

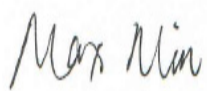
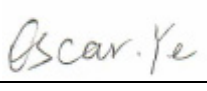
JAPAN MIC TEST REPORT

For

ESPRESSIF SYSTEMS (SHANGHAI) CO., LTD

Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China

Tested Model: ESP32-WROOM-32U

Report Type: CIIPC	Product Type: WIFI & Bluetooth Module
Test Engineer:	Max Min 
Report Number:	RSHD190417001-24D
Report Date:	2019-06-06
Reviewed By:	Oscar Ye RF Leader 
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	ESPRESSIF SYSTEMS (SHANGHAI) CO., LTD
Tested Model	ESP32-WROOM-32U
Product Type	WIFI & Bluetooth Module
Dimension	18.0 mm(L)×19.2 mm(W)×3.2 mm(H)
Power Supply	DC 3.3V

**All measurement and test data in this report was gathered from production sample serial number: 20190417001.
(Assigned by the BACL. The EUT supplied by the applicant was received on 2019-04-17)*

Objective

The objective of the manufacturer is to demonstrate compliance with Radio Law of Japan item 19-2 of Article 2 Paragraph 1, rules and limits for this device including:

This is a CIIPC report base on the original report RSHA171030001, the differences between the original device and the current one are as follows:

1. Add 2484MHz frequency.
2. Add an antenna and the antenna gain is 2 dBi.

The above differences will affect test, and others were referred to the original report.

Related Submittal(s)/Grant(s)

Item 19 of Article 2 Paragraph 1 for Wi-Fi 2412-2472 MHz
Item 19 of Article 2 Paragraph 1 for BT3.0
Item 19 of Article 2 Paragraph 1 for BLE

Test Methodology

All measurements contained in this report were conducted with technical regulations of the Radio Law of Japan.

EUT TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in a testing mode which was selected by manufacturer.

For frequency 2484MHz, EUT was tested with Channel 14.

Channel	Frequency (MHz)
14	2484

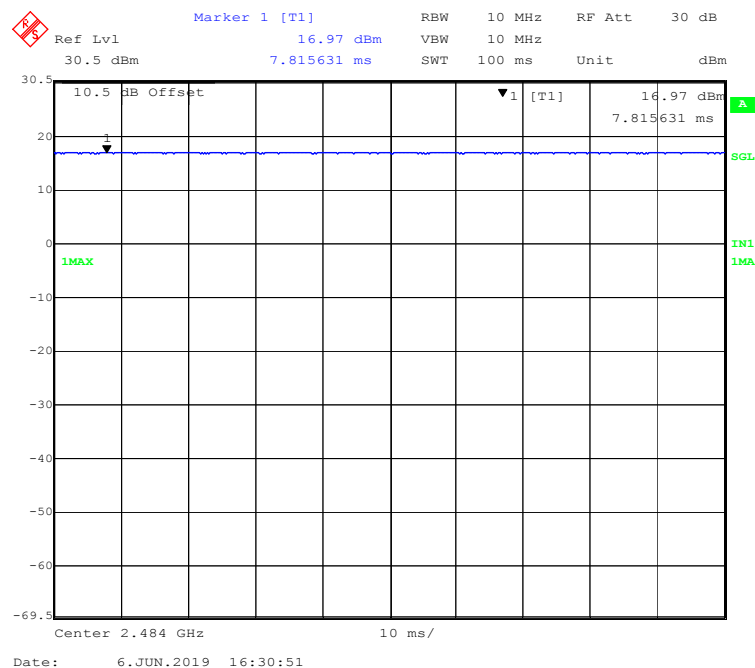
EUT Exercise Software

RF test tool: SecureCRT

The worst condition was performed under:

802.11b 2484MHz: Data rate: 1 Mbps, power level: 26

2484MHz Duty Cycle



Equipment Modifications

No modification was made to the EUT tested.

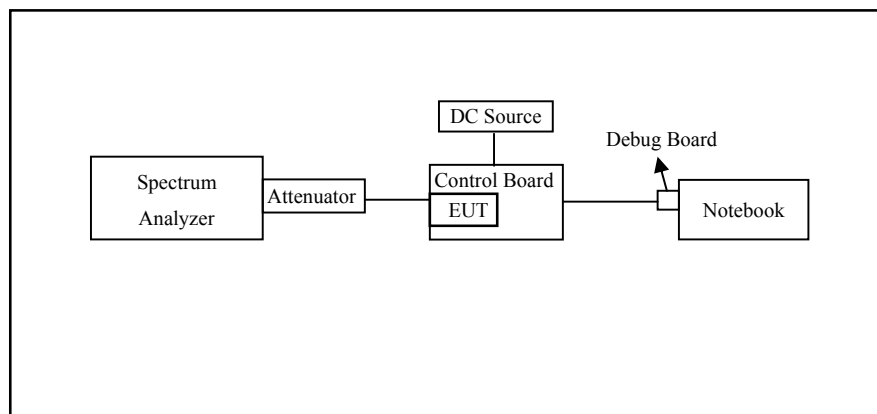
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
Narda	Attenuator	10dB	010
BEST	DC Power Supply	PS-1502D+	DC001
DELL	Notebook	GX620	D65874152
ESPRESSIF	Debug Board	ESP-WROOM-03	/
ESPRESSIF	Control Board	/	/

External I/O Cable

Cable Description	Length (m)	From/Port	To
RF Cable	0.8	Attenuator	EUT
DC Cable	0.8	Control Board	DC Source
Data Cable	0.3	Control Board	Debug Board

Configuration of Test Setup



SUMMARY OF TEST RESULTS

MIC Notice No.88 Appendix No.44 Article 2, Paragraph 1, Item 19-2 Rules Section	Description of Test	Result
3	Frequency Error	Compliant
4	Occupied Bandwidth and Spreading Bandwidth	Compliant
5	Transmitter Spurious Emission and Unwanted Emission Intensity	Compliant
6	Antenna Output Power and Output Power Tolerance	Compliant
7	Receiver Spurious Emission and Unwanted Emission Intensity	Compliant
8	Transmission Antenna Gain	Not Applicable (See Note 1)
9	Transmission Radiation Angle Width	Not Applicable (See Note 1)
10	Carrier Sense Function	Compliant
11	Frequency Hopping Dwell Time	Not Applicable (See Note 2)
12	Interference Prevention Function	Compliant
Appendix	Construction Protection Confirmation	Compliant

Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Note:

1. This test item will not be applied to the transmission antenna which EIRP is less than 12.14dBm/MHz.
2. This test item is only required for FHSS system devices.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2018-11-30	2019-11-29
Narda	Attenuator	10dB	010	2018-08-15	2019-08-14
Rohde & Schwarz	SMB 100A Signal Generator	SMB100A	110390	2018-07-21	2019-07-20
Mini-Circuits	Power Splitter	ZFRSC-14-S+	SF019411452	2018-11-10	2019-11-09
BEST	DC Power Supply	PS-1502D+	DC001	2018-10-10	2019-10-09
R & S	Wideband Radio Communication Tester	CMW500	104478	2018-07-21	2019-07-20

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements, traceable to National Primary Standards and International System of Units (SI).

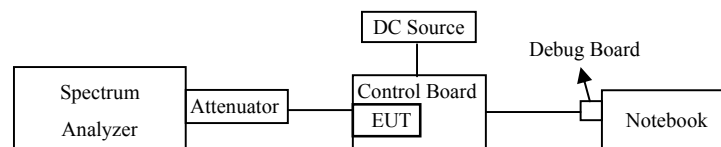
FREQUENCY ERROR

Limit

50 ppm or below

Test Procedure

Measurement System Diagram



Conditions of Application Equipment (EUT)

- Set the application equipment (EUT) to the measurement frequency.
- The modulation state shall be “continuous carrier wave without modulation” mode.

Spectrum Analyzer Conditions

- Center Frequency: Frequency to measure (2484 MHz)
- RBW: 1 kHz, VBW: 30 kHz
- Sweep time: Auto
- Log scale: 10dB/Div, Data points: 501points (400 points or more)
- Detection: Positive Peak, Sweep mode: Continuous
- Marker: Spot

If the EUT can't set at un-modulation mode, measure the 10dBc center frequency.

Measurement Result

Environmental Conditions

Temperature:	23.2°C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2019-06-06.

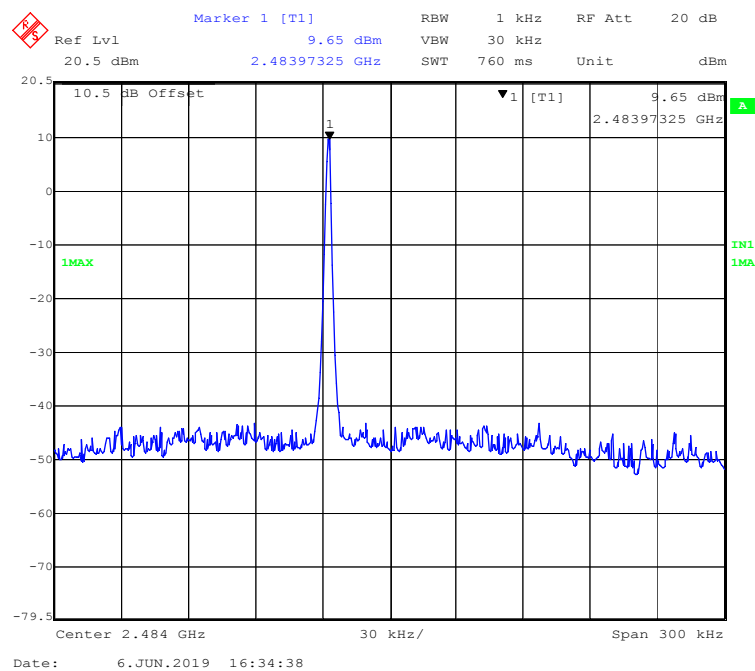
Test Result: Compliant

Test Mode: Transmitting

Frequency (MHz)	Voltage (V _{DC})	Measure Frequency (MHz)	Frequency Tolerance (ppm)	Limit (ppm)
2484	3.0	2483.97187	-11.32	± 50
	3.3	2483.97325	-10.77	
	3.6	2483.97334	-10.73	

Please refer to the following plots for normal voltage:

Test Frequency: 2484MHz



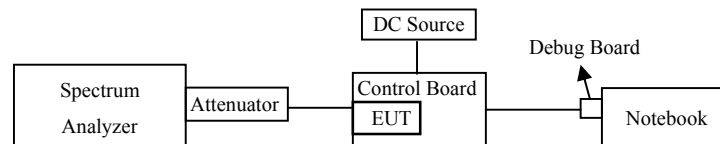
OCCUPIED BANDWIDTH AND SPREADING BANDWIDTH

Limit

- Occupied bandwidth: DS \leq 26 MHz; Others \leq 26 MHz
- Spread Bandwidth: \geq 500 kHz (FH, DS), Spread factor $>$ 10.

Test Procedure

1. Setting of SA is following as: RB: 300 kHz / VB: 300 kHz / Sweep time: Auto / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold
2. EUT have transmitted the maximum modulation signal and fixed channelize. SA set to 99% of occupied bandwidth to measure occupied bandwidth.
3. EUT have transmitted the maximum modulation signal and fixed channelize. SA set to 90% of occupied bandwidth to measure spread bandwidth.
4. Spread Factor=Spread Bandwidth/modulation rate. The modulation rate: MR=1.375 for 802.11b



Measurement Result

Environmental Conditions

Temperature:	23.2°C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2019-06-06.

Test Result: Compliant*Test Mode: Transmitting*

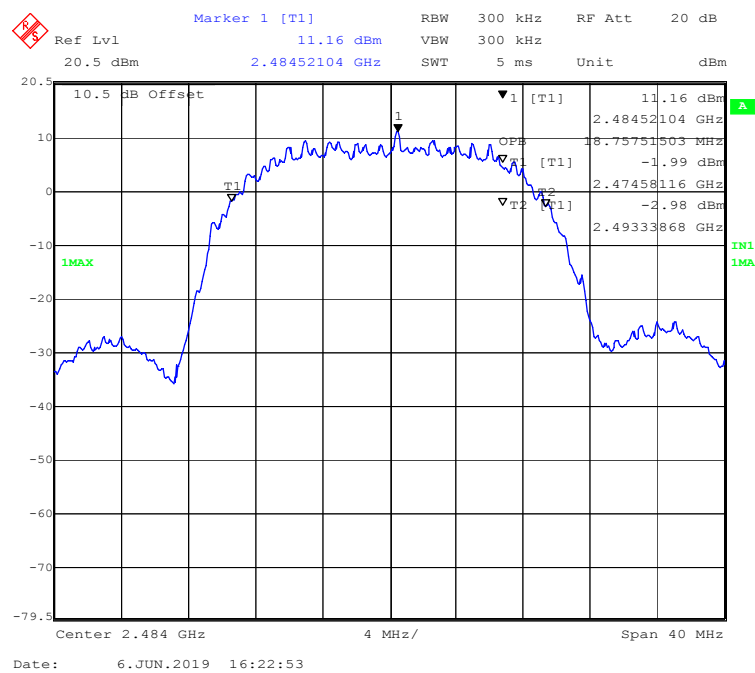
Frequency	2484MHz			Limit
Voltage(V _{DC})	3.0	3.3	3.6	
Occupied Bandwidth (MHz)	18.76	18.76	18.76	≤26MHz
Spread Bandwidth (MHz)	14.27	14.27	14.27	≥0.5MHz
Spread Factor	10.38	10.38	10.38	>10

Note: Spread factor = Spread bandwidth/Modulation rate
Modulation rate: 802.11b=1.375

Please refer to the following plots for normal voltage:

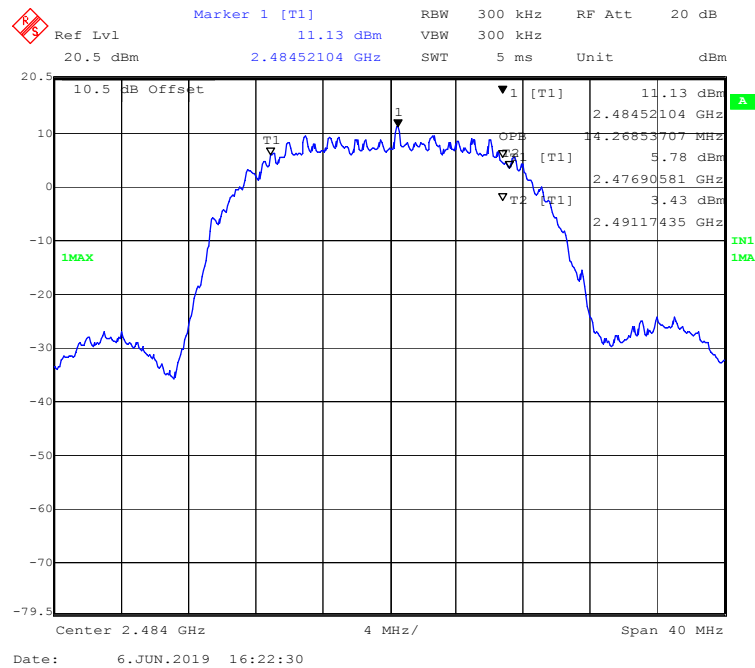
Occupied Bandwidth:

802.11b Mode Test Frequency:2484MHz



Spread Bandwidth:

802.11b Mode Test Frequency:2484MHz



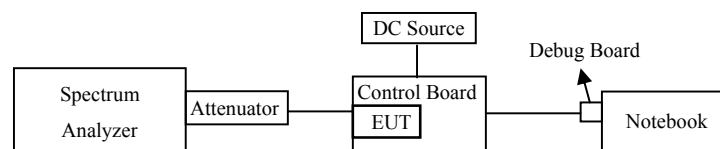
TRANSMITTER SPURIOUS EMISSION STRENGTH AND UNWANTED EMISSION INTENSITY

Limit

- $30 \text{ MHz} \leq f \leq 1 \text{ GHz}$: $\leq 0.25 \mu\text{W}/100\text{kHz}$
- $1 \text{ GHz} < f \leq 2458 \text{ MHz}$: $\leq 2.5 \mu\text{W}/\text{MHz}$
- $2458 \text{ MHz} < f \leq 2471 \text{ MHz}$: $\leq 25 \mu\text{W}/\text{MHz}$
- $2497 \text{ MHz} < f \leq 2510 \text{ MHz}$: $\leq 25 \mu\text{W}/\text{MHz}$
- $2510 \text{ MHz} < f \leq 12500 \text{ MHz}$: $\leq 2.5 \mu\text{W}/\text{MHz}$

Test Procedure

Measurement System Diagram



Conditions of Application Equipment (EUT)

- The modulation state shall be in continuously transmitting mode.

Spectrum Analyzer Conditions

- Setting of SA start 30MHz and stop frequency 1GHz, RB: 100kHz/VB:100kHz, Sweep time: Auto. Sweep mode: continuous sweep .Detect mode: Positive peak/Trace mode: max hold. Then to mark peak. Reading value + cable loss shall be less than 0.25μW.
- Setting of SA start 1GHz and stop frequency 2458MHz, RB: 1MHz/VB: 1MHz, Sweep time: Auto. Sweep mode: continuous sweep .Detect mode: Positive peak/Trace mode: max hold. Then to mark peak. Reading value + cable loss shall be less than 2.5μW.
- Setting of SA start 2458MHz and stop frequency 2471MHz, RB: 1MHz/VB: 1MHz, Sweep time: Auto. Sweep mode: continuous sweep .Detect mode: Positive peak/Trace mode: max hold. Then to mark peak. Reading value + cable loss shall be less than 25μW.
- Setting of SA start 2497MHz and stop frequency 2510MHz, RB: 1MHz/VB: 1MHz, Sweep time: Auto. Sweep mode: continuous sweep .Detect mode: Positive peak/Trace mode: max hold. Then to mark peak. Reading value + cable loss shall be less than 25μW.
- Setting of SA start 2510MHz and stop frequency 12500MHz, RB: 1MHz/VB: 1MHz, Sweep time: Auto. Sweep mode: continuous sweep .Detect mode: Positive peak/Trace mode: max hold. Then to mark peak. Reading value + cable loss shall be less than 2.5μW.

Measurement Result**Environmental Conditions**

Temperature:	23.2°C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2019-06-06.

Test Mode: Transmitting

Test Result: Compliant

Frequency (MHz)		2484			Limit
Voltage(V _{DC})		3.0	3.3	3.6	
802.11b Mode					
Raw data	Band I	-50.92	-50.90	-50.46	-36 dBm/100kHz
	(dBm/100kHz)				(0.25μW/100kHz)
	Band II	-30.64	-31.33	-30.92	-26 dBm/MHz
	(dBm/MHz)				(2.5μW/MHz)
	Band III	-22.45	-22.18	-21.45	-16dBm/MHz
	(dBm/MHz)				(25 μW/MHz)
	Band IV	-20.09	-19.89	-19.04	-16dBm/MHz
	(dBm/MHz)				(25 μW/MHz)
	Band V	-33.85	-33.87	-32.11	-26 dBm/MHz
	(dBm/MHz)				(2.5μW/MHz)

Note:

Band I: 30 MHz~1GHz

Band II: 1GHz~2458 MHz

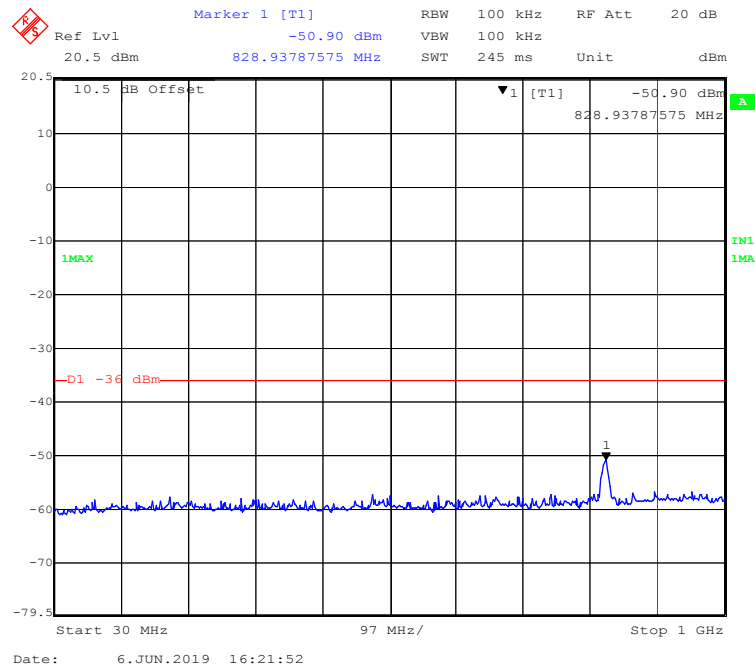
Band III: 2458 MHz~2471 MHz

Band IV: 2497 MHz-2510 MHz

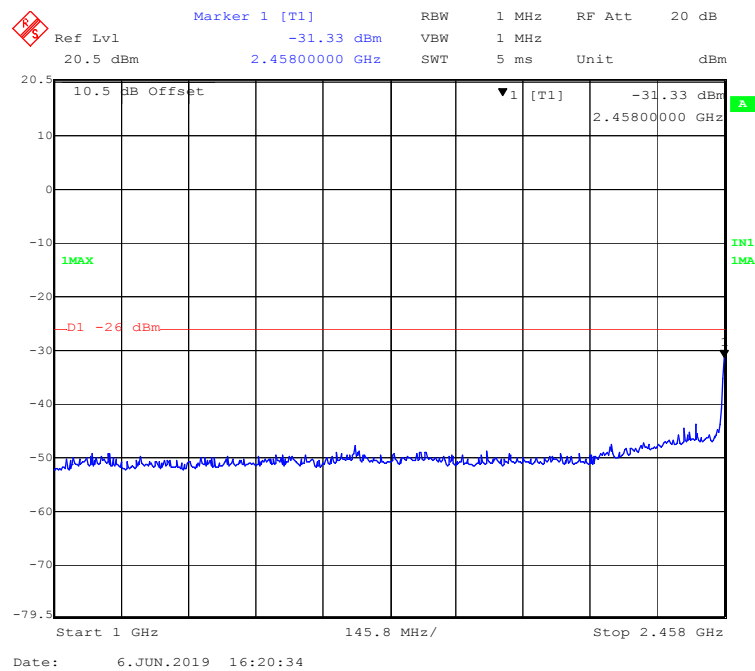
Band V: 2510 MHz-12500 MHz

Please refer to the plots for normal voltage test.

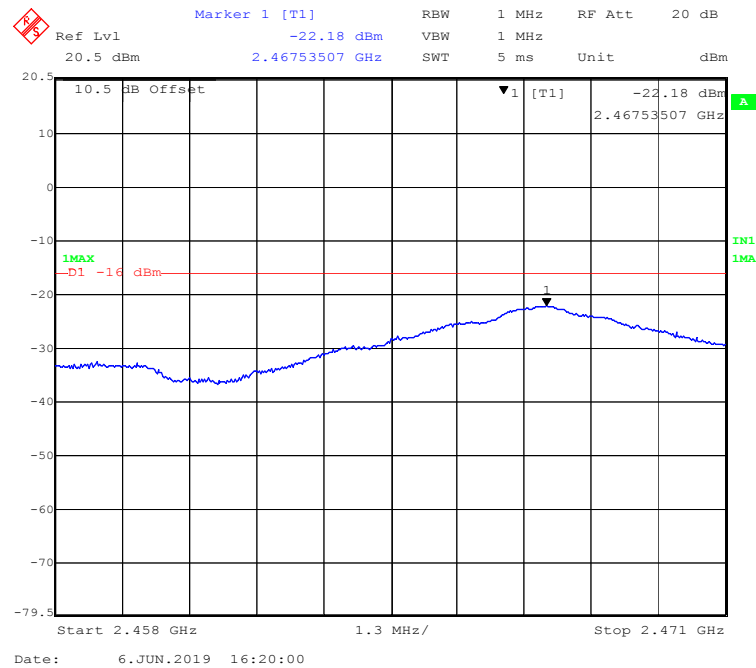
30MHz~1GHz



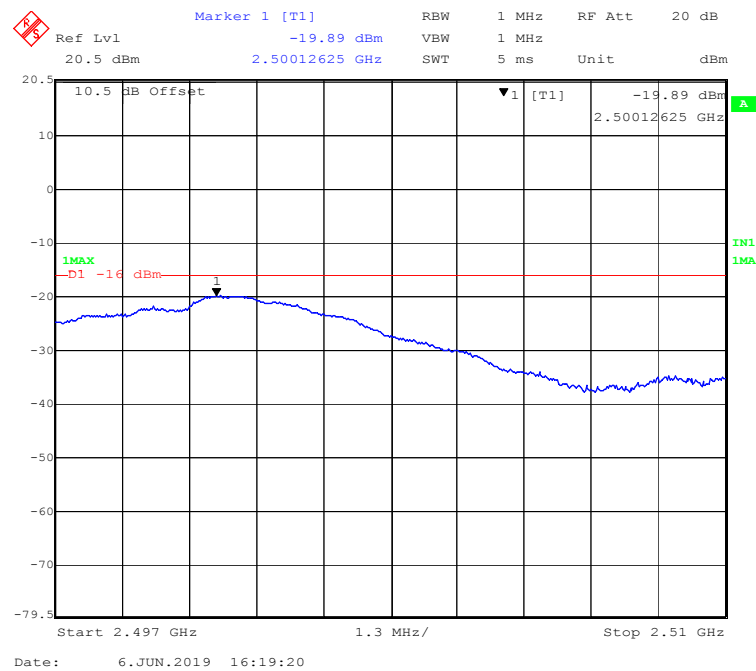
1GHz~2458MHz



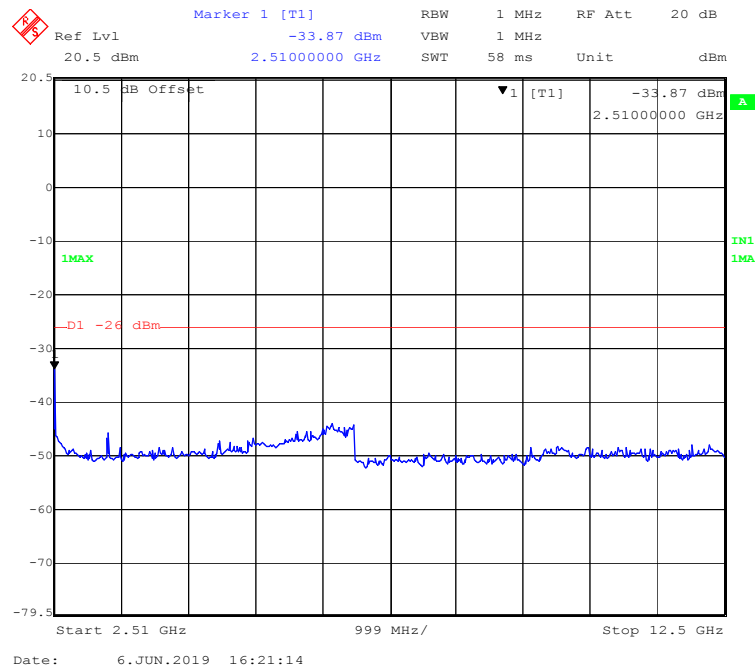
2458MHz ~ 2471MHz



2497MHz ~ 2510MHz



2510MHz~12500MHz



ANTENNA OUTPUT POWER, ANTENNA POWER TOLERANCE AND TRANSMISSION ANTENNA GAIN

Limit

- $\leq 10 \text{ mW/MHz}$

The Output Power Tolerance must be within +20%, -80%.

E.i.r.p:

- $\leq 12.14 \text{ dBm/MHz}$

Test Procedure

Step 1:

Connect the UUT to the spectrum analyser and use the following settings:

- Centre Frequency: The centre frequency of the channel under test.
- Resolution BW: 1 MHz.
- Video BW: 1 MHz.
- Span: Wide enough to cover the complete power envelope of the signal of the UUT.
- Detector: Peak.
- Trace Mode: Max Hold.

Step 2:

When the trace is complete, find the peak value of the power envelope and record the frequency.

Step 3:

Make the following changes to the settings of the spectrum analyser:

- Centre Frequency: Equal to the frequency recorded in step 2.
- Span: 3 MHz.
- Resolution BW: 1 MHz.
- Video BW: 1 MHz.
- Sweep time: 1 minute.
- Detector: Average (see note).
- Trace Mode: Max Hold.

NOTE: The detector mode "Average" is often referred to as "RMS Average" or "Sample" but do not use Video Average.

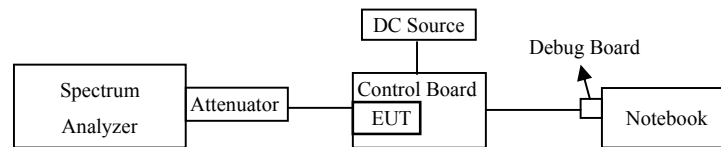
Step 4:

When the trace is complete, capture the trace, for example using the "View" option on the spectrum analyser.

Find the peak value of the trace and place the analyser marker on this peak. This level is recorded as the highest mean power (spectral power density) D in a 1 MHz band.

Alternatively, where a spectrum analyser is equipped with a facility to measure spectral power density, this facility may be used to display the spectral power density D in dBm/MHz.

D shall be recorded in the test report.

Test Setup Block diagram**Measurement Result****Environmental Conditions**

Temperature:	23.2°C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2019-06-06.

Test Result: Compliant

Test Mode: Transmitting

The worst case of Antenna 1:

Frequency Band	2484 MHz			Limit
Voltage(V _{DC})	3.0	3.3	3.6	
802.11b Mode				
Antenna Output Power (dBm/MHz)	5.07	5.15	5.26	10dBm/MHz
EIRP (dBm/MHz)	7.40	7.48	7.59	12.14dBm/MHz
Declared Power (mW/MHz)	5.70	5.70	5.70	/
Antenna Output Power (mW/MHz)	3.214	3.273	3.357	10mW/MHz
Antenna Output Power Tolerance (%)	-43.62	-42.57	-41.10	+20% ~ -80%

Note 1: 802.11b mode: Duty Cycle = 1, Duty Factor = 0

Antenna Output Power = Reading + Duty Factor

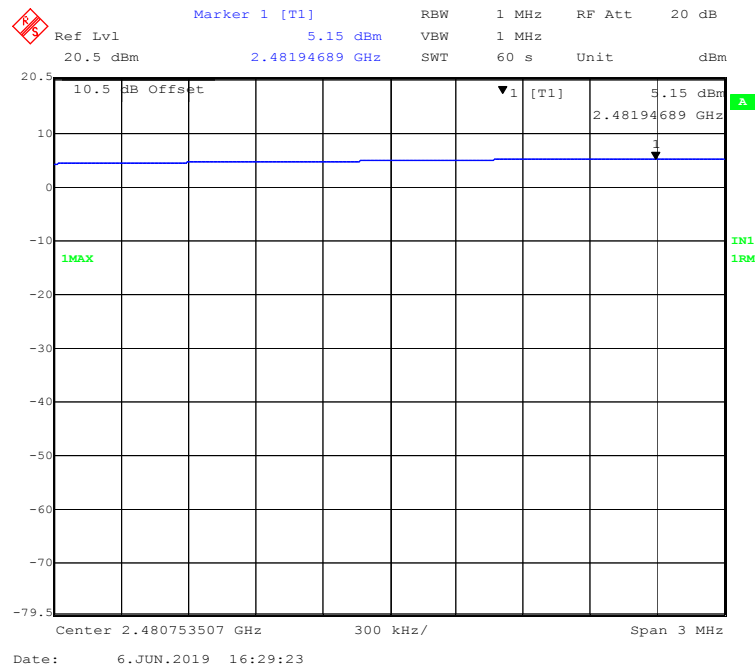
Note 2: Antenna Power Tolerance = (Antenna Output Power - Declared power) / Declared power * 100%

Note 3: The antenna gains are 2.33 dBi for Antenna 1 and 2.00 dBi for Antenna 2, which is declared by manufacturer.

Please refer to the plots for normal voltage test.

ANTENNA OUTPUT POWER:

802.11b mode Test Frequency:2484MHz



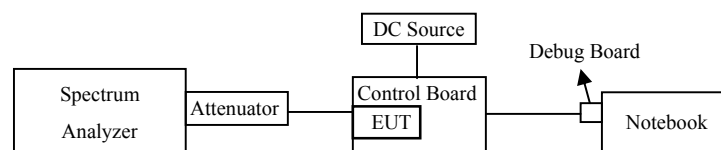
RECEIVER SPURIOUS EMISSION AND UNWANTED EMISSION INTENSITY

Limit

- $\leq 4 \text{ nW}$ ($30 \text{ MHz} \leq f \leq 1000 \text{ MHz}$)
- $\leq 20 \text{ nW}$ ($1 \text{ GHz} \leq f \leq 12.5 \text{ GHz}$)

Test Procedure

❖ Measurement System Diagram



❖ Conditions of Application Equipment (EUT)

- The modulation state shall be “continuous receiving mode”.

❖ Spectrum Analyzer Conditions

- Start Frequency: Start Frequency of frequency range to measure (30 MHz or 1 GHz)
- Stop Frequency: Stop Frequency of frequency range to measure (1 GHz or 12.5 GHz)
- Span: AUTO (Measurement Range)
- RBW: 100 kHz, VBW: 100 kHz for Frequency < 1 GHz
- RBW: 1MHz, VBW: 1MHz for Frequency > 1 GHz
- Sweep time: AUTO or more
- Sweep mode: Auto Sweep
- Detection: Positive Peak
- Reference Level: Enough level for maximum dynamic range

Measurement Result**Environmental Conditions**

Temperature:	23.2°C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2019-06-06.

Test Mode: Receiving

Frequency Band		2484 MHz			Limit
Voltage(V _{DC})		3.0	3.3	3.6	
802.11b Mode					
Unwanted Emission Intensity	Band V (dBm)	-76.01	-75.15	-76.57	-54dBm (4nW)
	Band VI (dBm)	-57.77	-57.20	-56.87	-47dBm (20nW)

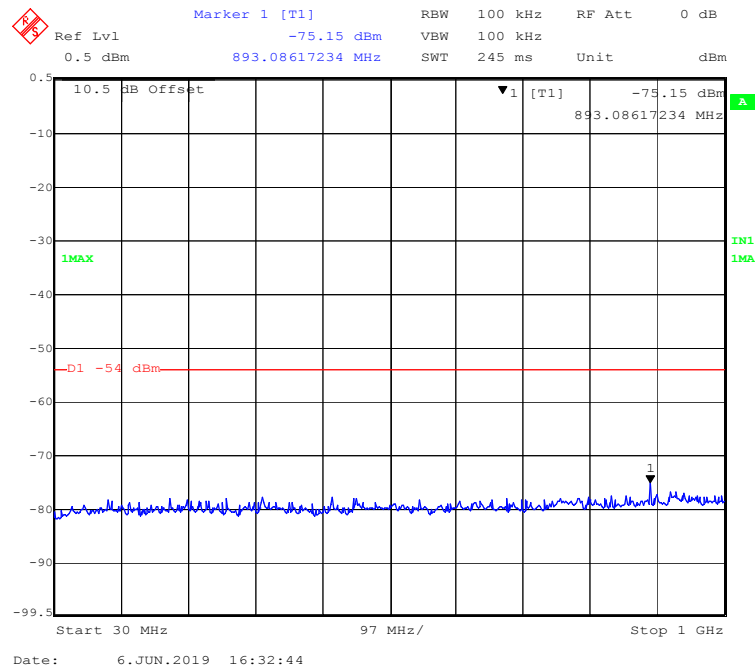
Note:

Band V: 30 MHz~1000 MHz

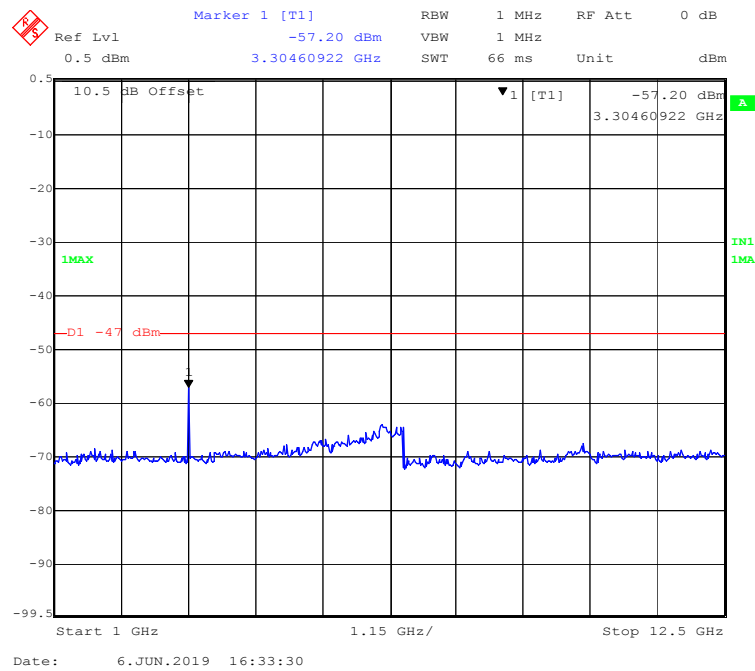
Band VI: 1000 MHz~12500 MHz

Please refer to the plots for normal voltage test.

30MHz~1000MHz



1000MHz~12500MHz



CARRIER SENSE CAPABILITY

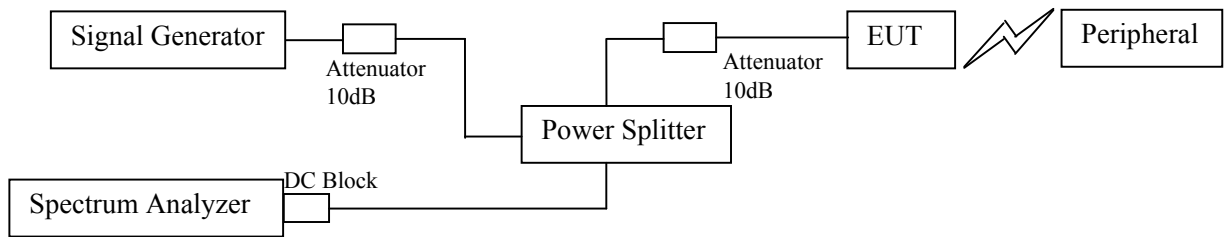
Requirement

MIC Notice No.88 Appendix No.44

Article 2, Paragraph 1, Item 19 Rules Section 10

Test Procedure

1. SG adjusted the frequency as same as the EUT transmitted signal and emitted the absence of modulation from SG and power level is $(on\ 22.79 + G - 20 * \log(f) dBm)$ (G is the antenna gain, f is the test frequency).
2. Turn off the RF signal of the SG
3. EUT have transmitted the maximum modulation signal and fixed channelize.
4. Setting of SA :RBW/VBW=1MHz/1MHz, Span=50MHz, Sweep time=auto, Sweep mode=continuous, Detect mode=positive peak
5. SG RF signal on.
6. EUT shall be stop the transmitted any signal and SG RF signal off, the EUT will be continuous, transmitted signal.

Test Block**Test Data****Environmental Conditions**

Temperature:	23.2°C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2019-06-06..

Test Result: Pass

INTERFERENCE PREVENTION FUNCTION

Requirement

The EUT shall have the interference prevention capability to transmit or to receive the identification automatically, so that sender and receiver shall exclude other equipment.

Test Procedure

In the case that the EUT has the function of automatically transmitting the identification code:

1. Transmit the predetermined identification codes from EUT
2. Check the transmitted identification codes with the demodulator.

In the case of receiving the identification codes:

1. Transmit the predetermined identification codes from the counterpart.
2. Check if communication is normal
3. Transmit the signal other than predetermined ID codes from the counterpart.
4. Check if the EUT stops the transmission, or if it displays that identification codes are different from the predetermined ones.

Measurement Result

Environmental Conditions

Temperature:	23.2°C
Relative Humidity:	50 %
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2019-06-06.

Test Result: Good.

CONSTRUCTION PROTECTION CONFIRMATION

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.

Confirmation Method

The EUT has shielding cover the high-frequency section except for the antenna system, the shielding can't be opened easily. Please refer the external photographs.

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