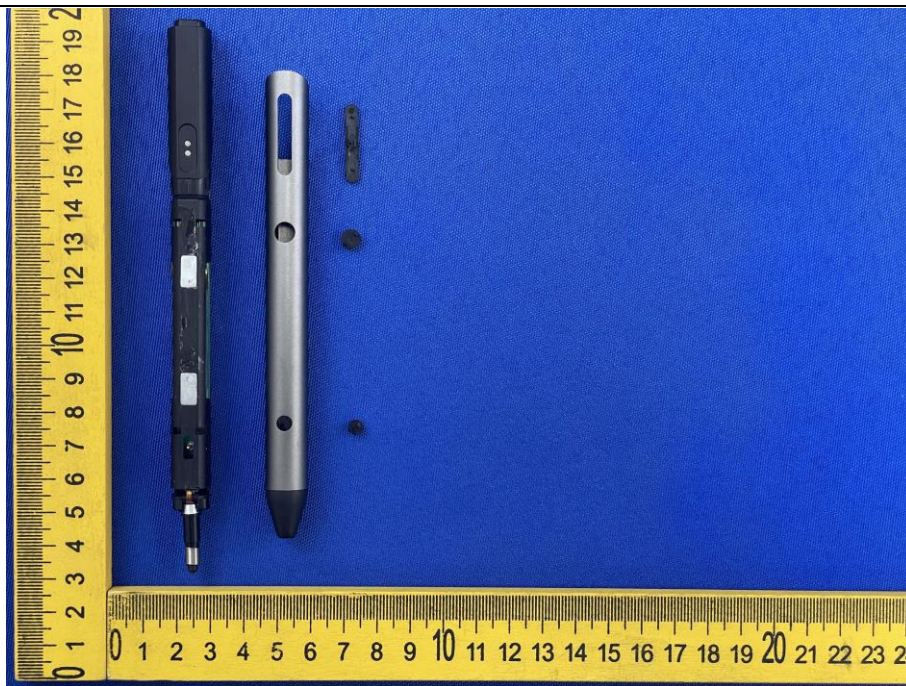


Photo 8

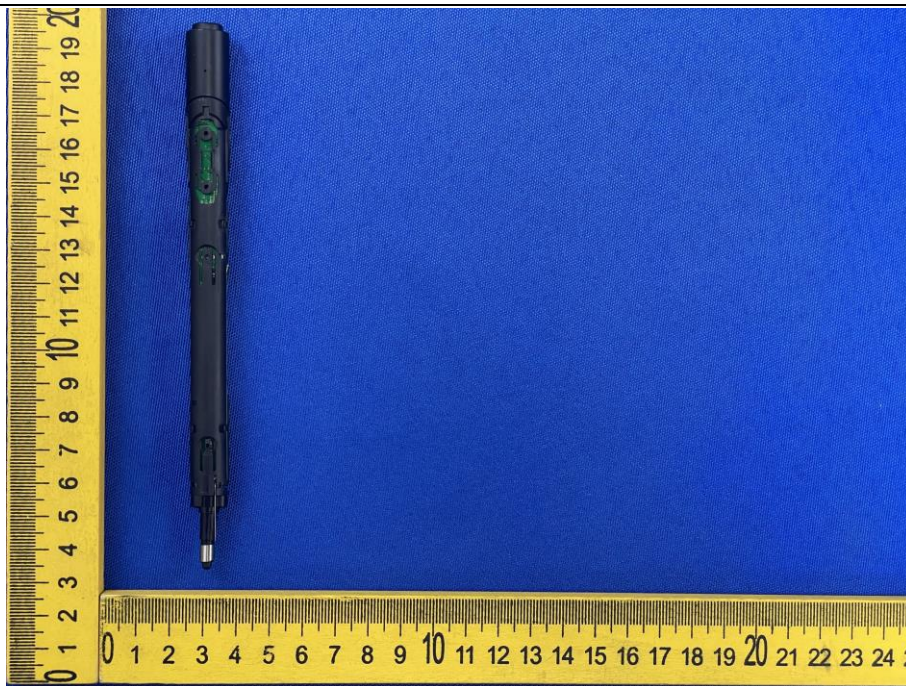


Photo 9

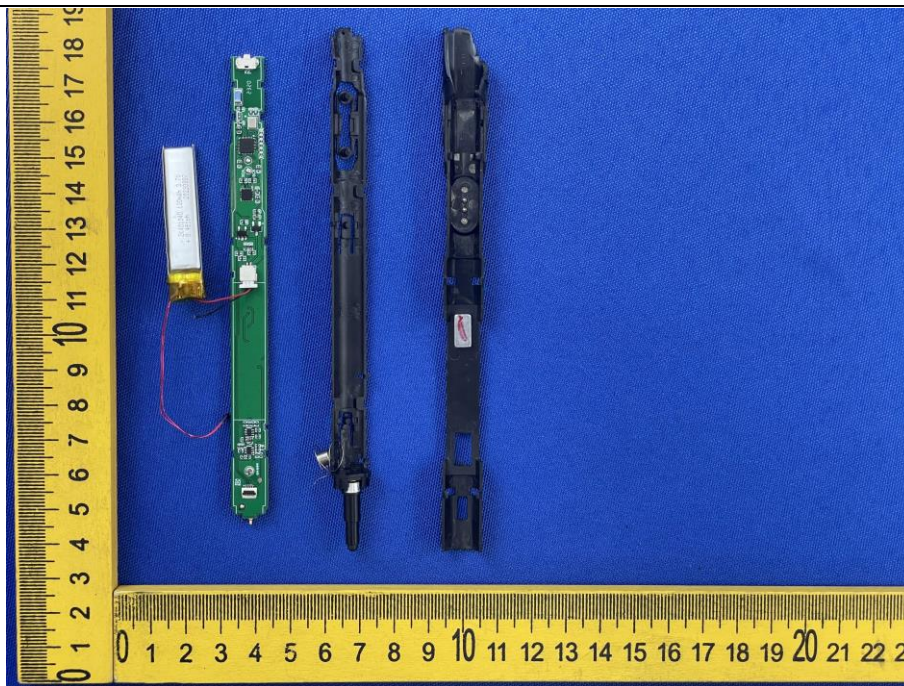


Photo 10

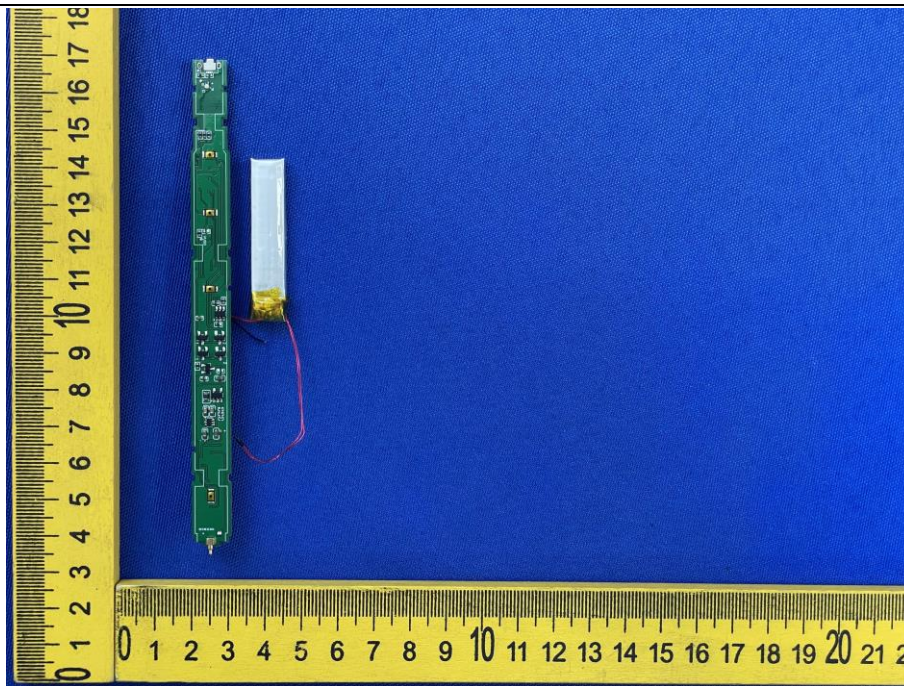


Photo 11

ANT

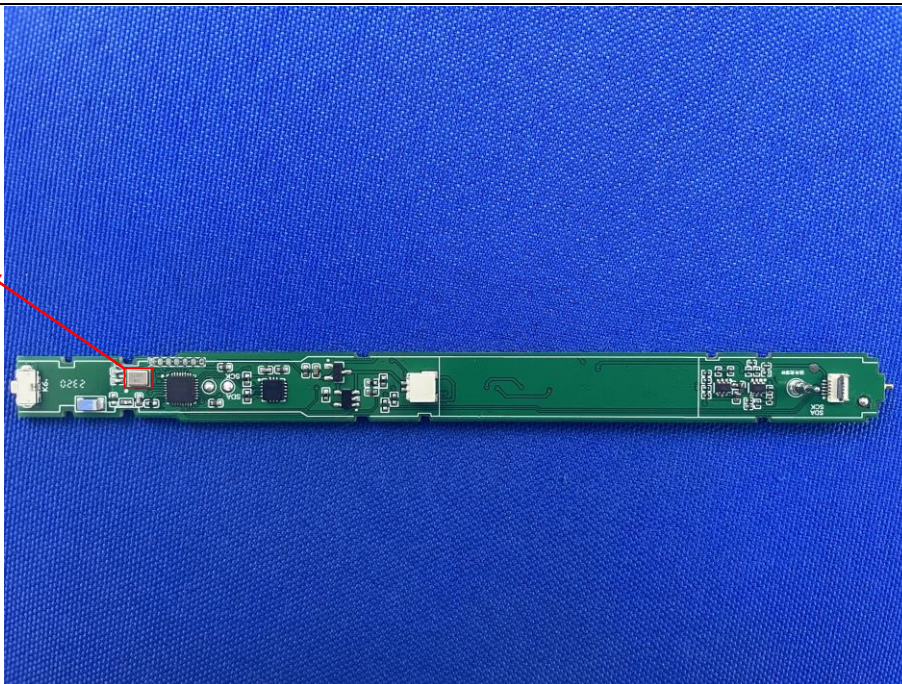


Photo 12

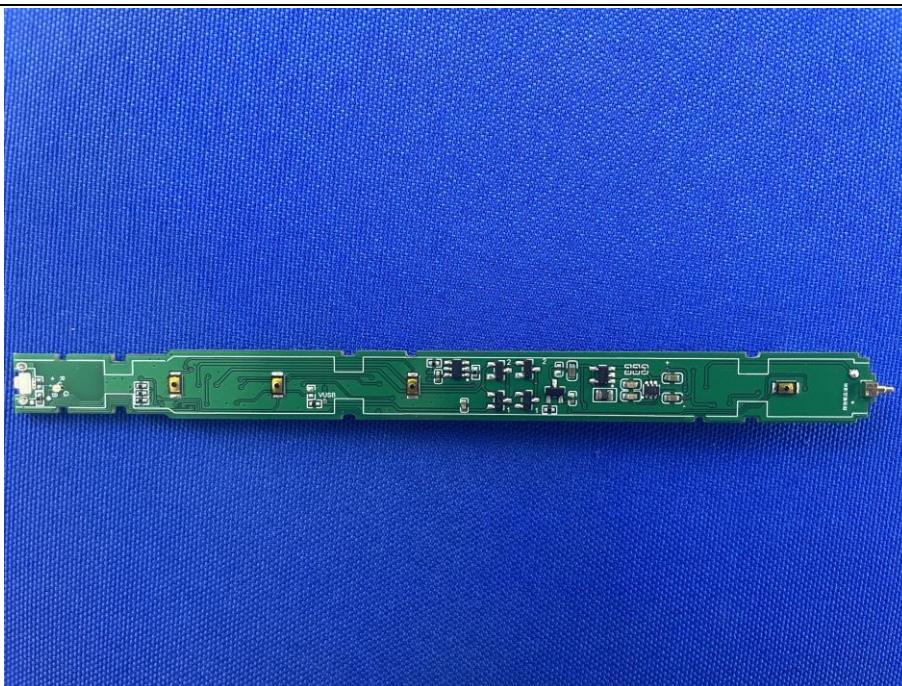


Photo 13

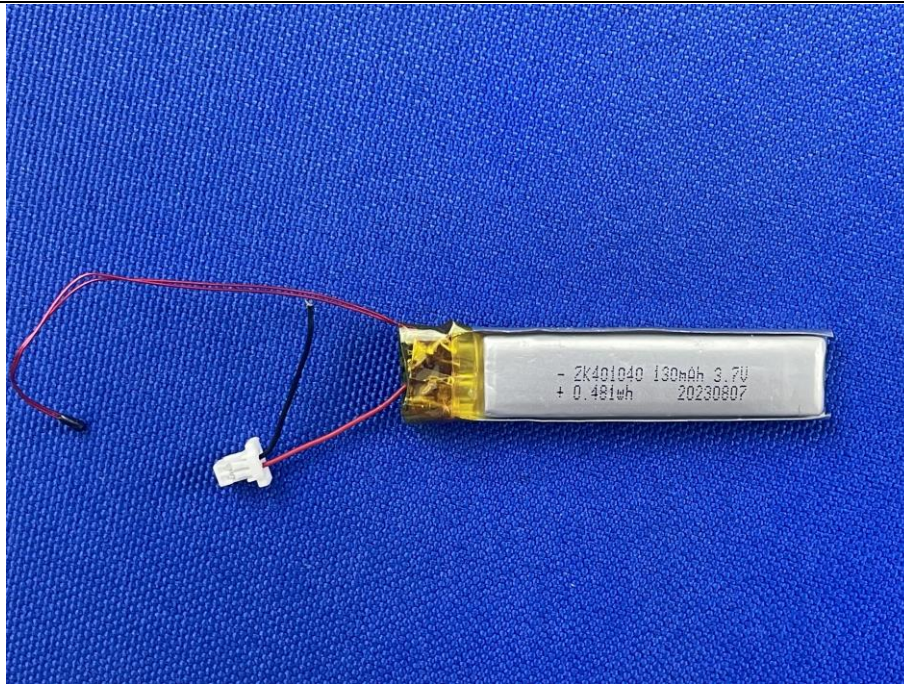
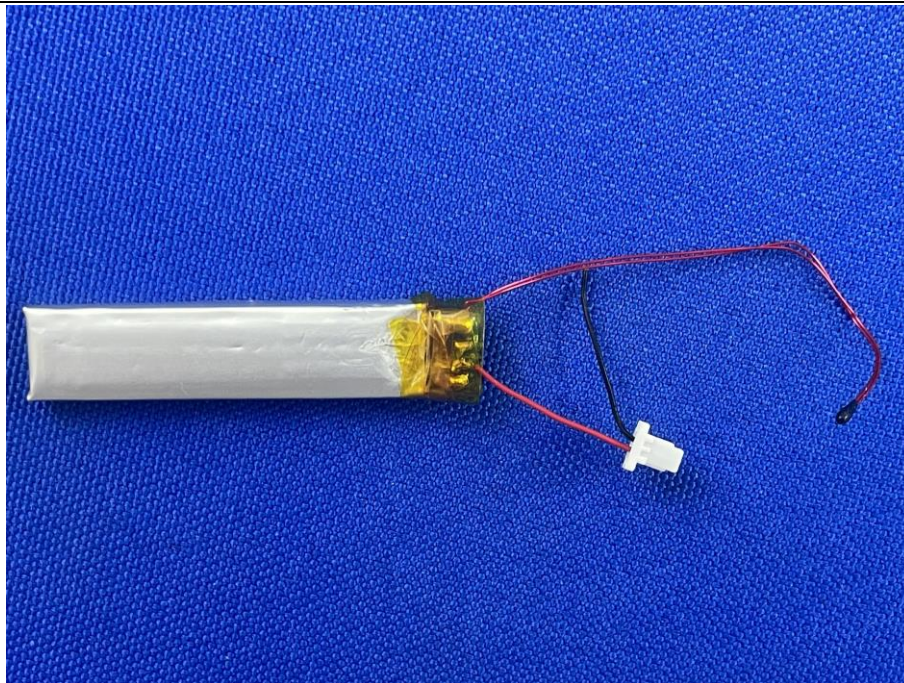


Photo 14



***** END OF REPORT *****