

**FCC- TEST REPORT**

Report Number : **709502047117-00** Date of Issue: December 22, 2020

Model : TRX2002/01BR, TRX20YY/ZZBR, ("Y"=0-9, "Z"=0-9. YY means the different running series of the product family. ZZ means version change)

Product Type : SENTINEL SHIELD

Applicant : HCS (Suzhou) Limited

Address : 19F-20F, Building B-3rd, No.209 Zhuyuan Road,  
New District, 215011 Suzhou PEOPLE'S REPUBLIC OF CHINA

Production Facility : WUJIANG CENTURY BILLION ELECTRONIC TECHNOLOGY  
CO., LTD

Address : No.149 West Tun Cun Road Tongli Town Wujiang Suzhou  
Jiangsu People's Republic of China 215216

Test Result : ☒ **Positive** ☐ **Negative**

Total pages including  
Appendices : 35



*TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch is a subcontractor to TÜV SÜD Product Service GmbH according to the principles outlined in ISO 17025.*

*TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch reports apply only to the specific samples tested under stated test conditions. Construction of the actual test samples has been documented. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. The manufacturer/importer is responsible to the Competent Authorities in Europe for any modifications made to the production units which result in non-compliance to the relevant regulations. TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch issued reports.*

*This report is the confidential property of the client. As a mutual protection to our clients, the public and ourselves, extracts from the test report shall not be reproduced except in full without our written approval.*

## 1 Table of Contents

|     |                                                   |    |
|-----|---------------------------------------------------|----|
| 1   | Table of Contents.....                            | 2  |
| 2   | Details about the Test Laboratory .....           | 3  |
| 3   | Description of the Equipment under Test .....     | 4  |
| 4   | Summary of Test Standards.....                    | 5  |
| 5   | Summary of Test Results .....                     | 6  |
| 6   | General Remarks .....                             | 7  |
| 7   | Test Setups.....                                  | 8  |
| 8   | Systems test configuration .....                  | 11 |
| 9   | Technical Requirement .....                       | 12 |
| 9.1 | Conducted Emission .....                          | 12 |
| 9.2 | Conducted peak output power .....                 | 15 |
| 9.3 | 6dB bandwidth .....                               | 17 |
| 9.4 | Power spectral density .....                      | 19 |
| 9.5 | Spurious RF conducted emissions .....             | 21 |
| 9.6 | Band edge .....                                   | 25 |
| 9.7 | Spurious radiated emissions for transmitter ..... | 27 |
| 10  | Test Equipment List.....                          | 32 |
| 11  | System Measurement Uncertainty .....              | 33 |
| 12  | Photographs of Test Set-ups .....                 | 34 |
| 13  | Photographs of EUT .....                          | 35 |



## 2 Details about the Test Laboratory

### Details about the Test Laboratory

#### Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch  
No.16 Lane, 1951 Du Hui Road,  
Shanghai 201108,  
P.R. China

Test Firm  
Registration  
Number: 820234

Test Firm IC  
Registration  
Number: 25988

Telephone: +86 21 6141 0123  
Fax: +86 21 6140 8600

### 3 Description of the Equipment under Test

#### Description of the Equipment Under Test

Product: SENTINEL SHIELD

Model no.: TRX20YY/ZZBR, ("Y"=0-9, "Z"=0-9. YY means the different running series of the product family. ZZ means version change)

FCC ID: 2AGOFTRX20A

Options and accessories: NA

Rating: DC 4.2V

RF Transmission Frequency: 2405~2480MHz

No. of Operated Channel: 16

Modulation: 16-ary orthogonal modulation, O-QPSK PHY

Channel list:

| Operation Frequency each of channel |           |         |           |
|-------------------------------------|-----------|---------|-----------|
| Channel                             | Frequency | Channel | Frequency |
| 11                                  | 2405 MHz  | 19      | 2445 MHz  |
| 12                                  | 2410 MHz  | 20      | 2450 MHz  |
| 13                                  | 2415 MHz  | 21      | 2455 MHz  |
| 14                                  | 2420 MHz  | 22      | 2460 MHz  |
| 15                                  | 2425 MHz  | 23      | 2465 MHz  |
| 16                                  | 2430 MHz  | 24      | 2470 MHz  |
| 17                                  | 2435 MHz  | 25      | 2475 MHz  |
| 18                                  | 2440 MHz  | 26      | 2480 MHz  |

Antenna Type: On board PCB antenna

Antenna Gain: 0dBi

Description of the EUT: The Equipment Under Test (EUT) is a SENTINEL SHIELD. Products are identical to electrical structure, mechanical structure. There are only cosmetic differences (color /painting/printed). We chose model TRX2002/01BR to test it and listed the worst data in this report.

Test sample no.: SHA-538832-1

The sample's mentioned in this report is supplied by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment, antenna gain or any information supplied.



## 4 Summary of Test Standards

| Test Standards        |                                                                        |
|-----------------------|------------------------------------------------------------------------|
| FCC Part 15 Subpart C | PART 15 - RADIO FREQUENCY DEVICES<br>Subpart C - Intentional Radiators |

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10 (2013).

## 5 Summary of Test Results

| Technical Requirements |                                             |            |           |                                     |                          |                                     |
|------------------------|---------------------------------------------|------------|-----------|-------------------------------------|--------------------------|-------------------------------------|
| FCC Part 15 Subpart C  |                                             |            |           |                                     |                          |                                     |
| Test Condition         |                                             | Pages      | Test Site | Test Result                         |                          |                                     |
|                        |                                             |            |           | Pass                                | Fail                     | N/A                                 |
| §15.207                | Conducted emission AC power port            | 12-14      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247 (b) (1)        | Conducted peak output power                 | 15-16      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(a)(1)          | 20dB bandwidth                              | ---        | ---       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| §15.247(a)(1)          | Carrier frequency separation                | ---        | ---       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| §15.247(a)(1)(iii)     | Number of hopping frequencies               | ---        | ---       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| §15.247(a)(1)(iii)     | Dwell Time                                  | ---        | ---       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| §15.247(a)(2)          | 6dB bandwidth                               | 17-18      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(e)             | Power spectral density                      | 19-20      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(d)             | Spurious RF conducted emissions             | 21-24      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(d)             | Band edge                                   | 25-26      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(d) & §15.209   | Spurious radiated emissions for transmitter | 27-31      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.203                | Antenna requirement                         | See note 1 |           | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses a patch antenna, which gain is 0dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.

## 6 General Remarks

### Remarks

This submittal(s) (test report) is intended for FCC ID: 2AGOFTRX20A complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules.

### SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

□ - **Does not** fulfill the general approval requirements.

Sample Received Date: December 10, 2020

Testing Start Date: December 11, 2020

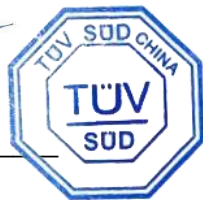
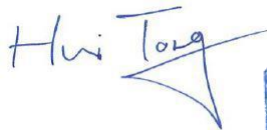
Testing End Date: December 21, 2020

- TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch

Reviewed by:

Prepared by:

Tested by:



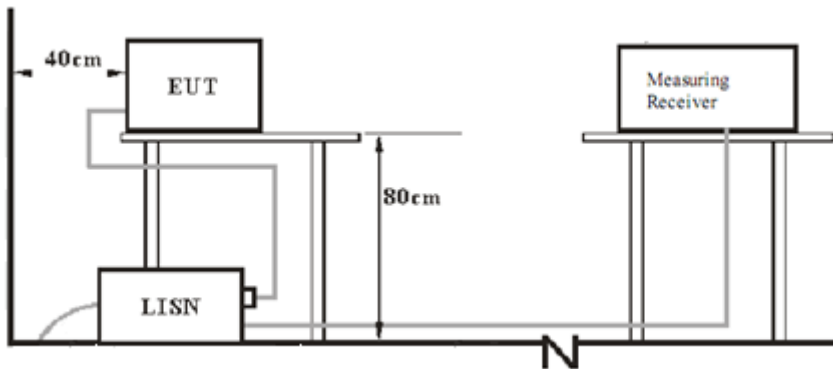
Hui TONG  
Review Engineer

Jiaxi XU  
Project Engineer

Wenqiang LU  
Test Engineer

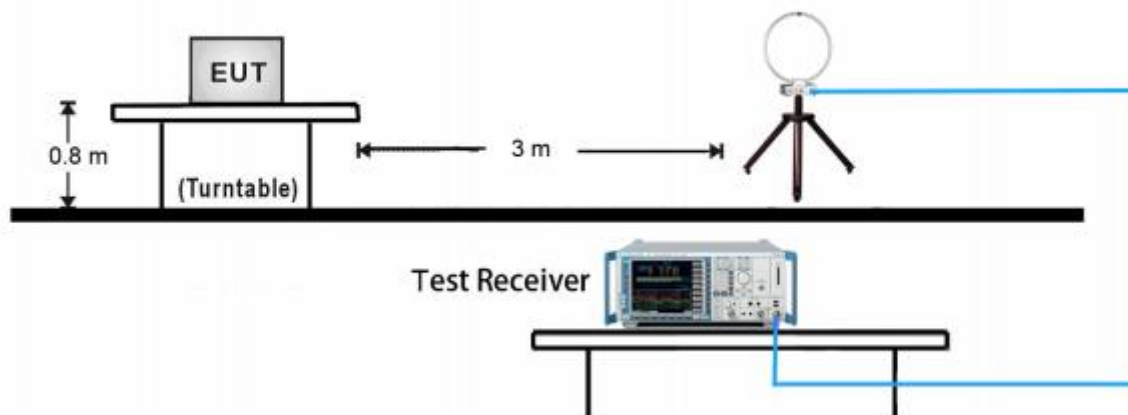
## 7 Test Setups

### 7.1 AC Power Line Conducted Emission test setups



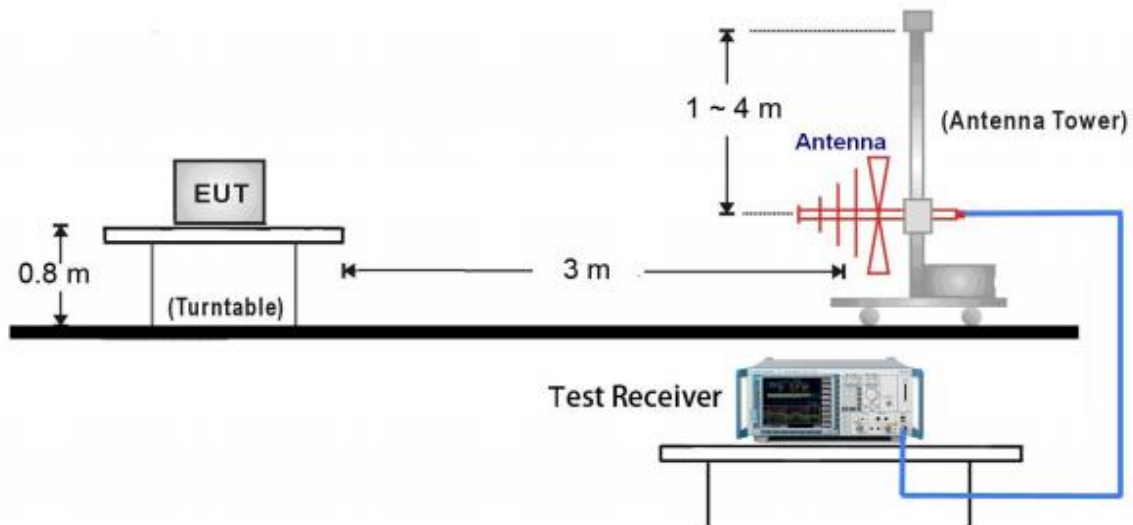
### 7.2 Radiated test setups

#### 9kHz ~ 30MHz Test Setup:

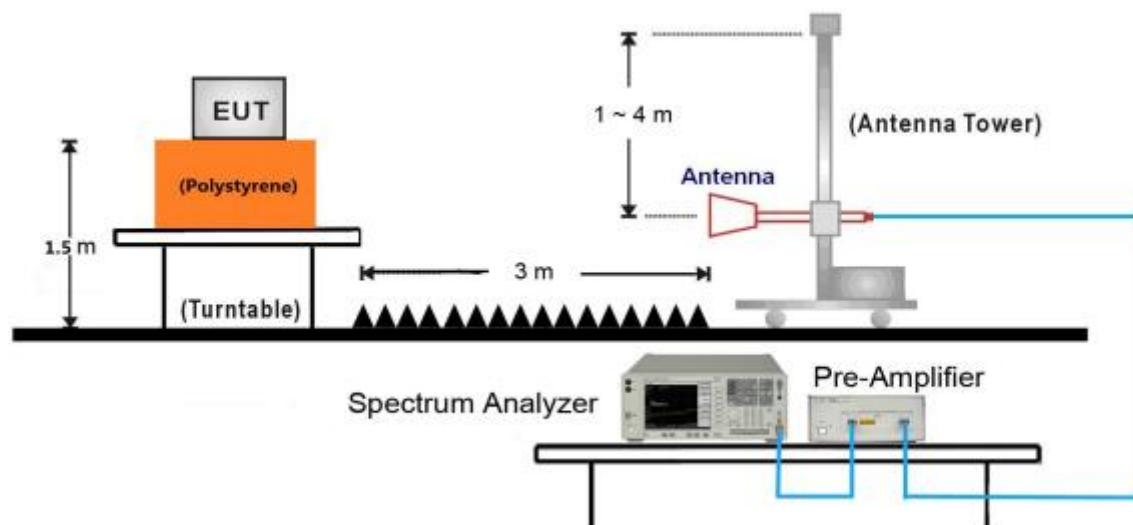




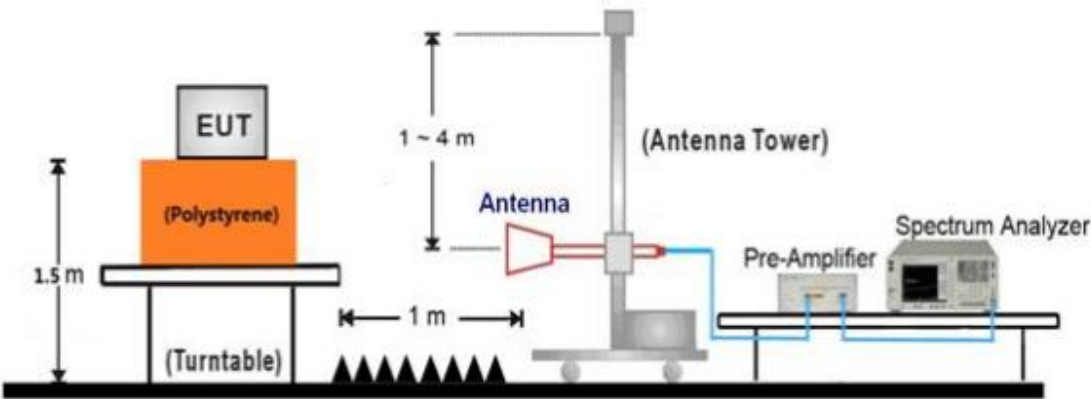
### 30MHz ~ 1GHz Test Setup:



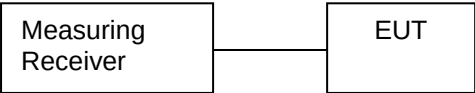
### 1GHz ~ 18GHz Test Setup:



18GHz ~ 25GHz Test Setup:



7.3 Conducted RF test setups



## 8 Systems test configuration

Auxiliary Equipment Used during Test:

| DESCRIPTION | MANUFACTURER | MODEL NO.(SHIELD) | S/N(LENGTH) |
|-------------|--------------|-------------------|-------------|
| Notebook    | Lenovo       | E470              | Notebook    |

Test software: serial port utility latest

The system was configured to channel 11, 18, and 26 for the test.

Non-hopping mode: The system was configured to operate at a signal channel transmitting. The test software allows the configuration and operation at the worst-case duty and the highest transmit power.

## 9 Technical Requirement

### 9.1 Conducted Emission

#### Test Method

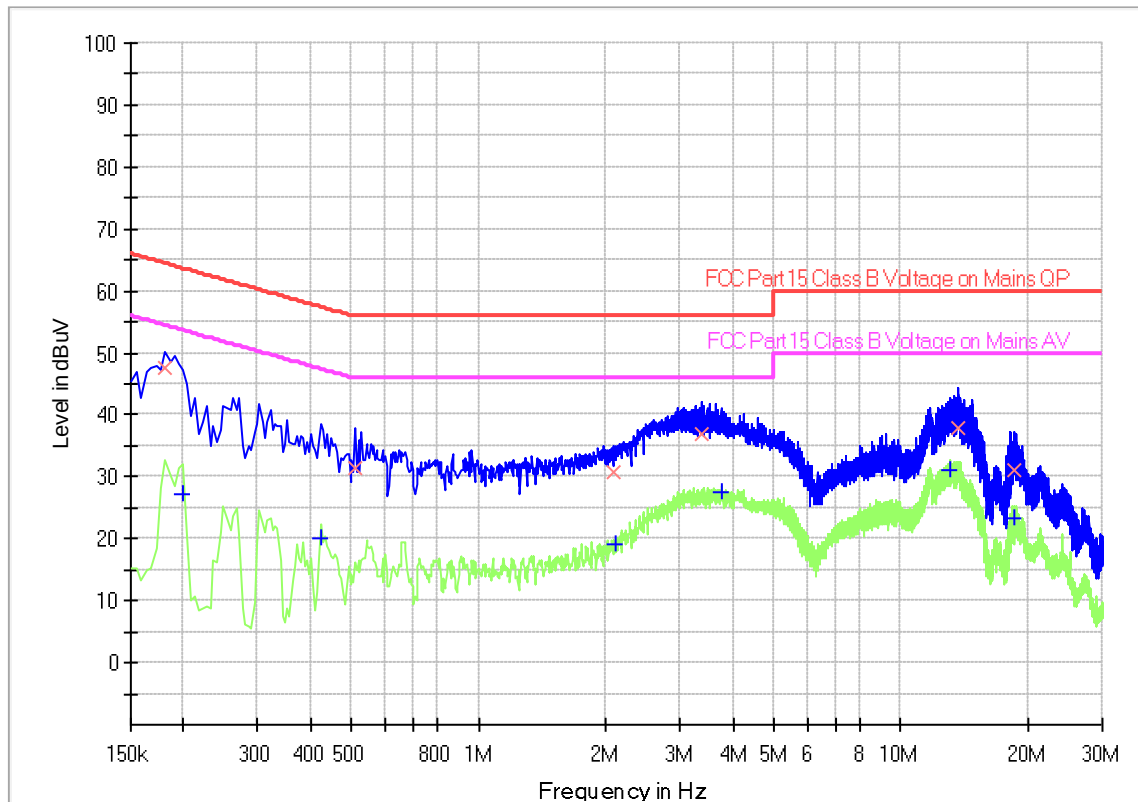
1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of AC line

#### Limit

| Frequency<br>MHz | QP Limit<br>dB $\mu$ V | AV Limit<br>dB $\mu$ V |
|------------------|------------------------|------------------------|
| 0.150-0.500      | 66-56*                 | 56-46*                 |
| 0.500-5          | 56                     | 46                     |
| 5-30             | 60                     | 50                     |

Decreasing linearly with logarithm of the frequency

Product Type : SENTINEL SHIELD  
 M/N : TRX2002/01BR  
 Operating Condition : Mode 1: Tx\_2480MHz  
 Test Specification : L-line  
 Comment : AC 120V/60Hz (powered by notebook)

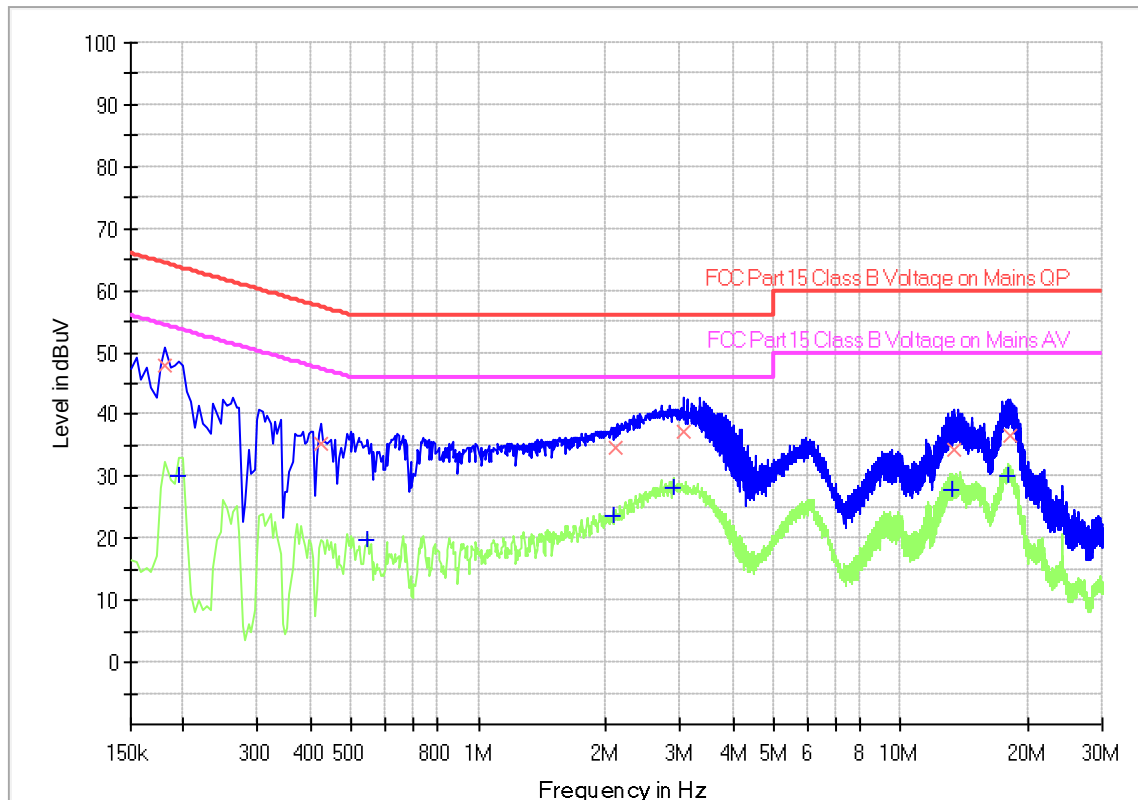


## Final Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|-----------------|------|------------|
| 0.181500        | 47.52            | ---             | 64.42        | 16.90       | 1000.0          | 9.000           | L1   | 19.5       |
| 0.199500        | ---              | 27.26           | 53.63        | 26.37       | 1000.0          | 9.000           | L1   | 19.5       |
| 0.424500        | ---              | 20.09           | 47.36        | 27.27       | 1000.0          | 9.000           | L1   | 19.5       |
| 0.510000        | 31.30            | ---             | 56.00        | 24.70       | 1000.0          | 9.000           | L1   | 19.5       |
| 2.085000        | 30.81            | ---             | 56.00        | 25.19       | 1000.0          | 9.000           | L1   | 19.5       |
| 2.112000        | ---              | 19.07           | 46.00        | 26.93       | 1000.0          | 9.000           | L1   | 19.5       |
| 3.385500        | 36.78            | ---             | 56.00        | 19.22       | 1000.0          | 9.000           | L1   | 19.5       |
| 3.777000        | ---              | 27.40           | 46.00        | 18.60       | 1000.0          | 9.000           | L1   | 19.5       |
| 13.105500       | ---              | 31.13           | 50.00        | 18.87       | 1000.0          | 9.000           | L1   | 19.7       |
| 13.636500       | 37.76            | ---             | 60.00        | 22.24       | 1000.0          | 9.000           | L1   | 19.7       |
| 18.465000       | ---              | 23.38           | 50.00        | 26.62       | 1000.0          | 9.000           | L1   | 19.7       |
| 18.514500       | 31.07            | ---             | 60.00        | 28.93       | 1000.0          | 9.000           | L1   | 19.7       |

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)  
 Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

Product Type : SENTINEL SHIELD  
 M/N : TRX2002/01BR  
 Operating Condition : Mode 1: Tx\_2480MHz  
 Test Specification : N-line  
 Comment : AC 120V/60Hz (powered by notebook)



## Final Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|-----------------|------|------------|
| 0.181500        | 48.00            | ---             | 64.42        | 16.42       | 1000.0          | 9.000           | N    | 19.5       |
| 0.195000        | ---              | 30.07           | 53.82        | 23.75       | 1000.0          | 9.000           | N    | 19.5       |
| 0.424500        | 35.30            | ---             | 57.36        | 22.06       | 1000.0          | 9.000           | N    | 19.5       |
| 0.546000        | ---              | 19.63           | 46.00        | 26.37       | 1000.0          | 9.000           | N    | 19.5       |
| 2.094000        | ---              | 23.63           | 46.00        | 22.37       | 1000.0          | 9.000           | N    | 19.5       |
| 2.112000        | 34.65            | ---             | 56.00        | 21.35       | 1000.0          | 9.000           | N    | 19.5       |
| 2.890500        | ---              | 28.28           | 46.00        | 17.72       | 1000.0          | 9.000           | N    | 19.6       |
| 3.057000        | 37.21            | ---             | 56.00        | 18.79       | 1000.0          | 9.000           | N    | 19.6       |
| 13.240500       | ---              | 27.96           | 50.00        | 22.04       | 1000.0          | 9.000           | N    | 19.8       |
| 13.348500       | 34.31            | ---             | 60.00        | 25.69       | 1000.0          | 9.000           | N    | 19.8       |
| 18.006000       | ---              | 30.11           | 50.00        | 19.89       | 1000.0          | 9.000           | N    | 19.8       |
| 18.132000       | 36.43            | ---             | 60.00        | 23.57       | 1000.0          | 9.000           | N    | 19.8       |

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)  
 Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

## 9.2 Conducted peak output power

### Test Method

1. Use the following spectrum analyzer settings:  
RBW > the 6 dB bandwidth of the emission being measured, VBW $\geq$ 3RBW, Span $\geq$ 3RBW  
Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power.

### Limits

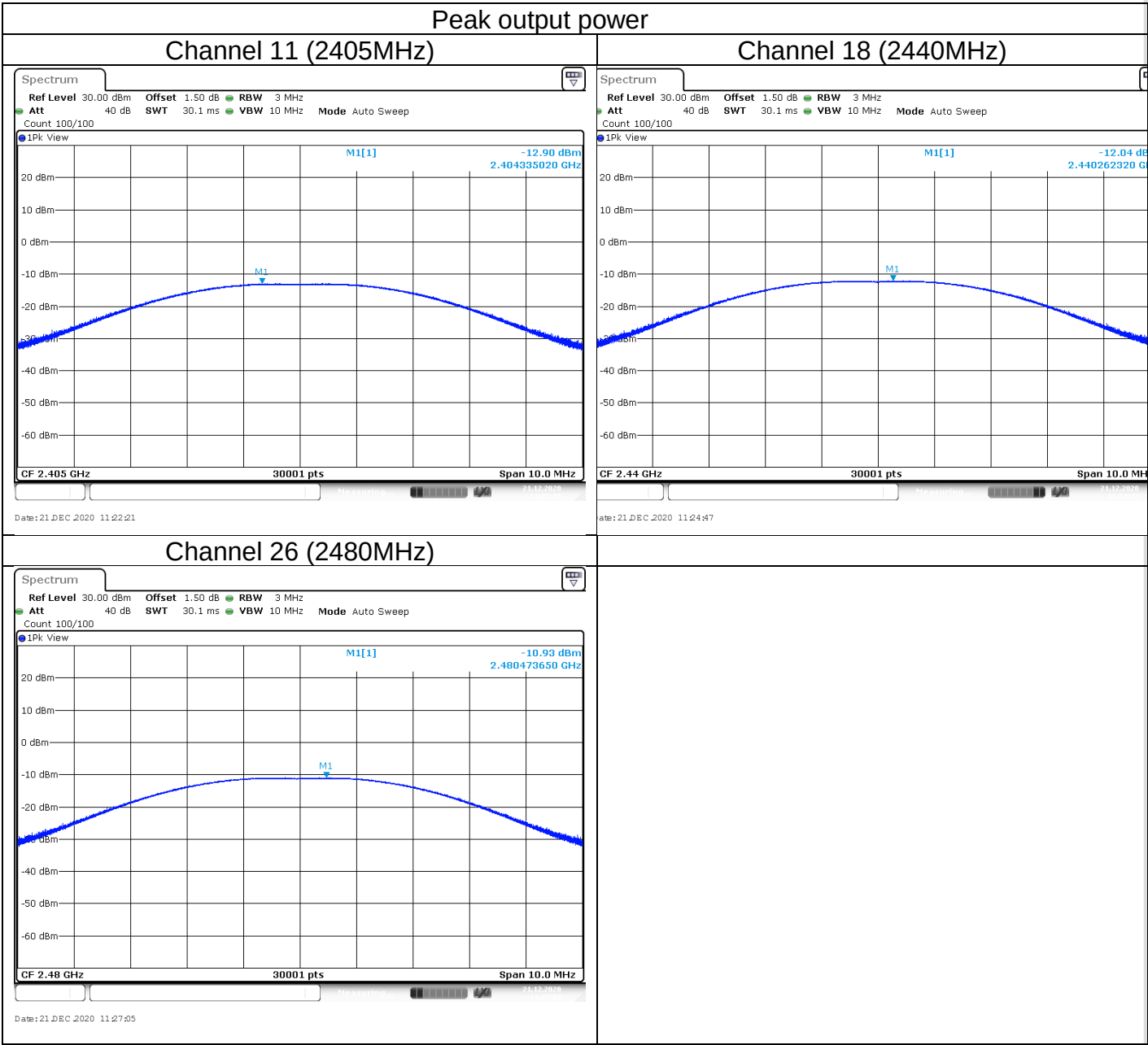
| Frequency Range<br>MHz | Limit<br>W | Limit<br>dBm |
|------------------------|------------|--------------|
| 2400-2483.5            | $\leq 1$   | $\leq 30$    |

Test result as below table

| Frequency<br>MHz       | Conducted Peak<br>Output Power<br>dBm | Result |
|------------------------|---------------------------------------|--------|
| Low channel 2405MHz    | -12.90                                | Pass   |
| Middle channel 2440MHz | -12.04                                | Pass   |
| High channel 2480MHz   | -10.93                                | Pass   |



China







9.3 6dB bandwidth

Test Method

- 1. Use the following spectrum analyzer settings:  
RBW=100K, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
- 2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
- 3. Allow the trace to stabilize, record the X dB Bandwidth value.

Limit

Limit [kHz]

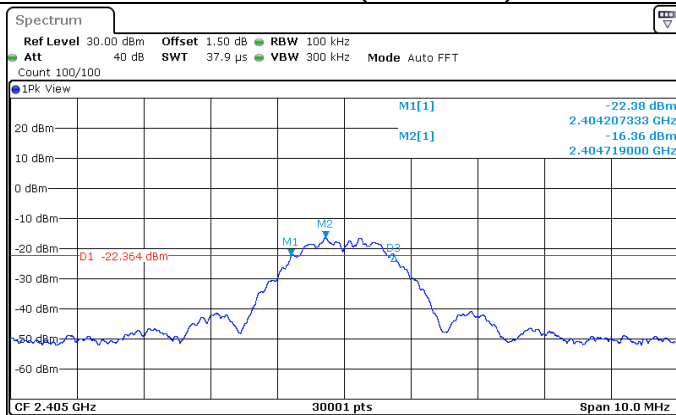
≥500

Test result

| Frequency<br>MHz       | 6dB bandwidth<br>kHz | Result |
|------------------------|----------------------|--------|
| Top channel 2405MHz    | 1545                 | Pass   |
| Middle channel 2440MHz | 1557                 | Pass   |
| Bottom channel 2480MHz | 1590                 | Pass   |

## 6dB Bandwidth

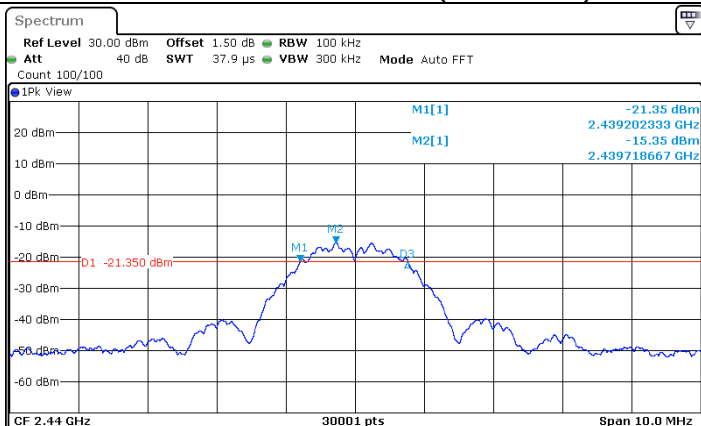
## Channel 11 (2405MHz)



| Type | Ref | Trc | X-value         | Y-value    | Function | Function Result |
|------|-----|-----|-----------------|------------|----------|-----------------|
| M1   |     | 1   | 2.404207333 GHz | -22.38 dBm |          |                 |
| M2   |     | 1   | 2.404719 GHz    | -16.36 dBm |          |                 |
| D3   | M1  | 1   | 1.544667 MHz    | -0.00 dB   |          |                 |

Date: 21 DEC 2020 11:21:57

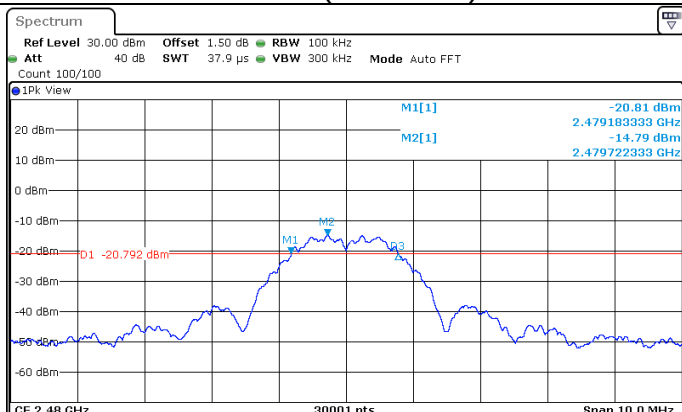
## Channel 18 (2440MHz)



| Type | Ref | Trc | X-value         | Y-value    | Function | Function Result |
|------|-----|-----|-----------------|------------|----------|-----------------|
| M1   |     | 1   | 2.439202333 GHz | -21.35 dBm |          |                 |
| M2   |     | 1   | 2.439718667 GHz | -15.35 dBm |          |                 |
| D3   | M1  | 1   | 1.557333 MHz    | -0.01 dB   |          |                 |

Date: 21 DEC 2020 11:24:23

## Channel 26 (2480MHz)



| Type | Ref | Trc | X-value         | Y-value    | Function | Function Result |
|------|-----|-----|-----------------|------------|----------|-----------------|
| M1   |     | 1   | 2.479183333 GHz | -20.81 dBm |          |                 |
| M2   |     | 1   | 2.479722333 GHz | -14.79 dBm |          |                 |
| D3   | M1  | 1   | 1.59 MHz        | 0.01 dB    |          |                 |

Date: 21 DEC 2020 11:26:41

## 9.4 Power spectral density

### Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency.  
RBW=3kHz, VBW $\geq$ 3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed.

### Limit

Limit [dBm/3KHz]

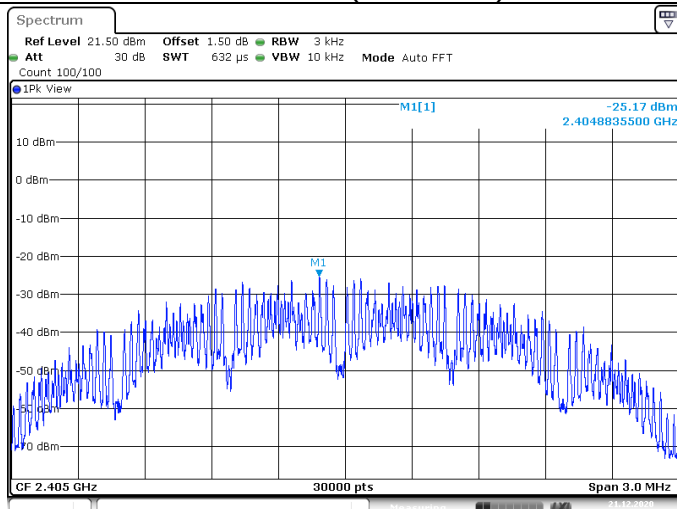
$\leq 8$

### Test result

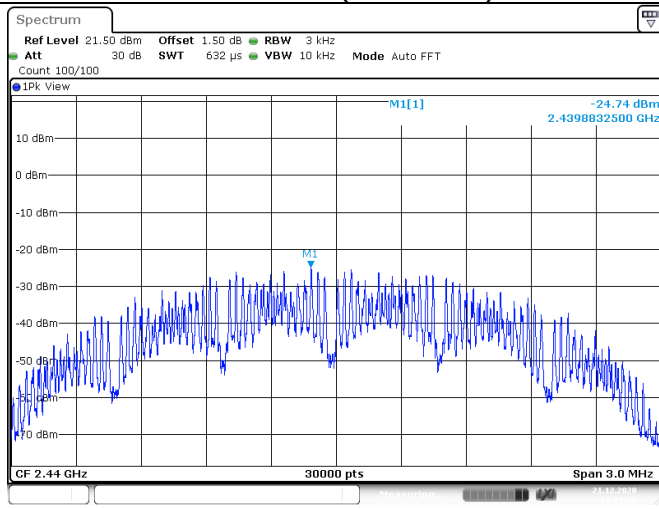
| Frequency<br>MHz       | Power spectral<br>density<br>dBm/3KHz | Result |
|------------------------|---------------------------------------|--------|
| Top channel 2405MHz    | -25.17                                | Pass   |
| Middle channel 2440MHz | -24.74                                | Pass   |
| Bottom channel 2480MHz | -23.91                                | Pass   |

## PK PSD

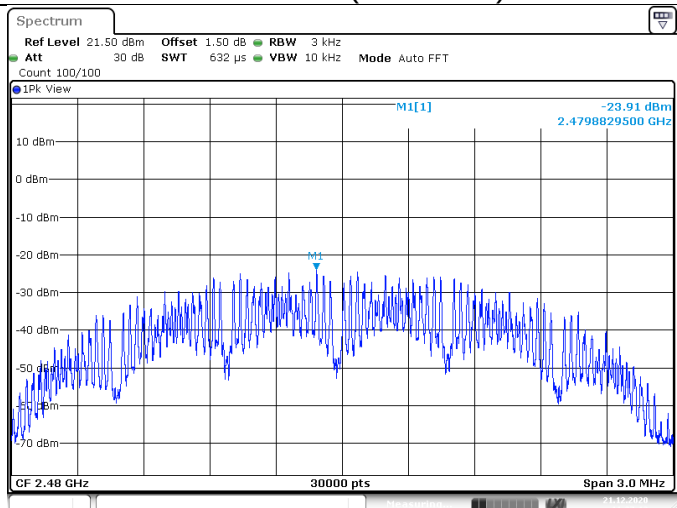
## Channel 11 (2405MHz)



## Channel 18 (2440MHz)



## Channel 26 (2480MHz)



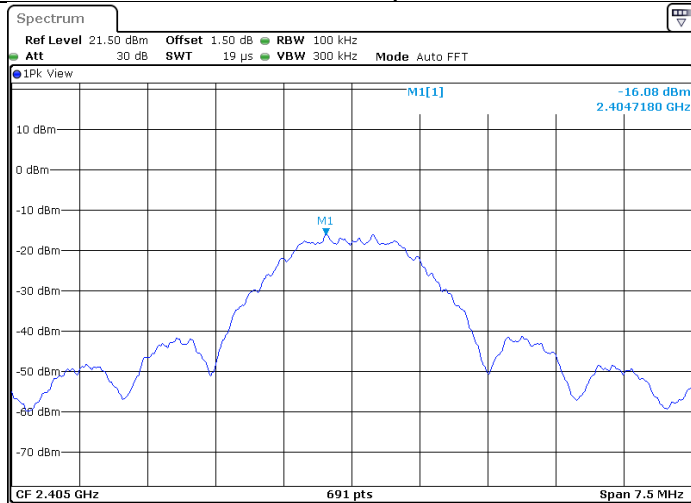
## 9.5 Spurious RF conducted emissions

### Test Method

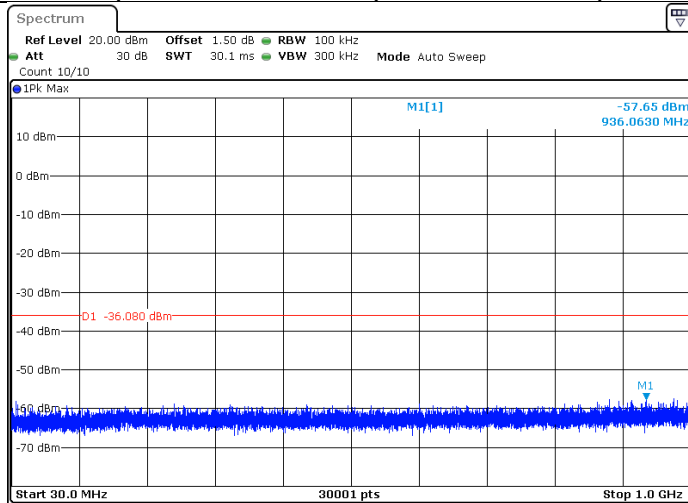
1. Establish a reference level by using the following procedure:
  - a. Set RBW=100 kHz. VBW $\geq$ 3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
  - b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
2. Use the maximum PSD level to establish the reference level.
  - a. Set the center frequency and span to encompass frequency range to be measured.
  - b. Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements, report the three highest emissions relative to the limit.
3. Repeat above procedures until other frequencies measured were completed.

### Limit

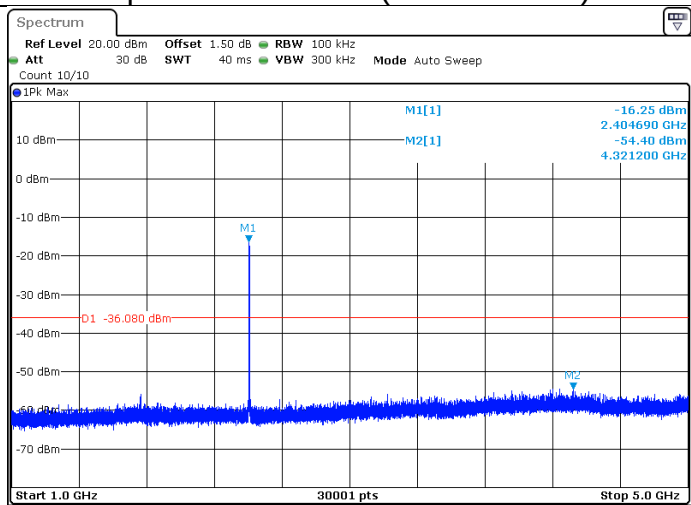
| Frequency Range<br>MHz | Limit (dBc) |
|------------------------|-------------|
| 30-25000               | -20         |

**Spurious RF conducted emissions****Out-of-Band Emissions****Channel 11 (2405MHz)****Reference point**

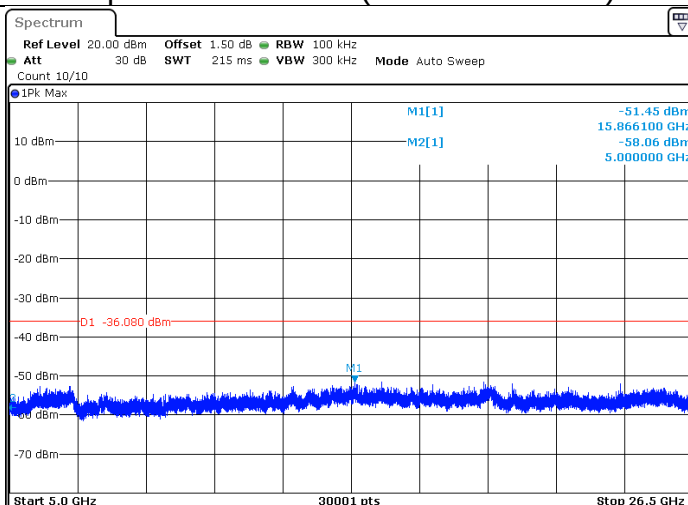
Date: 21 DEC 2020 11:22:49

**Spurious Emission (30MHz – 1GHz)**

Date: 21 DEC 2020 11:22:56

**Spurious Emission (1GHz – 5GHz)**

Date: 21 DEC 2020 11:23:11

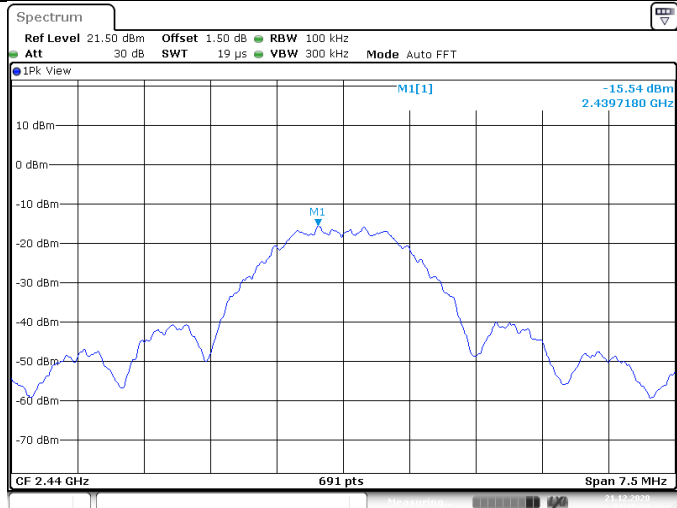
**Spurious Emission (5GHz – 26.5GHz)**

Date: 21 DEC 2020 11:23:45

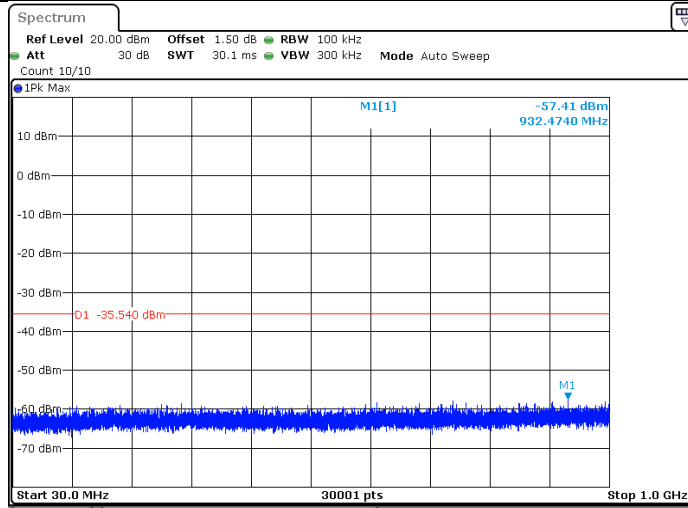
Remark: The emissions exceed the limit, it is fundamental signal.

## Out-of-Band Emissions Channel 18 (2440MHz)

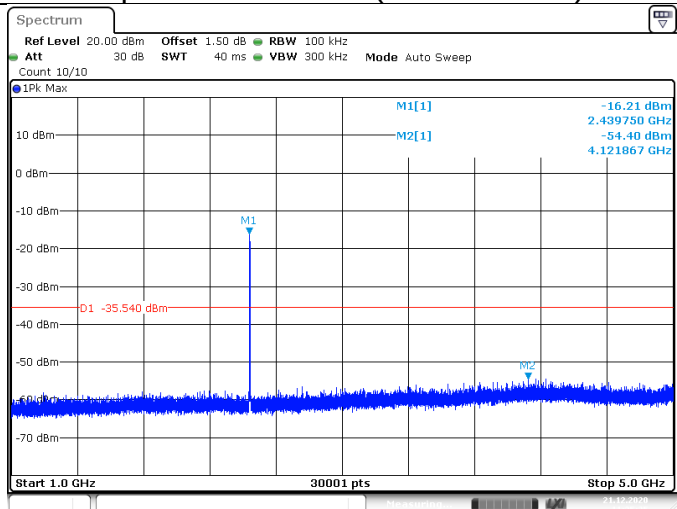
### Reference point



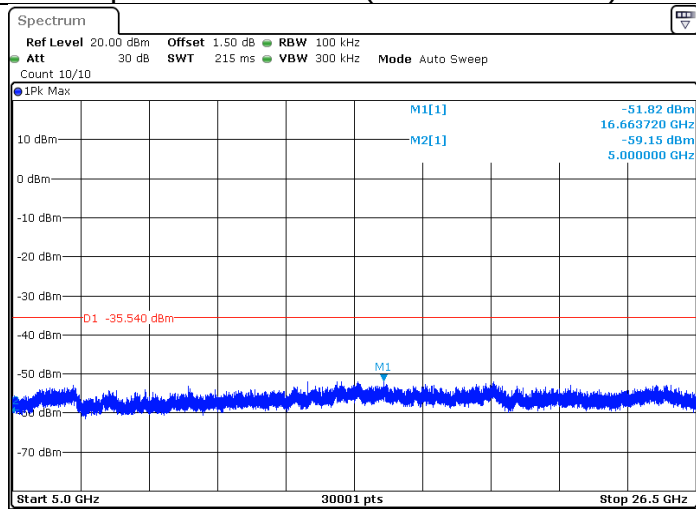
### Spurious Emission (30MHz – 1GHz)



### Spurious Emission (1GHz –5GHz)



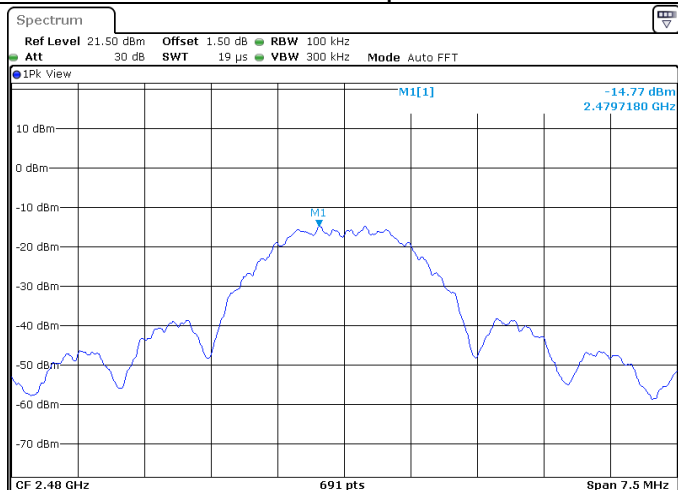
### Spurious Emission (5GHz –26.5GHz)



Remark: The emissions exceed the limit, it is fundamental signal.

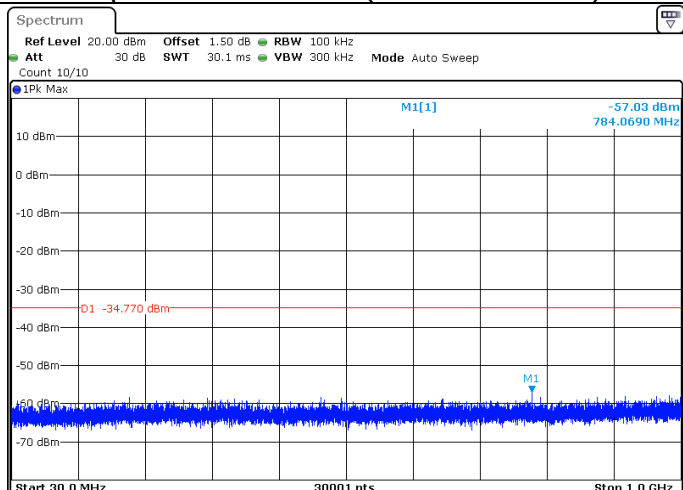
## Out-of-Band Emissions Channel 26 (2480MHz)

### Reference point



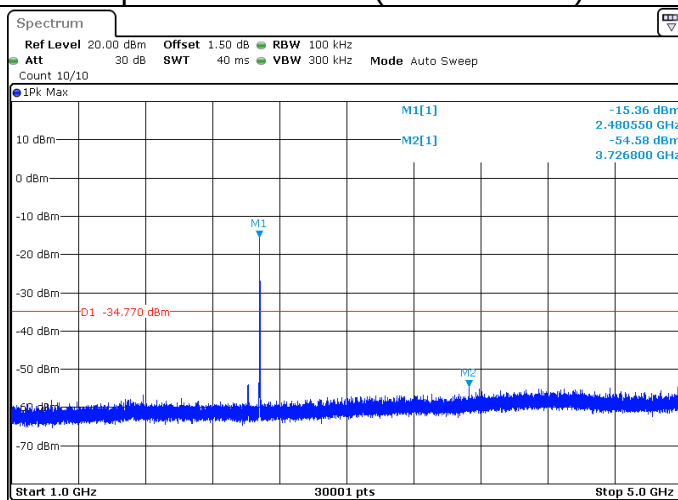
Date: 21.DEC.2020 11:27:33

### Spurious Emission (30MHz – 1GHz)



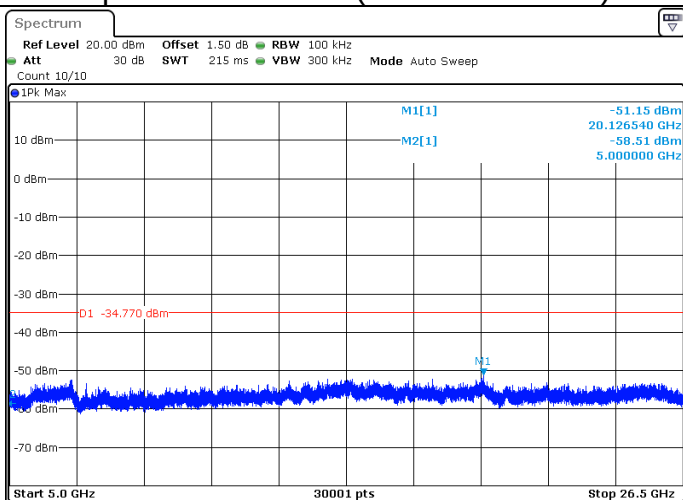
Date: 21.DEC.2020 11:27:40

### Spurious Emission (1GHz – 5GHz)



Date: 21.DEC.2020 11:27:55

### Spurious Emission (5GHz – 26.5GHz)



Date: 21.DEC.2020 11:28:29

Remark: The emissions exceed the limit, it is fundamental signal.



## 9.6 Band edge

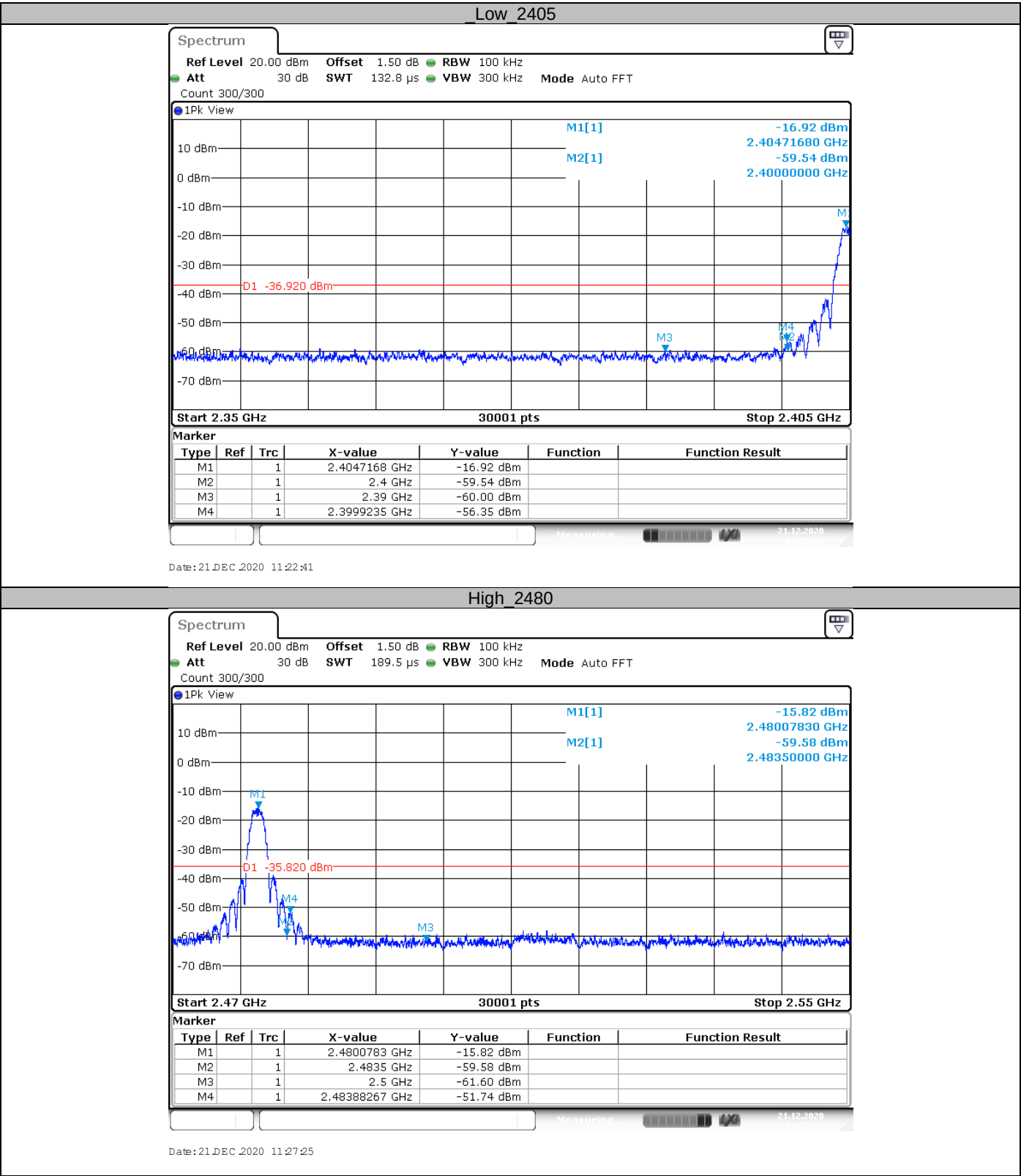
### Test Method

- 1 Use the following spectrum analyzer settings:  
Span = wide enough to capture the peak level of the in-band emission and all spurious  
RBW = 100 kHz, VBW  $\geq$  RBW, Sweep = auto, Detector function = peak, Trace = max hold.
- 2 Allow the trace to stabilize, use the peak and delta measurement to record the result.
- 3 The level displayed must comply with the limit specified in this Section.

### Limit

In any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)).

Test result



## 9.7 Spurious radiated emissions for transmitter

### Test Method

1. The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
3. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. Use the following spectrum analyzer settings According to C63.10:

#### For Below 1GHz

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious  
 RBW = 100 kHz to 120 kHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

#### For Peak unwanted emissions Above 1GHz:

Span = wide enough to capture the peak level of the in-band emission and all spurious  
 RBW = 1MHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

#### Procedures for average unwanted emissions measurements above 1000 MHz

- a) RBW = 1MHz.
- b)  $VBW \geq [3 \times RBW]$ .
- c) Detector = RMS (power averaging), if  $[span / (\# \text{ of points in sweep})] \leq RBW / 2$ .  
 Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
- d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
- e) Sweep time = auto.
- f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of  $1 / D$ , where  $D$  is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
- g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
  - 1) If power averaging (rms) mode was used in the preceding step e), then the correction

factor is  $[10 \log (1 / D)]$ , where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.

2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is  $[20 \log (1 / D)]$ , where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.

3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

## Limit

The radio emission outside the operating frequency band shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. Radiated emissions which fall in the restricted bands, as defined in section 15.205, must comply with the radiated emission limits specified in section 15.209.

| Frequency<br>MHz | Field Strength<br>uV/m | Measured Distance<br>Meters |
|------------------|------------------------|-----------------------------|
| 0.009~0.490      | 2400/F (kHz)           | 300                         |
| 0.490~1.705      | 24000/F (kHz)          | 30                          |
| 1.705~30         | 30                     | 30                          |

| Frequency<br>MHz | Field Strength<br>uV/m | Field Strength<br>dBuV/m | Detector |
|------------------|------------------------|--------------------------|----------|
| 30-88            | 100                    | 40                       | QP       |
| 88-216           | 150                    | 43.5                     | QP       |
| 216-960          | 200                    | 46                       | QP       |
| 960-1000         | 500                    | 54                       | QP       |
| Above 1000       | 500                    | 54                       | AV       |
| Above 1000       | 5000                   | 74                       | PK       |

### Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

### Transmitting spurious emission test result as below:

Pre-scan with three orthogonal axis and worst case as X axis listed below table

| Test mode: O-QPSK    |                        |                |             |          |              |
|----------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 11 (2405MHz) |                        |                |             |          |              |
| Frequency (MHz)      | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 2386.2               | 44.20                  | 74.0           | 29.80       | Peak     | Horizontal   |
| 4810.0               | 43.66                  | 74.0           | 30.34       | Peak     | Horizontal   |
| 7213.5               | 44.45                  | 74.0           | 29.55       | Peak     | Horizontal   |
| 2327.7               | 44.13                  | 74.0           | 29.87       | Peak     | Vertical     |
| 4809.0               | 42.78                  | 74.0           | 31.22       | Peak     | Vertical     |
| Test mode: O-QPSK    |                        |                |             |          |              |
| Channel 18 (2440MHz) |                        |                |             |          |              |
| Frequency (MHz)      | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 4880.6               | 45.91                  | 74.0           | 28.09       | Peak     | Horizontal   |
| 4880.6               | 45.47                  | 74.0           | 28.53       | Peak     | Vertical     |
| Test mode: O-QPSK    |                        |                |             |          |              |
| Channel 26 (2480MHz) |                        |                |             |          |              |
| Frequency (MHz)      | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 2483.5               | 50.69                  | 74.0           | 23.31       | Peak     | Horizontal   |
| 4960.6               | 45.87                  | 74.0           | 28.13       | Peak     | Horizontal   |
| 2483.5               | 46.80                  | 74.0           | 27.20       | Peak     | Vertical     |
| 4960.6               | 44.27                  | 74.0           | 29.73       | Peak     | Vertical     |

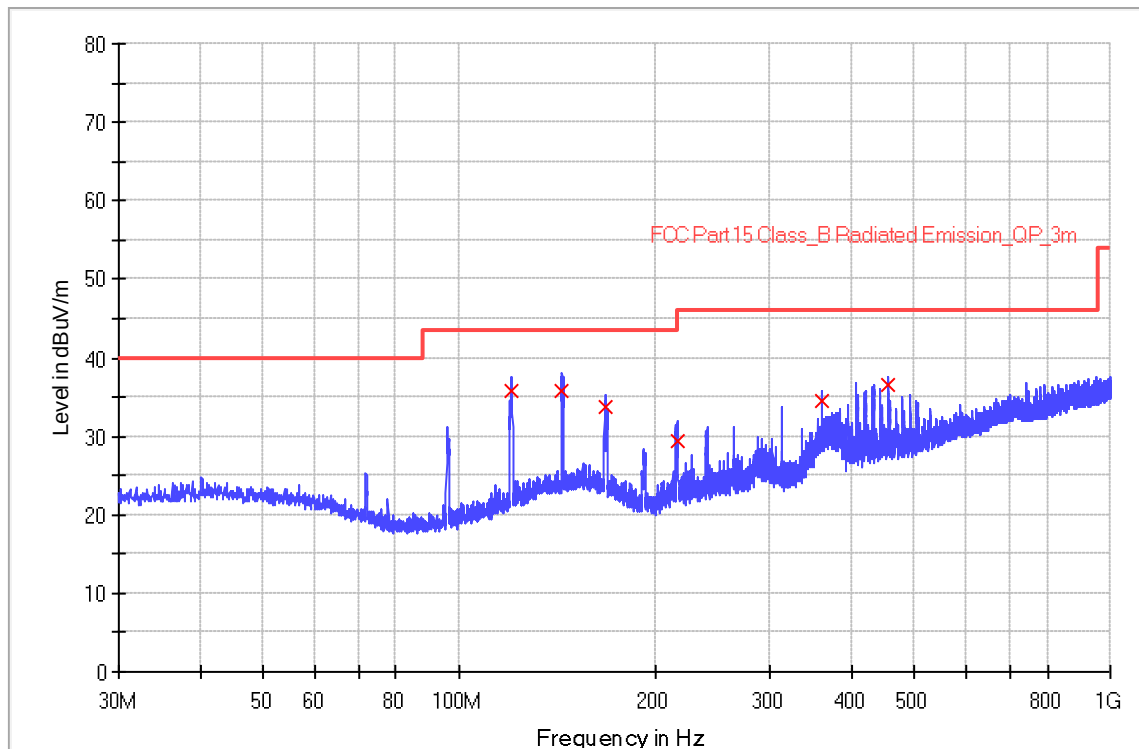
Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading

## The worst case of Radiated Emission below 1GHz:

|                                                                  |                          |
|------------------------------------------------------------------|--------------------------|
| Site: 3 meter chamber                                            | Time: 2020/12/18 - 14:24 |
| Limit: FCC_Part15.209_RE(3m)_ClassB                              | Engineer: Jiaxi XU       |
| Probe: VULB9168                                                  | Polarity: Horizontal     |
| EUT: SENTINEL SHIELD, Model no: TRX2002/01BR                     | Power: 120VAC, 60Hz      |
| Note: Transmit by at channel 2480MHz.                            |                          |
| Note: There is the worst case within frequency range 30MHz~1GHz. |                          |

RE\_VULB9168\_pre\_Cont\_30-1000



## Limit and Margin

| Frequency (MHz) | QuasiPeak (dBuV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) | Margin - QPK (dB) | Limit - QPK (dBuV/m) |
|-----------------|--------------------|-----------------|-----------------|-------------|-----|---------------|------------|-------------------|----------------------|
| 119.960000      | 35.8               | 1000.0          | 120.000         | 199.9       | H   | 36.0          | 13.5       | 7.7               | 43.5                 |
| 144.040000      | 35.8               | 1000.0          | 120.000         | 199.9       | H   | 102.0         | 15.2       | 7.7               | 43.5                 |
| 168.000000      | 33.8               | 1000.0          | 120.000         | 199.9       | H   | 192.0         | 14.9       | 9.7               | 43.5                 |
| 215.920000      | 29.4               | 1000.0          | 120.000         | 199.9       | H   | 259.0         | 12.3       | 14.1              | 43.5                 |
| 360.000000      | 34.5               | 1000.0          | 120.000         | 199.9       | H   | 359.0         | 16.5       | 11.5              | 46.0                 |
| 456.040000      | 36.5               | 1000.0          | 120.000         | 199.9       | H   | 125.0         | 18.6       | 9.5               | 46.0                 |

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

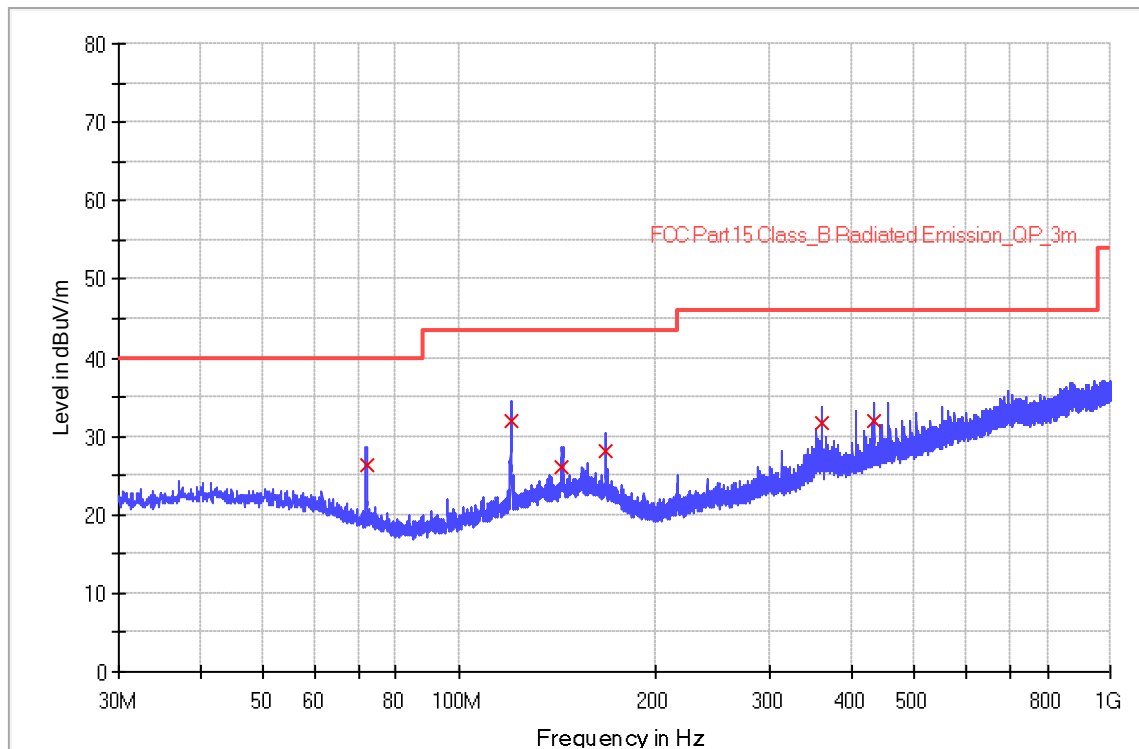
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

## The worst case of Radiated Emission below 1GHz:

|                                                                  |                          |
|------------------------------------------------------------------|--------------------------|
| Site: 3 meter chamber                                            | Time: 2020/12/18 - 15:31 |
| Limit: FCC_Part15.209_RE(3m)_ClassB                              | Engineer: Jiaxi XU       |
| Probe: VULB9168                                                  | Polarity: Vertical       |
| EUT: SENTINEL SHIELD, Model no: TRX2002/01BR                     | Power: 120VAC, 60Hz      |
| Note: Transmit by at channel 2480MHz.                            |                          |
| Note: There is the worst case within frequency range 30MHz~1GHz. |                          |

RE\_VULB9168\_pre\_Cont\_30-1000



## Limit and Margin

| Frequency (MHz) | QuasiPeak (dBuV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) | Margin - QPK (dB) | Limit - QPK (dBuV/m) |
|-----------------|--------------------|-----------------|-----------------|-------------|-----|---------------|------------|-------------------|----------------------|
| 71.960000       | 26.3               | 1000.0          | 120.000         | 100.1       | V   | 201.0         | 11.5       | 13.7              | 40.0                 |
| 119.960000      | 32.0               | 1000.0          | 120.000         | 100.1       | V   | 322.0         | 13.5       | 11.5              | 43.5                 |
| 144.040000      | 26.1               | 1000.0          | 120.000         | 100.1       | V   | 146.0         | 15.2       | 17.5              | 43.5                 |
| 167.920000      | 28.1               | 1000.0          | 120.000         | 100.1       | V   | 258.0         | 14.9       | 15.4              | 43.5                 |
| 360.000000      | 31.8               | 1000.0          | 120.000         | 100.1       | V   | 108.0         | 16.5       | 14.2              | 46.0                 |
| 432.680000      | 31.9               | 1000.0          | 120.000         | 100.1       | V   | 21.0          | 18.1       | 14.2              | 46.0                 |

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

## 10 Test Equipment List

### List of Test Instruments

Test Site1

|    | DESCRIPTION                                                       | MANUFACTURER    | MODEL NO. | SERIAL NO. | CAL. DATE | CAL. DUE DATE |
|----|-------------------------------------------------------------------|-----------------|-----------|------------|-----------|---------------|
| C  | Signal Analyzer                                                   | Rohde & Schwarz | FSV40     | 101091     | 2020-8-4  | 2021-8-3      |
| RE | EMI Test Receiver                                                 | Rohde & Schwarz | ESR3      | 101906     | 2020-8-4  | 2021-8-3      |
|    | Signal Analyzer                                                   | Rohde & Schwarz | FSV40     | 101091     | 2020-8-4  | 2021-8-3      |
|    | Trilog Super Broadband Test Antenna                               | Schwarzbeck     | VULB 9168 | 961        | 2019-3-16 | 2022-3-15     |
|    | Horn Antenna                                                      | Rohde & Schwarz | HF907     | 102393     | 2018-6-11 | 2021-4-1      |
|    | Pre-amplifier                                                     | Rohde & Schwarz | SCU-18D   | 19006451   | 2020-8-4  | 2021-8-3      |
|    | Loop antenna                                                      | Rohde & Schwarz | HFH2-Z2   | 100443     | 2020-3-13 | 2023-3-14     |
|    | DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ) | ETS-Lindgren    | 3116C-PA  | 002222727  | 2018-1-29 | 2021-1-28     |
|    | 3m Semi-anechoic chamber                                          | TDK             | 9X6X6     | ----       | 2018-5-11 | 2021-5-10     |
| CE | EMI Test Receiver                                                 | Rohde & Schwarz | ESR3      | 101907     | 2020-8-4  | 2021-8-3      |
|    | LISN                                                              | Rohde & Schwarz | ENV216    | 101924     | 2020-8-4  | 2021-8-3      |

| Measurement Software Information |                                |                              |             |
|----------------------------------|--------------------------------|------------------------------|-------------|
| Test Item                        | Software                       | Manufacturer                 | Version     |
| C                                | Bluetooth and WiFi Test System | Shenzhen JS tonscond co.,ltd | 2.6.77.0518 |
| RE                               | EMC 32                         | Rohde & Schwarz              | V9.15.00    |
| CE                               | EMC 32                         | Rohde & Schwarz              | V9.15.03    |

#### C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density\*
- Spurious RF conducted emissions
- Band edge



## 11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

| Items                                    | Extended Uncertainty                                                                                                                                           |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conducted Disturbance at Mains Terminals | 150kHz to 30MHz, LISN, $\pm 3.16\text{dB}$                                                                                                                     |
| Radiated Disturbance                     | 30MHz to 1GHz, $\pm 5.03\text{dB}$ (Horizontal)<br>$\pm 5.12\text{dB}$ (Vertical)<br>1GHz to 18GHz, $\pm 5.49\text{dB}$<br>18GHz to 40GHz, $\pm 5.63\text{dB}$ |
| Carrier power conducted measurement      | 50MHz~18GHz, $\pm 1.238\text{dB}$                                                                                                                              |
| Spurious Emission Conducted Measurement  | 9kHz ~40GHz, $\pm 1.224\text{dB}$                                                                                                                              |



## 12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.



## 13 Photographs of EUT

Refer to the < External Photos > & < Internal Photos >.

---

THE END