

JAPAN MIC TEST REPORT

For

ESPRESSIF SYSTEMS (SHANGHAI) PTE LTD

ROOM 204, BUILDING2,690 BIBO ROAD, PUDONG DIST. SHANGHAI, P.R. CHINA

Tested Model: ESP32-WROVER

This Report Concerns: <input checked="" type="checkbox"/> Original Report		Equipment Type: WIFI & Bluetooth Module
Test Engineer:	Max Min <i>Max Min</i>	
Report Number:	RSA180524001-24D	
Report Date:	2018-06-11	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	ESPRESSIF SYSTEMS (SHANGHAI) PTE LTD
Tested Model	ESP32-WROVER
Series Model	ESP32-WROVER-I
Model Difference	Antenna Type
Product Type	WIFI & Bluetooth Module
Dimension	18 mm(L)×31.4 mm(W)×3.3 mm(H)
Power Supply	DC 3.3V

**All measurement and test data in this report was gathered from production sample serial number: 20180524001.
(Assigned by the BACL. The EUT supplied by the applicant was received on 2018-05-24)*

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:

- Frequency Error
- Occupied Bandwidth and Spreading Bandwidth
- Transmitter Spurious Emission and Unwanted Emission Intensity
- Antenna Output Power And Output Power Tolerance
- Transmission Antenna Gain
- Transmission Radiation Angle Width
- Receiver Spurious Emission Strength
- Construction Protection Confirmation

Related Submittal(s)/Grant(s)

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

Test Methodology

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

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road, Kunshan, Jiangsu province, China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 under the FCC KDB 974614 D01. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

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 Software: Secure CRT

The test was performed under:

802.11b 2484MHz: Data rate: 1 Mbps, power level: 16

Equipment Modifications

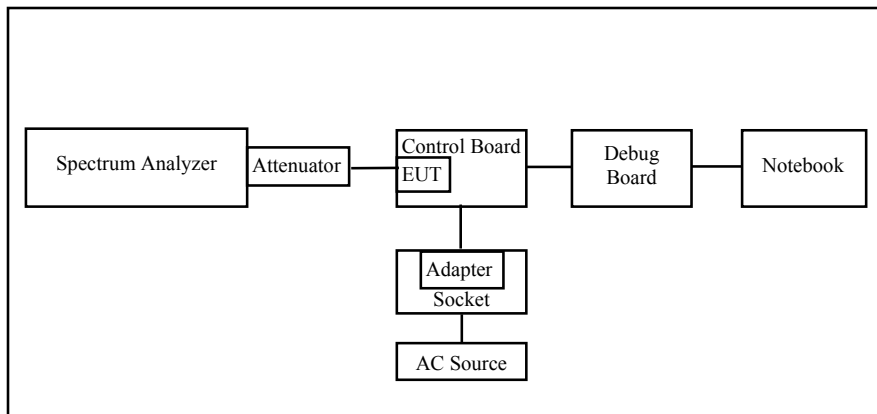
No modification was made to the EUT tested.

Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
DELL	Notebook	GX620	D65874152
ESPRESSIF	Debug Board	ESP-WROOM-03	/
ESPRESSIF	Control Board	ESP32_Module_Test board_2L_V1	/
Narda	Attenuator/2dB	2dB	/
ESPRESSIF	Adapter	/	/

External I/O Cable

Cable Description	Length (m)	From/Port	To
RF Cable	0.1	Attenuator	EUT
Data Cable	0.3	Control Board	Debug Board
USB Cable	0.8	Debug Board	Notebook

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	Compliance
4	Occupied Bandwidth and Spreading Bandwidth	Compliance
5	Transmitter Spurious Emission and Unwanted Emission Intensity	Compliance
6	Antenna Output Power and Output Power Tolerance	Compliance
7	Receiver Spurious Emission and Unwanted Emission Intensity	Compliance
8	Transmission Antenna Gain	Not Applicable (See Note 1)
9	Transmission Radiation Angle Width	Not Applicable (See Note 1)
10	Carrier Sense Function	Not Applicable (See Note 2)
11	Frequency Hopping Dwell Time	Not Applicable (See Note 3)
12	Interference Prevention Function	Compliance
Appendix	Construction Protection Confirmation	Compliance

Note:

1. This test item will not be applied to the transmission antenna which EIRP is less than 12.14dBm/MHz.
2. The test only required for bandwidth more than 26MHz and less than 38MHz.
3. Testing is only required for FHSS system devices.

FREQUENCY ERROR

Limit

50 ppm or below

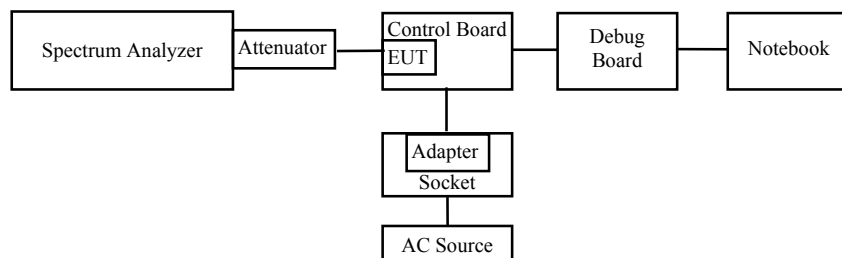
Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Narda	Attenuator/2dB	2dB	/	2017-08-15	2018-08-14

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

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: 691points (400 points or more)
- Reference level: 22.5dBm, Attenuator: 30dB
- Detection: Positive Peak, Sweep mode: Continuous
- Marker: Spot

Measurement Result**Environmental Conditions**

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

The testing was performed by Max Min on 2018-05-29.

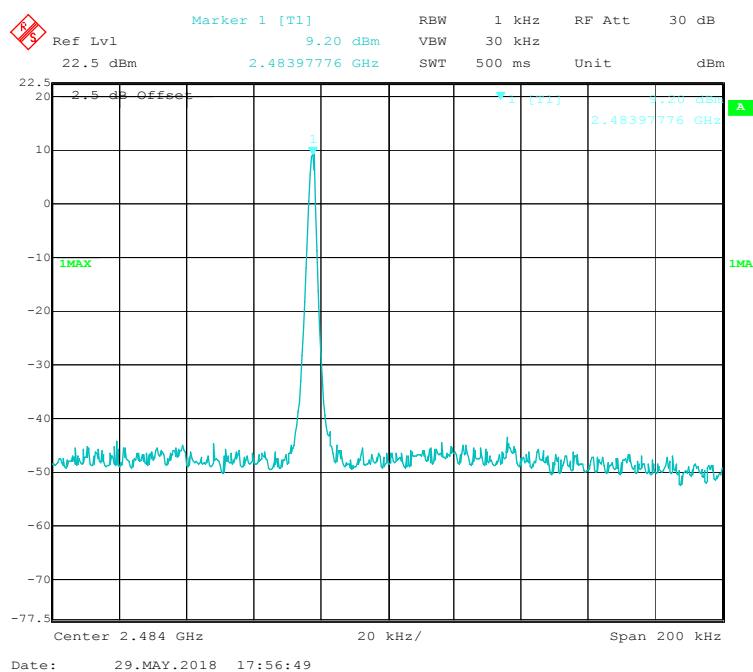
Test Result: Compliant

Test Mode: Transmitting

Frequency (MHz)	Voltage (V _{AC})	Measure Frequency (MHz)	Frequency Tolerance (ppm)	Limit (ppm)
2484	90	2483.9772	-9.18	<50
	100	2483.9778	-8.94	
	110	2483.9782	-8.78	

Please refer to the following plots for normal voltage:

Test Frequency: 2484MHz



OCCUPIED BANDWIDTH AND SPREADING BANDWIDTH

Limit

- Occupied bandwidth: FH \leq 83.5 MHz; OFDM \leq 38MHz; DS \leq 26 MHz; Others \leq 26 MHz
- Spread Bandwidth: \geq 500 kHz (FH, DS), Spread factor $>$ 10.

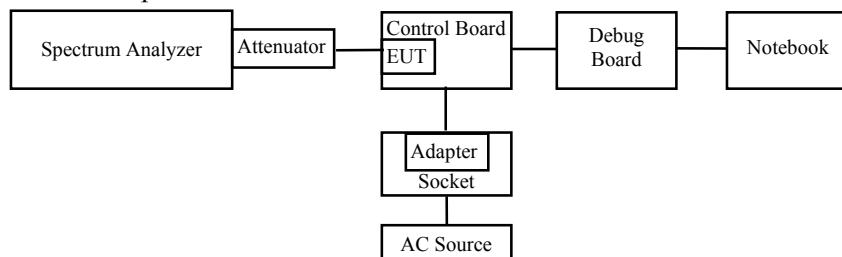
Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Narda	Attenuator/2dB	2dB	/	2017-08-15	2018-08-14

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

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 2018-05-29.

Test Result: Compliant

Test Mode: Transmitting

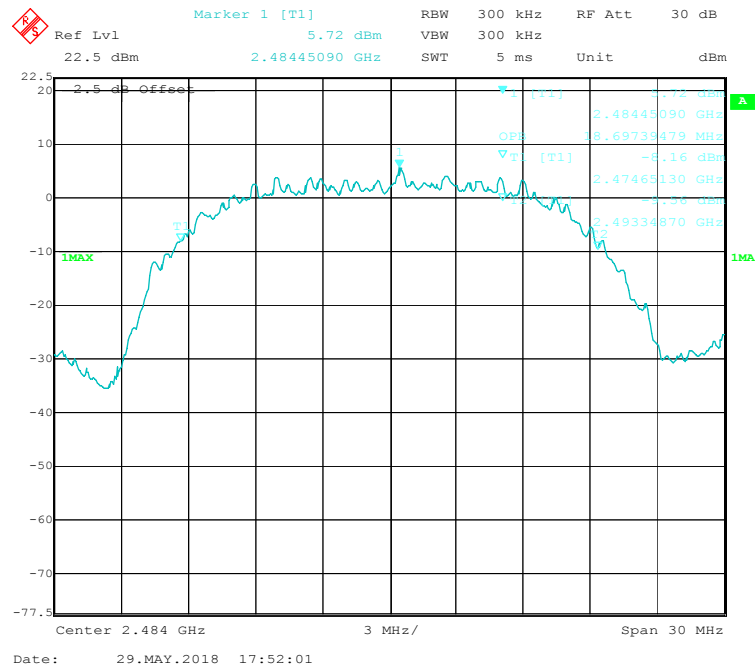
Frequency	2484MHz			Limit
Voltage(V _{AC})	90	100	110	
Occupied Bandwidth (MHz)	18.71	18.70	18.72	<26MHz
Spread Bandwidth (MHz)	14.05	14.07	14.07	>0.5MHz
Spread Factor	10.22	10.23	10.23	>10

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

Please refer to the following plots for normal voltage:

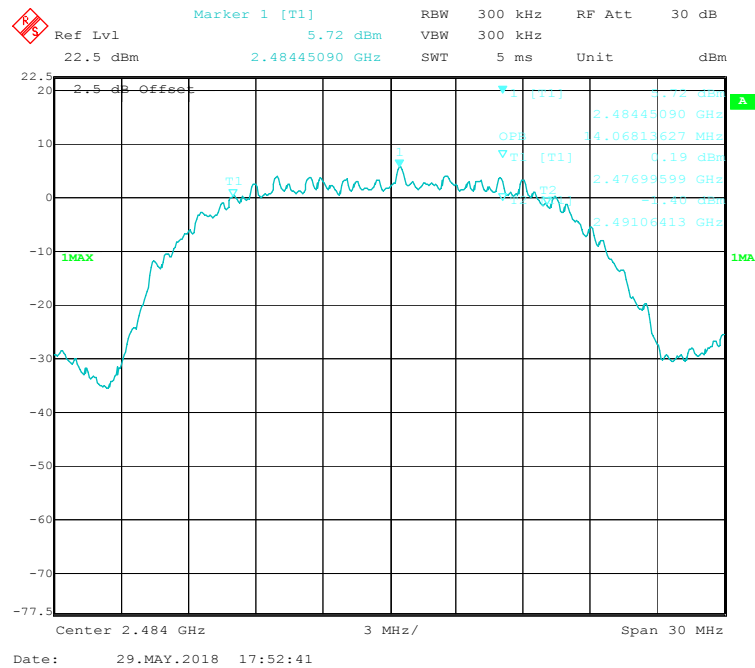
Occupied Bandwidth:

802.11b Mode Test Frequency:2484MHz



Spread Bandwidth:

802.11b Mode Test Frequency:2484MHz



TRANSMITTER SPURIOUS EMISSION STRENGTH AND UNWANTED EMISSION INTENSITY

Limit

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

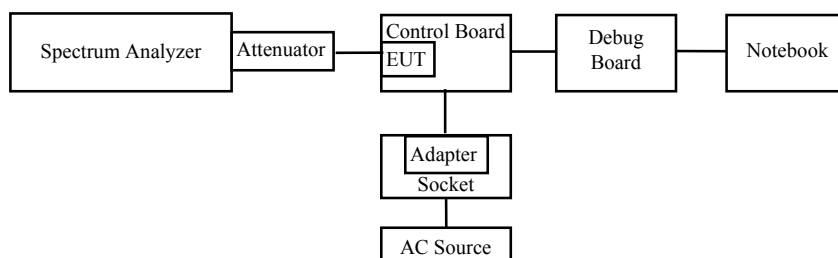
Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Narda	Attenuator/2dB	2dB	/	2017-08-15	2018-08-14

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

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 0.25 μW .
- 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 2.5 μW .

- 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 2018-05-29.

Test Mode: Transmitting

Test Result: Compliant

Frequency (MHz)		2484			Limit
Voltage(V _{AC})		90	100	110	
802.11b Mode					
Raw data	Band I	-56.36	-56.37	-56.35	-36 dBm/MHz
	(dBm/MHz)				(0.25μW/MHz)
	Band II	-32.75	-32.77	-32.76	-26 dBm/MHz
	(dBm/MHz)				(2.5μW/MHz)
	Band III	-20.01	-19.96	-19.94	-16dBm/MHz
	(dBm/MHz)				(25 μW/MHz)
	Band IV	-19.22	-19.20	-19.19	-16dBm/MHz
	(dBm/MHz)				(25 μW/MHz)
	Band V	-32.81	-32.80	-32.84	-26 dBm/MHz
	(dBm/MHz)				(2.5μW/MHz)

Note:

Band I: 30 MHz~1GHz

Band II: 1GHz~2458 MHz

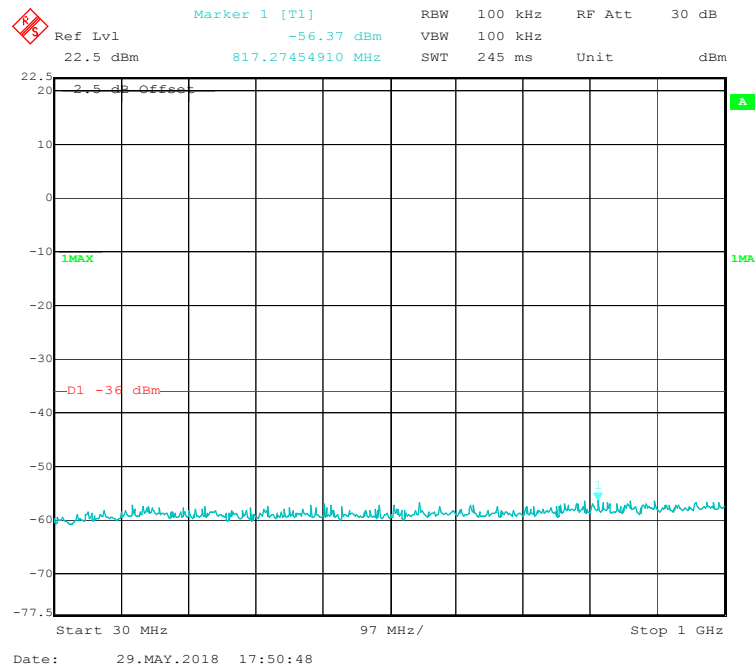
Band III: 2458 MHz~2471 MHz

Band IV: 2497 MHz-2510 MHz

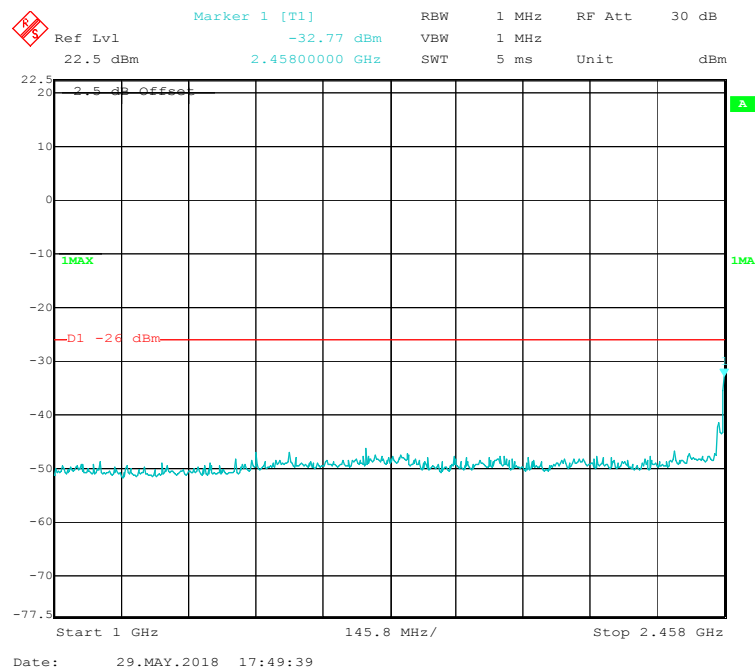
Band V: 2510 MHz-12500 MHz

Please refer to the plots for normal voltage test.

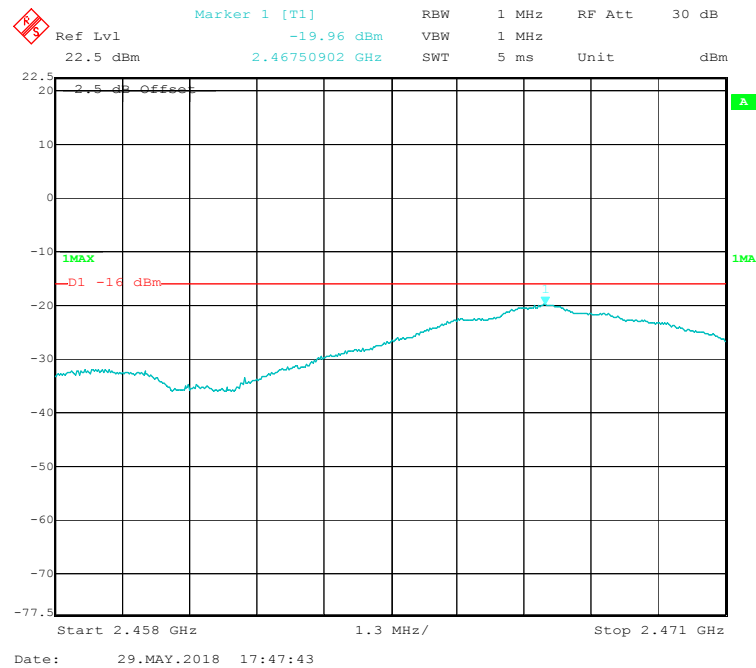
30MHz~1GHz



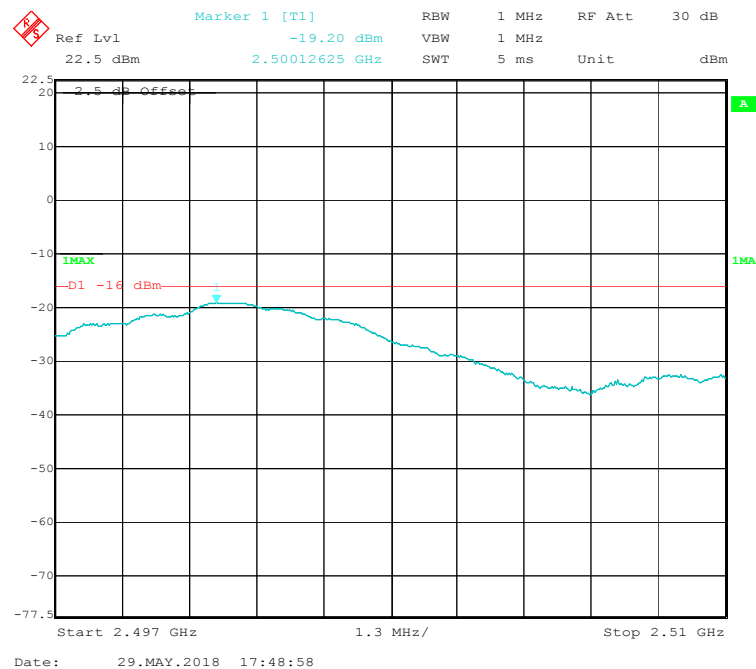
1GHz~2458MHz



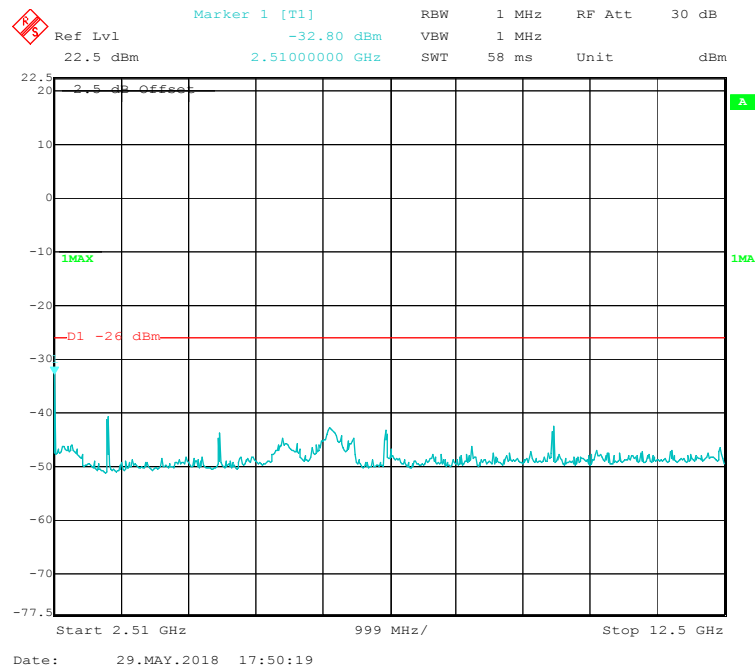
2458MHz ~ 2471MHz



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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Narda	Attenuator/2dB	2dB	/	2017-08-15	2018-08-14

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

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:

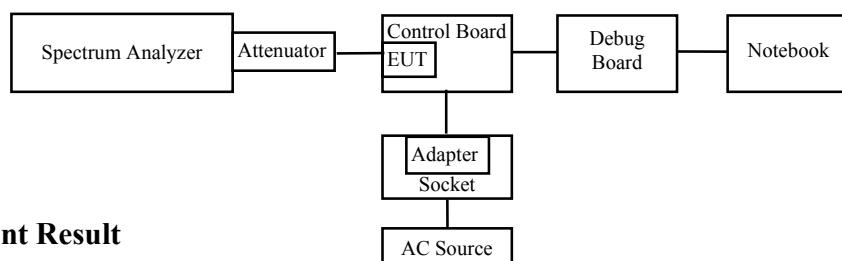
When the trace is complete, capture the trace, for example using the "View" option on the spectrum analyser.

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 2018-05-29.

Test Mode: Transmitting

Test Result: Compliant

Frequency Band	2484 MHz			Limit
Voltage(V _{AC})	90	100	110	
802.11b Mode				
Antenna Output Power (dBm/MHz)	-0.29	-0.27	-0.24	/
EIRP for PCB antenna (dBm/MHz)	2.01	2.03	2.06	12.14dBm/MHz
EIRP for IPEX antenna (dBm/MHz)	2.04	2.06	2.09	12.14dBm/MHz
Declared Power (mW/MHz)	1.00	1.00	1.00	/
Antenna Output Power (mW/MHz)	0.935	0.940	0.946	10mW/MHz
Antenna Output Power Tolerance(%)	-6.50	-6.00	-5.40	+20% ~ -80%

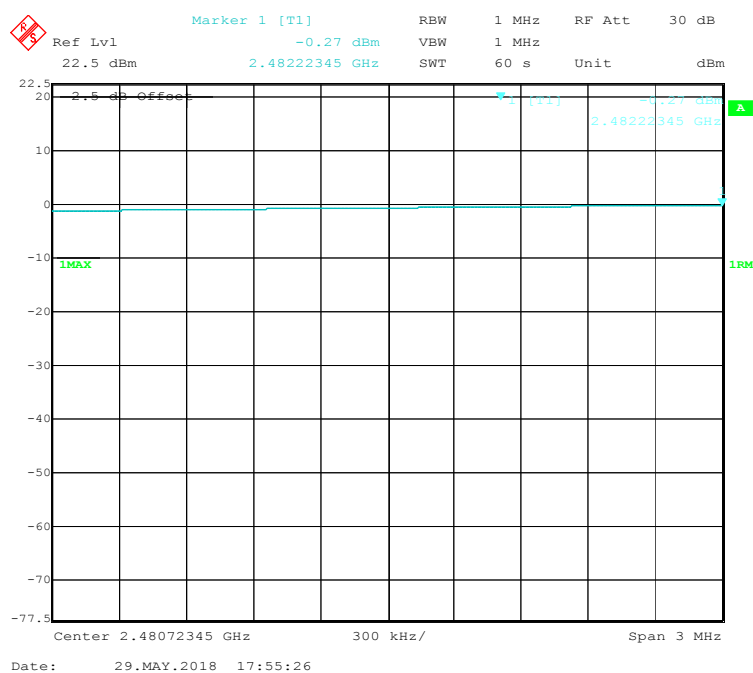
Note 1: Antenna Power Error = (Antenna Output Power - Declared Antenna power)/ Declared Antenna power *100%

Note 2: Antenna gain for PCB antenna = 2.3dBi; Antenna gain for IPEX antenna = 2.33dBi
802.11b mode (Channel 14:2484MHz): Declared Antenna power is 1.0 mW/MHz.

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

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

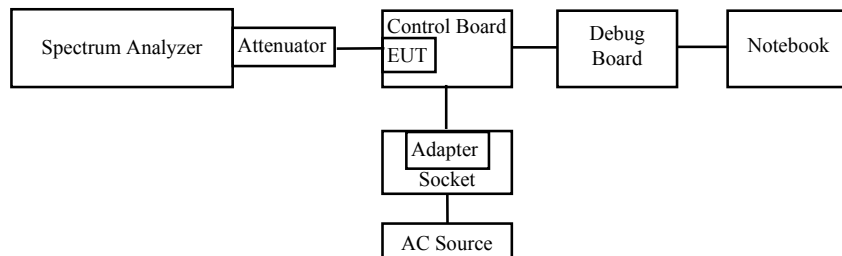
Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Narda	Attenuator/2dB	2dB	/	2017-08-15	2018-08-14

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

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 2018-05-29.

Test Mode: Receiving

Frequency Band		2484 MHz			Limit
Voltage(V _{AC})		90	100	110	
802.11b Mode					
Unwanted Emission Intensity	Band V (dBm)	-76.12	-76.09	-76.07	-54dBm (4nW)
	Band VI (dBm)	-50.39	-50.38	-50.35	-47dBm (20nW)

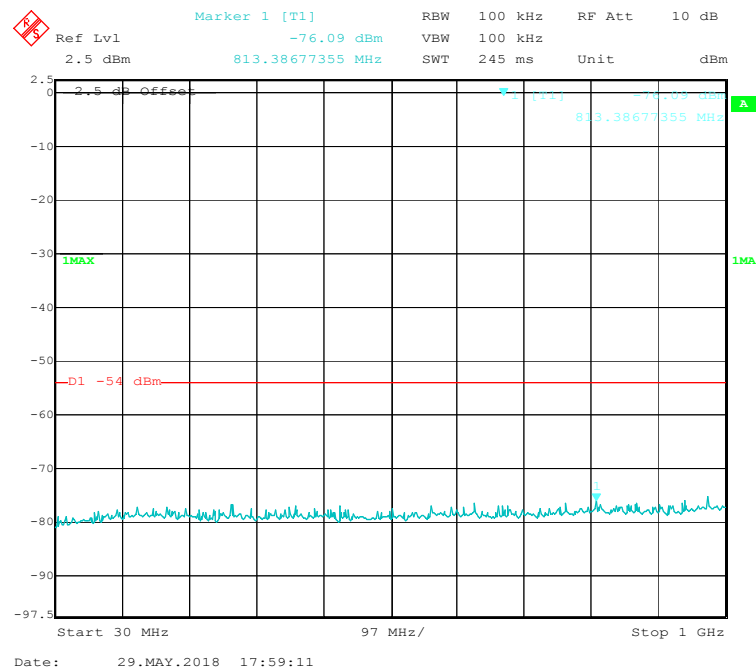
Note:

Band V: 30 MHz~1000 MHz

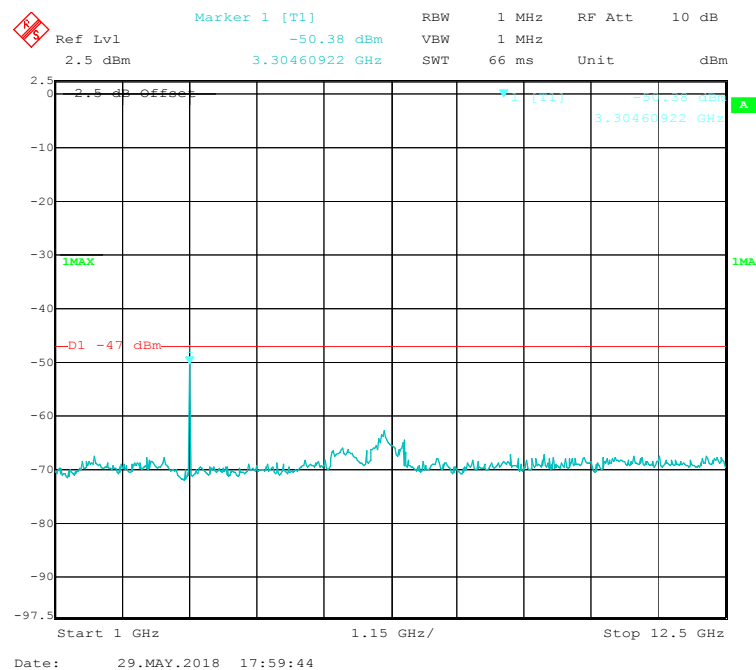
Band VI: 1000 MHz~12500 MHz

Please refer to the plots for normal voltage test.

30MHz~1000MHz



1000MHz~12500MHz



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 2018-05-29.

Test Result: Good.

CONSTRUCTION PROTECTION CONFIRMATION

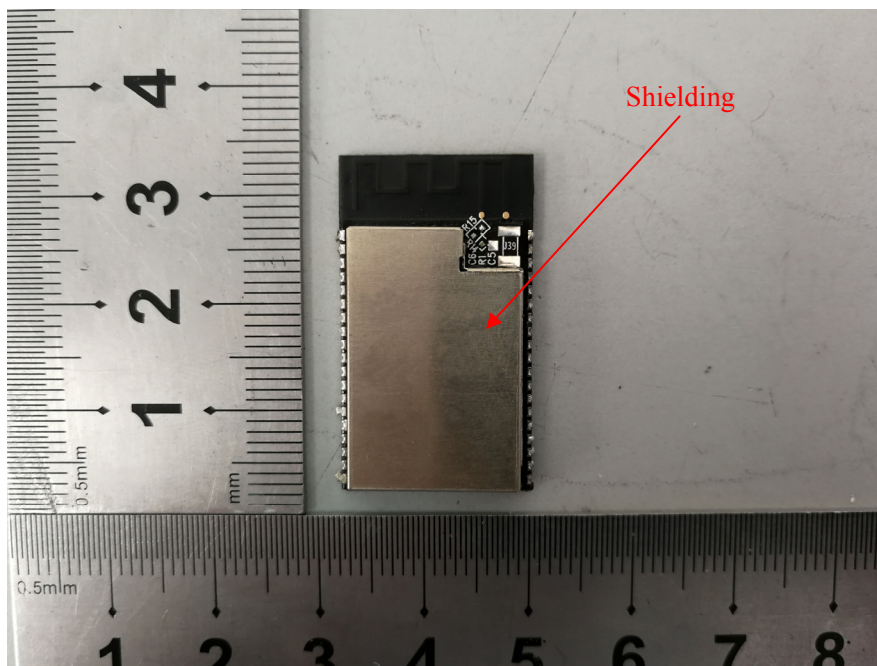
Limit

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

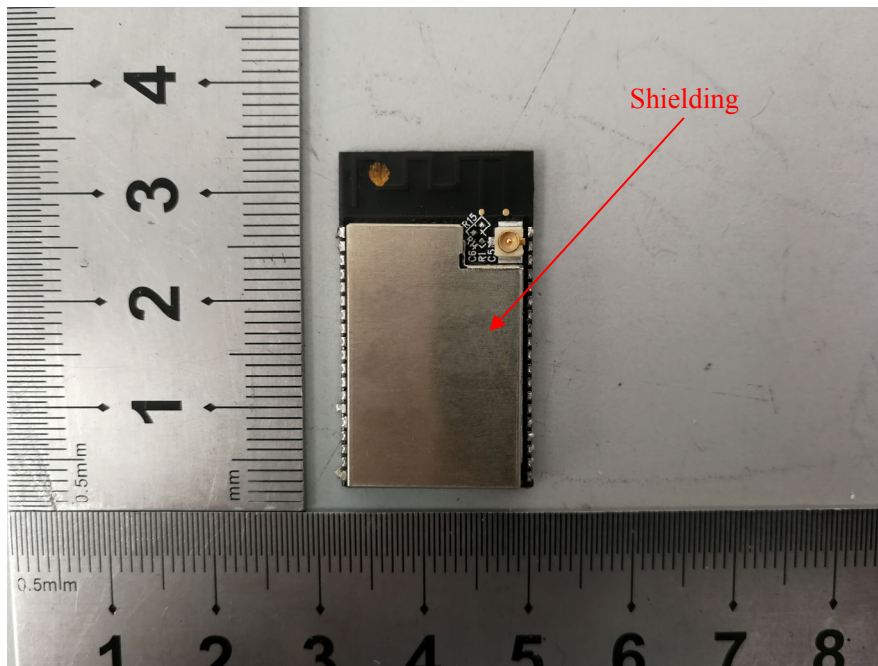
Confirmation Method

The EUT and the series model have shieldings cover the high-frequency section except for the antenna system, the shieldings can't be opened easily. Please refer the photos below.

Tested Model: ESP32-WROVER



Series Model: ESP32-WROVER-I



****END OF REPORT****