



REPORT No.: SZ22070130W01

# TEST REPORT

**APPLICANT** : Seeed Technology Co., Ltd.

**PRODUCT NAME** : Seeed Studio XIAO ESP32C3

**MODEL NAME** : XIAO ESP32C3

**BRAND NAME** : Seeed Studio

**STANDARD(S)** : Article 2 Paragraph 1 of Item 19

**RECEIPT DATE** : 2022-07-11

**TEST DATE** : 2022-07-14 to 2022-07-19

**ISSUE DATE** : 2022-07-29

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Change History		
Version	Date	Reason for change
1.0	2022-07-29	First edition

## 1. Summary of Test Result

No.	Description of Test	Test Engineer	Result	Method determination /Remark
1	Frequency Error	He Yuyang	PASS	No deviation
2	Occupied Bandwidth	He Yuyang	PASS	No deviation
3	Unwanted Emission Intensity	He Yuyang	PASS	No deviation
4	Antenna Power Error	He Yuyang	PASS	No deviation
5	Limitation of Collateral Emission of Receiver	He Yuyang	PASS	No deviation
6	E.I.R.P.	He Yuyang	PASS	No deviation
7	Radiation Angle of Antenna	He Yuyang	PASS	No deviation
8	Radio Interference Prevention Capability	He Yuyang	PASS	No deviation
9	Construction Protection Confirmation	N/A	PASS	No deviation

**Note 1:** Additions to, deviation, or exclusions from the method shall be judged in the "method determination" column of add, deviate or exclude from the specific method shall be explained in the "Remark" of the above table.

**Note 2:** When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.

### 1.1. Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- MIC Notice No.88 Appendix No.43, Item 19



## 1.2. Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Due Date
EXA Signal Analyzer	Agilent	N9010A	MY53470836	2022.03.01	2023.02.28
DC Power Supply	IVYTECH	IV3610	1709D361010	2021.10.20	2022.10.19
Power Sensor	Agilent	U2021XA	MY54180008	2021.10.21	2022.10.20
Radio Communication Tester	R&S	CMW500	108950	2022.03.01	2023.02.28

**Note 1:** The equipments were calibrated by CCIC (Shenzhen) Metrology&Testing Service Co.,Ltd and Shenzhen Academy of Metrology and Quality Inspection.

## 1.3. Measurement Uncertainty

No.	Test Items	Uncertainty	Remark
1	Frequency Error / 99% & 90% Bandwidth	$\pm 1.75 \times 10^{-6}$	Confidence levels of 95%
2	Antenna Power	$\pm 1.14\text{dB}$	Confidence levels of 95%
3	Spurious Emissions(<1GHz)	$\pm 2.23\text{dB}$	Confidence levels of 95%
4	Spurious Emissions(>1GHz)	$\pm 1.72\text{dB}$	Confidence levels of 95%
5	Transmission Antenna Gain	$\pm 2.49\text{dB}$	Confidence levels of 95%

## 1.4. Testing Laboratory

Laboratory Name	Shenzhen Morlab Communications Technology Co., Ltd.
Laboratory Address	FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
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## 2. General Description

### 2.1. Information of Applicant and Manufacturer

<b>Applicant</b>	Seed Technology Co., Ltd.
<b>Applicant Address</b>	9F, G3 Building, TCL International E City, Zhongshanyuan Road, Nanshan District, Shenzhen, Guangdong Province, P.R.C
<b>Manufacturer</b>	Seed Technology Co., Ltd
<b>Manufacturer Address</b>	9F, G3 Building, TCL International E City, Zhongshanyuan Road, Nanshan District, Shenzhen, Guangdong Province, P.R.C

### 2.2. Information of EUT

<b>Product Name</b>	Seed Studio XIAO ESP32C3		
<b>Sample No.</b>	1#		
<b>Hardware Version</b>	N/A		
<b>Software Version</b>	V1.0		
<b>Equipment Type</b>	Bluetooth LE		
<b>Bluetooth Version</b>	5.0		
<b>Modulation Technology</b>	GFSK		
<b>Data Rate</b>	1Mbps, 2Mbps		
<b>Operating Frequency Range</b>	2402MHz–2480MHz (at interval of 2MHz)		
<b>Channel List</b>	Please refer as chapter 2.4 in this report.		
<b>Power Supply</b>	Type		Adapter
	Voltage (V)	Low	4.5
		Rated	<b>5.0</b>
		High	5.5

**Note 1:** The black bold voltage values were selected for test, about the voltage fluctuation evaluation, please refer as chapter 2.6.2 in this report.

**Note 2:** For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.



## 2.3. Information of Antenna

Antenna Manufacturer	N/A
Brand Name	N/A
Model Name	N/A
Antenna Type	ANT1: FPC Antenna ANT2: Dipole Antenna
Antenna Gain	ANT1: 2.81dBi ANT2: 2.42dBi

**Note 1:** The EUT can be used with two kinds of antenna and it operates in single antenna.

## 2.4. Channel List of EUT

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
<b>0</b>	<b>2402</b>	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	<b>19</b>	<b>2440</b>	29	2460	<b>39</b>	<b>2480</b>

**Note 1:** The black bold channels were selected for test.



## 2.5. Test Configuration of EUT

### 2.5.1. Evaluation of The Worst Case

Investigation has been done on all the possible configurations for searching the worst cases. The following table is a list of the test modes shown in this test report.

Test Items	Mode	Channel
Frequency Error	Unmodulated Single Carrier	0/19/39
Occupied Bandwidth	GFSK	0/19/39
Unwanted Emission Intensity	GFSK	0/19/39
Antenna Power and Antenna Power Error	GFSK	0/19/39
Limitation of Collateral Emission of Receiver	GFSK	0/19/39
Transmission Radiation Angle Width	GFSK	0/19/39
Radio Interference Prevention Capability	GFSK	Normal Use

### 2.5.2. Operation and Transmitter Power Setting

The EUT was tested while in a continues transmitter/receiver mode under the control of tool which is provided by manufacturer, all the items of transmitter were tested under the power setting as below:

Mode	Data Rate	Channel	Power Setting
Unmodulated Single Carrier	-	0/19/39	Default
GFSK	1Mbps	0/19/39	Default
GFSK	2Mbps	0/19/39	Default



## 2.6. Test Conditions

### 2.6.1. Environment Condition

Temperature (°C)	5-35
Relative Humidity (%)	45-85
Atmospheric Pressure (kPa)	86-106

### 2.6.2. Power Supply Voltage Fluctuation

During the input supply voltage to the EUT from the external power source is varied by +/- 10%, the output voltage had been confirmed that the fluctuation of power supply to the RF unit of EUT is equal to or less +/- 1%.

Power Supply		External Voltage $V_E(V)$		Internal Voltage $V_I$		
		$V_{EN}$	$V_{EL}/V_{EH}$	$V_{IN}(V)$	$V_{IE}(V)$	Variation of $V_I$
Type1	Adapter	5.00	$V_{EL}$	3.30	3.27	0.91%
			$V_{EH}$		3.33	0.91%

$V_{EN}$ : Normal Voltage

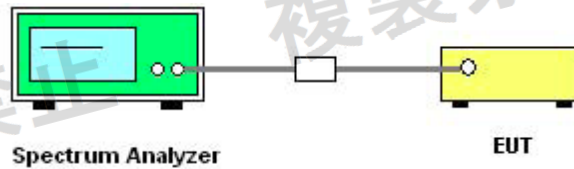
$V_{EL}$ :  $V_{EL}$  is the declared low voltage provided that  $V_{EN} \times 90\%$  is less than the declared low voltage, otherwise it is  $V_{EN} \times 90\%$

$V_{EH}$ :  $V_{EH}$  is the declared high voltage provided that  $V_{EN} \times 110\%$  is larger than the declared high voltage, otherwise it is  $V_{EN} \times 110\%$

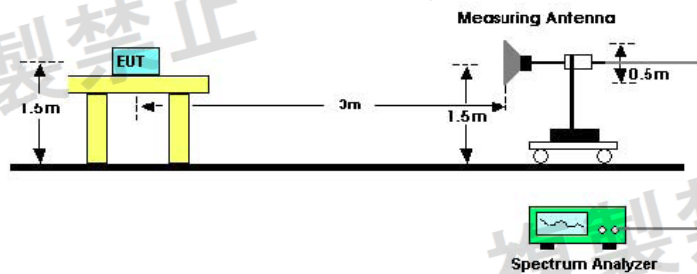
$V_{IN}$ : The voltage supply to the radio unit.

## 2.7. Test Setup Layout Diagram

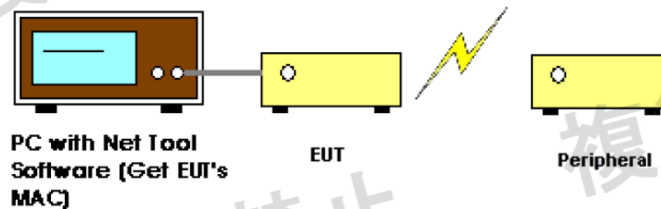
### 2.7.1. Conducted Measurement



### 2.7.2. Radiation Angle of Antenna



### 2.7.3. Radio Interference Prevention Capability Measurement





### 3. Test Results

#### 3.1. Frequency Error

##### 3.1.1. Limit

Within +/-50ppm.

##### 3.1.2. Measuring Instrument Setting

Spectrum Parameter	Setting
Center Frequency	Equal to the center frequency of the testing signal
Attenuation	Auto
RBW/VBW	10 kHz / 30 kHz
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

##### 3.1.3. Test Procedures

1. Control the EUT to transmit the unmodulated single carrier signal.
2. Setting the spectrum analyzer following the table in chapter 3.1.2 of this report.
3. Center Frequency: The center frequency of testing for EUT.
4. Use the peak search function of the SA to mark the frequency of the highest level signal and record as f.
5. The  $f_c$  is declaring of channel frequency. Then use the formula that  $(f_c - f)/f_c \times 10^6$  to calculate the frequency error.

##### 3.1.4. Test Setup Layout

Refer to chapter 2.7.1 in this report.

##### 3.1.5. Test Deviation

There is no deviation with the original standard.

##### 3.1.6. Test Result

Refer to Annex A.1 in this report.



## 3.2. Occupied Bandwidth

### 3.2.1. Limit

Type	Limits
FHSS	≤83.5MHz
DSSS	≤26MHz
OFDM	
Other	

### 3.2.2. Measuring Instruments Setting

Spectrum Parameter	Setting
Span	3MHz for 1Mbps; 5MHz for 2Mbps
RBW/VBW	100kHz/300 kHz
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

### 3.2.3. Test Procedures

1. Control the EUT to transmit the continue modulated signal.
2. Setting the spectrum analyzer following the table in chapter 3.2.2 of this report.
3. Center Frequency: The center frequency of testing for EUT.
4. Use the occupied bandwidth measurement function of the SA to get the OBW value automatically, then record it.

### 3.2.4. Test Setup Layout

Refer to chapter 2.7.1 in this report.

### 3.2.5. Test Deviation

There is no deviation with the original standard.

### 3.2.6. Test Result

Refer to Annex A.2 in this report.



### 3.3. Unwanted Emission Intensity

#### 3.3.1. Limit

Frequency Range	Limits
30MHz-1000MHz	$\leq 0.25 \mu\text{W}/100\text{kHz}$
1000MHz-2387MHz	$\leq 2.5 \mu\text{W}/\text{MHz}$
2387MHz-2400MHz	$\leq 25 \mu\text{W}/\text{MHz}$
2483.5MHz-2496.5MHz	$\leq 25 \mu\text{W}/\text{MHz}$
2496.5MHz-12500MHz	$\leq 2.5 \mu\text{W}/\text{MHz}$

#### 3.3.2. Measuring Instruments Setting

Spectrum Parameter	Setting
Attenuation	Auto
RBW/VBW	100kHz/100kHz(below 1GHz); 1MHz/1MHz(above 1GHz)
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

#### 3.3.3. Test Procedures

1. Control the EUT to transmit the continue modulated signal.
2. Use the spurious emissions function of the SA.
3. Setting the spectrum analyzer following the table in chapter 3.3.2 of this report for every frequency range.
4. The SA will capture the spurious results, only the spurious with the minimum margin from the limit line will be displayed in the mark table.

#### 3.3.4. Test Setup Layout

Refer to chapter 2.7.1 in this report.

#### 3.3.5. Test Deviation

There is no deviation with the original standard.



### 3.3.6. Test Result

Refer to Annex A.3 in this report.

**Note1:** The spurious emissions mask that displayed on the plots is composed of several frequency ranges below:

Range	Start Freq. (MHz)	Stop Freq. (MHz)	RBW	VBW	Detector Type	Trace Mode	Limit ( $\mu$ W)
1	30	1000	100kHz	100kHz	Peak	Max Hold	0.25
2	1000	2387	1MHz	1MHz	Peak	Max Hold	2.5
3	2387	2400	1MHz	1MHz	Peak	Max Hold	25
4	2400	2483.5	1MHz	1MHz	Peak	Max Hold	20000
5	2483.5	2496.5	1MHz	1MHz	Peak	Max Hold	25
6	2496.5	12500	1MHz	1MHz	Peak	Max Hold	2.5

**Note 2:** Only the spurious with the minimum margin from the limit line will be displayed in the mark table (The lower window on the test plots).

### 3.4. Antenna Power Error

#### 3.4.1. Limit

Type	Limits	
	Antenna Power Density	Antenna Power Error
FHSS	$\leq 3$ mW/MHz	-80~+20%
DSSS	$\leq 10$ mW/MHz	
OFDM	$\leq 10$ mW/MHz (20MHz System) $\leq 5$ mW/MHz (40MHz System)	
Other	$\leq 10$ mW/MHz	

#### 3.4.2. Measuring Instruments Setting

Spectrum Parameter	Setting
Center Frequency	Equal to the center frequency of the testing signal
Attenuation	Auto
Span	1.5 times the bandwidth approximately
RBW/VBW	1MHz / 1MHz
Detector	Average
Trace	Average
Sweep Time	Auto

#### 3.4.1. Test Procedures

- Control the EUT to transmit the unmodulated single carrier signal.
- Setting the spectrum analyzer following the table in chapter 3.4.2 of this report.
- Wait for the trace to become stable
- Use the peak search function of the SA to mark the highest level signal and record as  $P_t$ .
- Calibrate the  $P_t$  use the duty cycle, and record the calibrated value as  $P$ .
- Use the record value  $P_t$  and declared value  $P_c$  calculate the antenna error.

#### 3.4.2. Test Setup Layout

Refer to chapter 2.7.1 in this report.



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#### 3.4.3. Test Deviation

There is no deviation with the original standard.

#### 3.4.4. Test Result

Refer to Annex A.4 in this report.



### 3.5. Limitation of Collateral Emission of Receiver

#### 3.5.1. Limit

Frequency Range	Limits
30MHz-1000MHz	$\leq 4\text{nW}/100\text{kHz}$
1000MHz-12500MHz	$\leq 20\text{nW}/\text{MHz}$

#### 3.5.2. Measuring Instruments Setting

Refer to chapter 3.3.2 in this report.

#### 3.5.3. Test Procedures

1. Control the EUT into receive mode.
2. Use the spurious emissions function of the SA.
3. Setting the spectrum analyzer following the table in chapter 3.3.2 of this report for every frequency range.
4. The SA will capture the spurious results, only the spurious with the minimum margin from the limit line will be displayed in the mark table.

#### 3.5.4. Test Setup Layout

Refer to chapter 2.7.1 in this report.

#### 3.5.5. Test Deviation

There is no deviation with the original standard.



### 3.5.6. Test Result

Refer to Annex A.5 in this report.

**Note 1:** The spurious emissions mask that displayed on the plots is composed of several frequency ranges below:

Range	Start Freq. (MHz)	Stop Freq. (MHz)	RBW	VBW	Detector Type	Trace Mode	Limit (nW)
1	30	1000	100kHz	100kHz	Peak	Max Hold	4
2	1000	12500	1MHz	1MHz	Peak	Max Hold	20

**Note 2:** Only the spurious with the minimum margin from the limit line will be displayed in the mark table (The lower window on the test plots).



### 3.6.E.I.R.P.

#### 3.6.1.Limit

Type	Limits
FHSS	6.91-16.91dBm/MHz
DSSS	12.14-22.14dBm/MHz
OFDM	12.14-22.14dBm/MHz (20MHz System) 9.13-19.13dBm/MHz (40MHz System)
Other	12.14-22.14dBm

**Note:** This item not be applied to the transmission antenna which has a gain of 2.14dBi or less

#### 3.6.2.Measuring Instruments Setting

Refer to chapter 3.4.2 in this report.

#### 3.6.3.Test Procedures

Add antenna gain to the value P which got in chapter 3.4.1 to calculate E.I.R.P. value.

#### 3.6.4.Test Setup Layout

Refer to chapter 2.7.1 in this report.

#### 3.6.5.Test Deviation

There is no deviation with the original standard.

#### 3.6.6.Test Result

Refer to Annex A.6 in this report.

### 3.7. Radiation Angle of Antenna

#### 3.7.1. Limit

Type	Limits
FHSS	360° /A; (A= E.I.R.P./ 6.91, if A<1; then A=1)
DSSS	360° /A; (A= E.I.R.P./ 12.14, if A<1; then A=1)
OFDM	
Other	

**Note:** This item not be applied to the transmission antenna which has a gain of 2.14dBi or less

#### 3.7.2. Measuring Instruments Setting

Spectrum Parameter	Setting
RBW	1MHz
VBW	1kHz
Y scale	5dB
Detector	Peak
Trace	Max Hold

#### 3.7.3. Test Procedures

1. Set the EUT and measuring antenna at the same height and roughly facing each other.
2. Set spectrum analyzer and tune reference level to observe receiving signal position.
3. Rotate directions of the EUT horizontally and erotically to find the maximum receiving power.
4. Move the measuring antenna height up and down within  $\pm 50\text{cm}$  of EUT height and swing it to find the maximum output of measuring antenna. The output level at the spectrum analyzer is read as "E"
5. Calculate permitted radiation angle in horizontal and vertical using E.I.R.P. measured in another test method.
6. Calculate 3dB antenna beam width by the formula below  $360/A$  (If  $A<1$ ; then  $A=1$ ).  $A = \{E.I.R.P. \text{ Power [mW]} / 16.36 \text{ for DS, OFDM}\}$  or  $A = \{E.I.R.P. \text{ Power [mW]} / 4.9 \text{ for FH}\}$

#### 3.7.4. Test Setup Layout

Refer to chapter 2.7.2 in this report.



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### 3.7.5. Test Deviation

There is no deviation with the original standard.

### 3.7.6. Test Result

Refer to Annex A.7 in this report.



## 3.8. Radio Interference Prevention Capability

### 3.8.1. Limit

The one automatically to transmit and to receive identification code with the wireless equipment of the wireless station used in the same premises.

### 3.8.2. Test Procedures

1. In the case that the EUT has the function of automatically transmitting the identification code:
  - a) Transmit the predetermined identification codes form EUT.
  - b) Check the transmitted identification codes with the demodulator.
2. In the case of receiving the identification code:
  - a) Transmit the predetermined identification codes form the counterpart.
  - b) Check if communication is normal.
  - c) Transmit the signals other than predetermined ID codes form the counterpart.
  - d) check if the EUT stops the transmission, or if it displays that identification codes are different from the predetermined ones.

### 3.8.3. Test Setup Layout

Refer to chapter 2.7.3 in this report.

### 3.8.4. Test Deviation

There is no deviation with the original standard.

### 3.8.5. Test Result

Refer to Annex A.8 in this report.

## 3.9. Construction Protection Confirmation Method

### 3.9.1. Limit

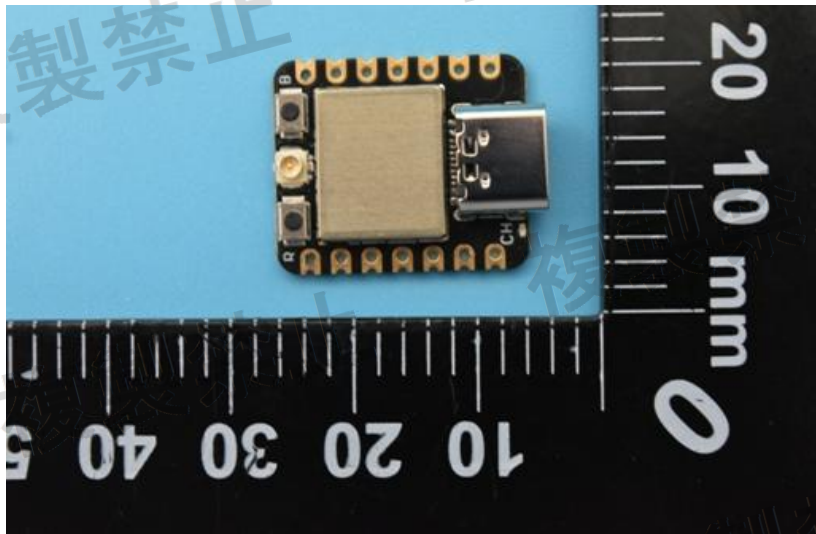
The high-frequency section and modulation section of the radio equipment except for the antenna system shall not be capable of being opened easily.

### 3.9.2. Confirmation Method

The RF and modulation portions are protected against illegal modification as following method:

Protected Method	Description
Shield	The RF module use a shield to protect the RF and modulation portions, if the shield is removed, the module will be damaged to the point that it will not work properly.

### 3.9.3. Reference Documents

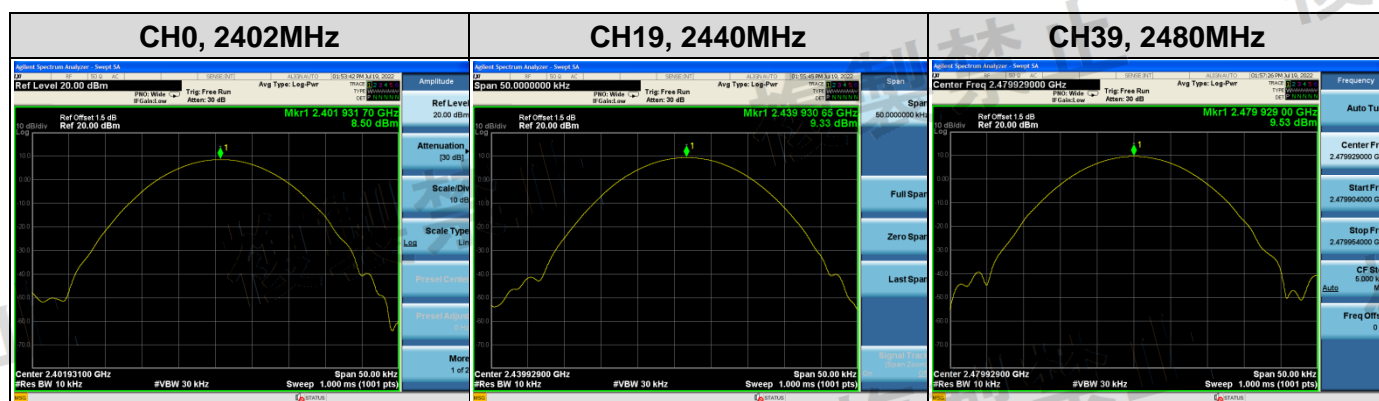
Reference Documents	Item
Photo	



## Annex A Test Data and Result

### A.1. Frequency Error

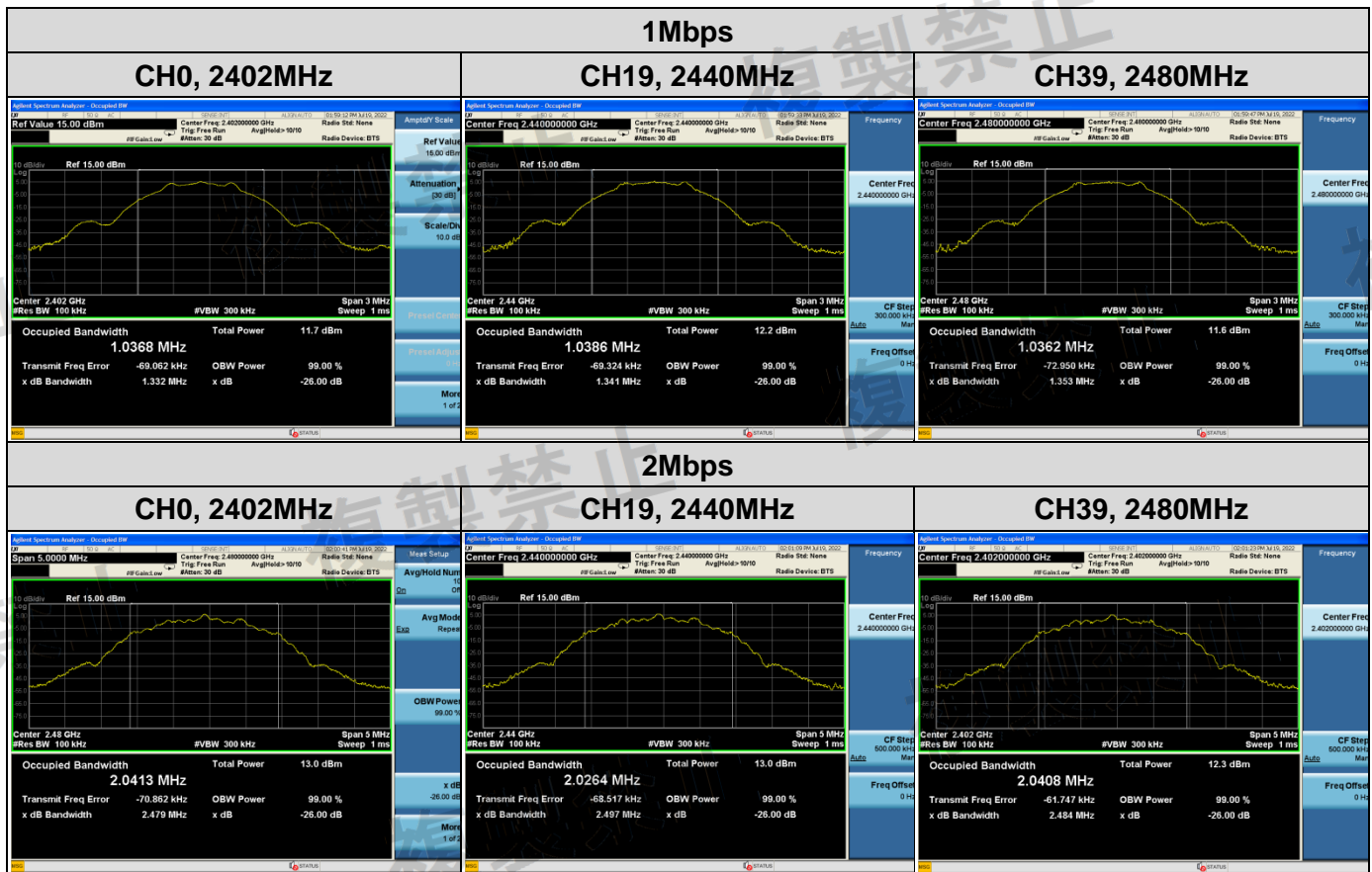
Channel	Frequency $f_c$ (MHz)	Test Frequency $f$ (MHz)	Frequency Error (ppm)	Verdict
0	2402	2401.9317	-28.43	PASS
19	2440	2439.9307	-28.40	PASS
39	2480	2479.9290	-28.63	PASS





## A.2. Occupied Bandwidth

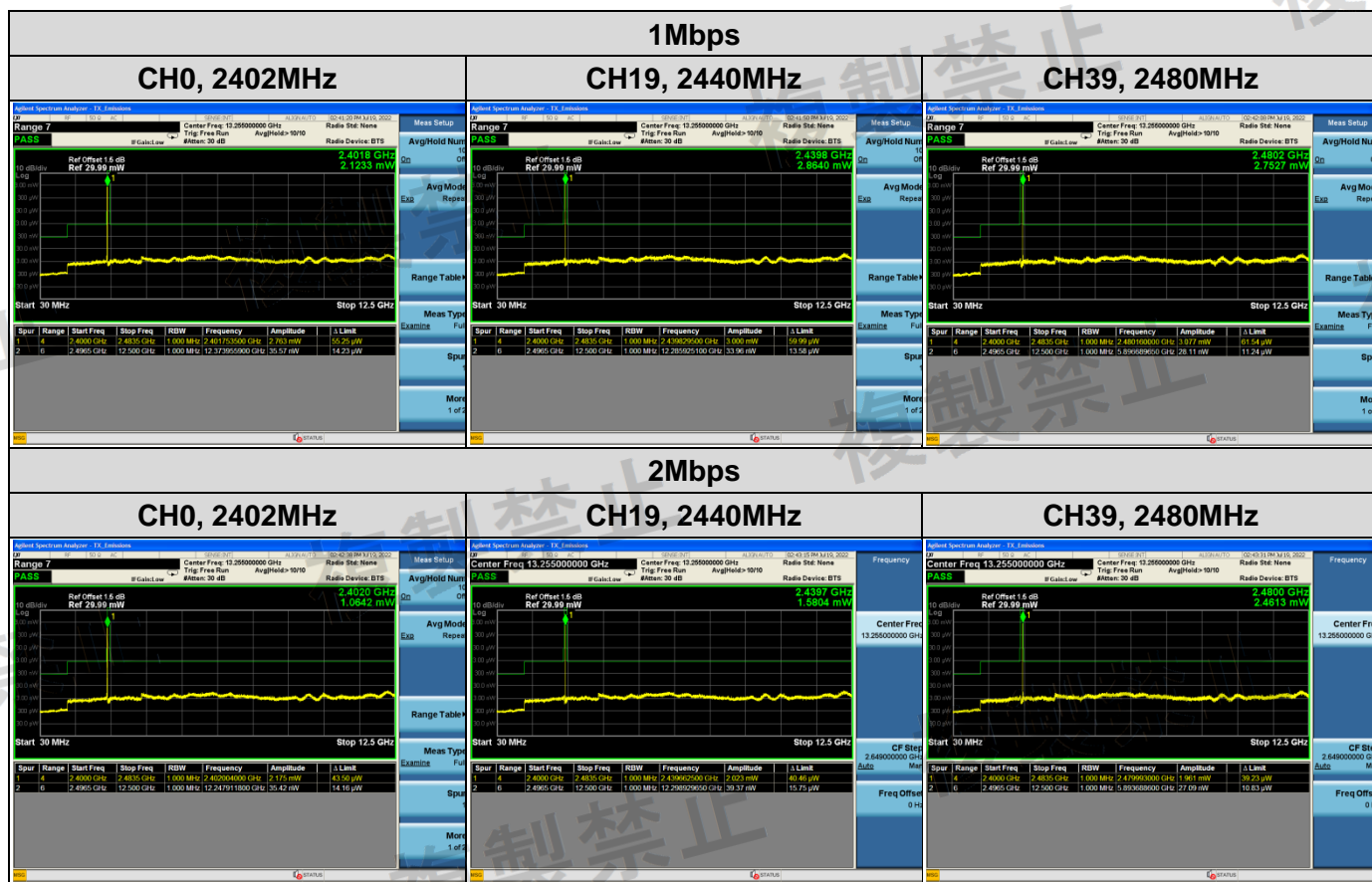
Mode	Channel	Frequency (MHz)	Measured 99% Occupied Bandwidth (MHz)	Verdict
1Mbps	0	2402	1.037	PASS
	19	2440	1.039	PASS
	39	2480	1.036	PASS
2Mbps	0	2402	2.041	PASS
	19	2440	2.026	PASS
	39	2480	2.041	PASS





## A.3. Unwanted Emission Intensity

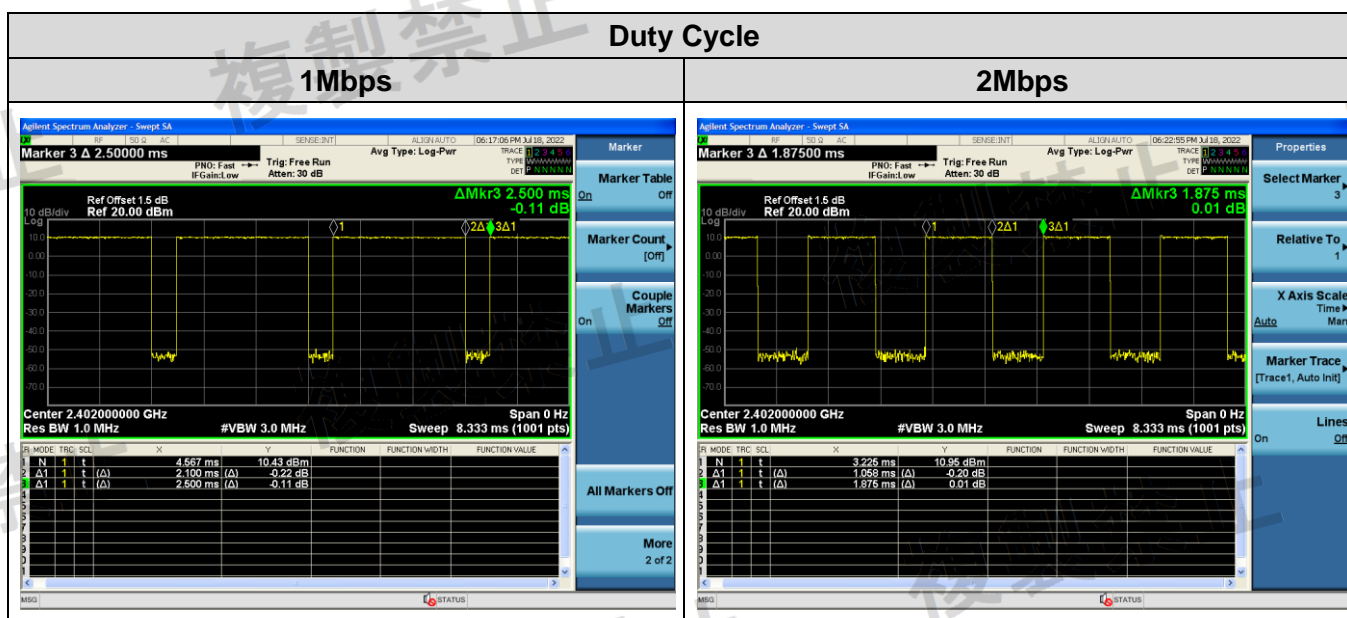
Mode	Frequency Range (MHz)	Test Result Value	Limit	Verdict
1Mbps & 2Mbps	30~1000	Refer to below plot	0.25 $\mu$ W/100kHz	PASS
	1000~2387		2.5 $\mu$ W/MHz	PASS
	2387~2400		25 $\mu$ W/MHz	PASS
	2483.5~2496.5		25 $\mu$ W/MHz	PASS
	2496.5~12500		2.5 $\mu$ W/MHz	PASS





## A.4. Antenna Power Error

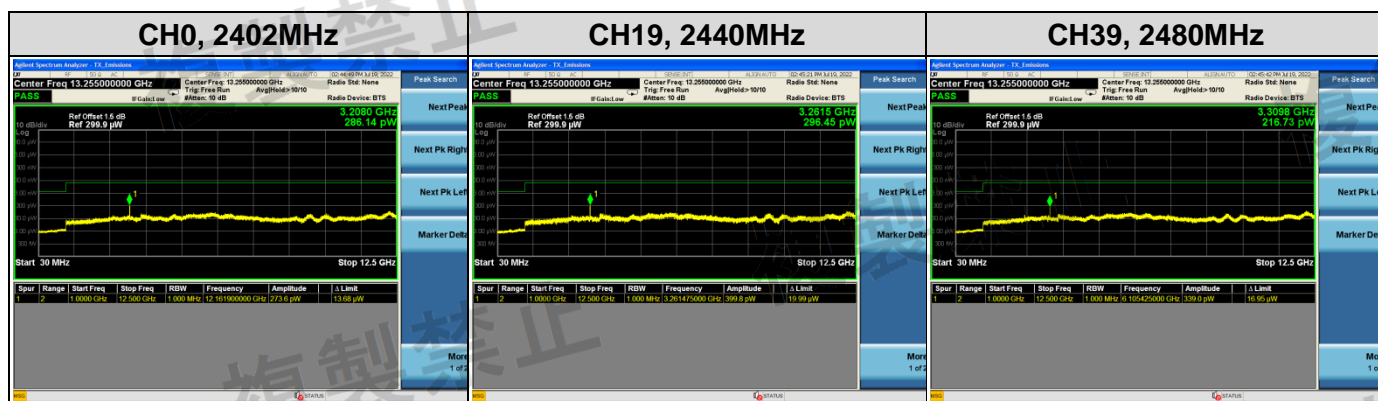
Mode	Channel	Test Value $P_t$ (dBm)	Duty Factor	Antenna Power $P$ (dBm)	Antenna Power $P$ (mW)	Declare Power (mW)	Antenna Power Error	Verdict
1Mbps	2402	9.10	0.76	9.86	9.68	10	-3.20%	PASS
	2440	8.70		9.46	8.83		-11.70%	PASS
	2480	7.11		7.87	6.12		-38.80%	PASS
2Mbps	2402	7.25	2.48	9.73	9.40	10	-6.00%	PASS
	2440	7.06		9.54	8.99		-10.10%	PASS
	2480	5.60		8.08	6.43		-35.70%	PASS





## A.5. Limitation of Collateral Emission of Receiver

Mode	Frequency Range (MHz)	Test Result Value	Limit	Verdict
Receive	30~1000	Refer to below plot	4nW/100kHz	PASS
	1000~12500		20nW/MHz	PASS





## A.6. E.I.R.P.

## ANT1

Mode	Channel	Frequency (MHz)	Measured E.I.R.P. (dBm)	Limit (dBm)	Verdict
1Mbps	0	2402	12.67	14.95	PASS
	19	2440	12.27		PASS
	39	2480	10.68		PASS
2Mbps	0	2402	12.54	14.95	PASS
	19	2440	12.35		PASS
	39	2480	10.89		PASS

## ANT2

Mode	Channel	Frequency (MHz)	Measured E.I.R.P. (dBm)	Limit (dBm)	Verdict
1Mbps	0	2402	12.28	14.56	PASS
	19	2440	11.88		PASS
	39	2480	10.29		PASS
2Mbps	0	2402	12.15	14.56	PASS
	19	2440	11.96		PASS
	39	2480	10.50		PASS



## A.7. Radiation Angle of Antenna

## ANT1

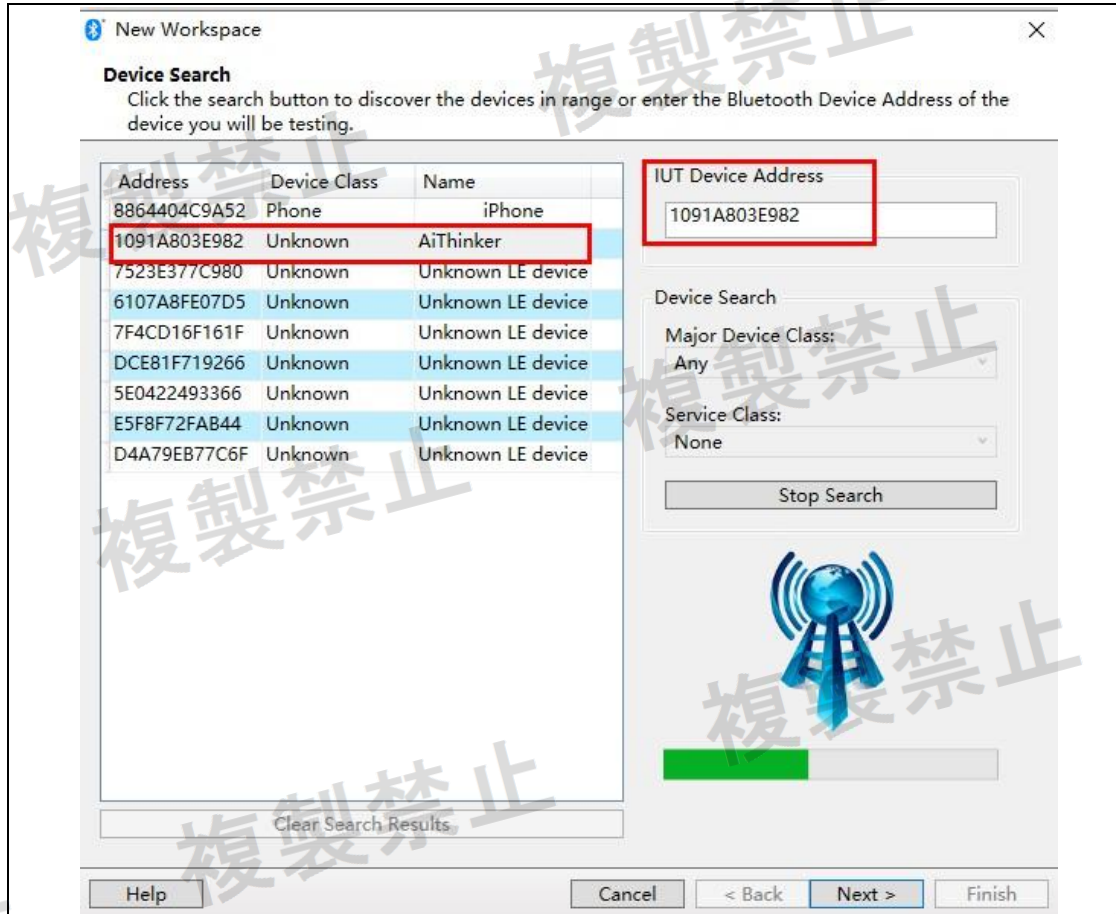
Mode	Channel	Frequency (MHz)	3dB Beamwidth (Degree)	Limit (Degree)	Verdict
1Mbps	0	2402	116	360	PASS
	19	2440	112		PASS
	39	2480	99		PASS
2Mbps	0	2402	103	360	PASS
	19	2440	100		PASS
	39	2480	92		PASS

## ANT2

Mode	Channel	Frequency (MHz)	3dB Beamwidth (Degree)	Limit (Degree)	Verdict
1Mbps	0	2402	113	360	PASS
	19	2440	111		PASS
	39	2480	96		PASS
2Mbps	0	2402	106	360	PASS
	19	2440	98		PASS
	39	2480	95		PASS

### A.8. Radio Interference Prevention Capability

The identification code of the EUT is: 1091A803E982



END OF REPORT