



RF TEST REPORT

Applicant Shanghai Smawave Technology Co. ,Ltd
FCC ID 2AU8HSPH420-BQ
Product Industrial smart handheld terminal
Model SPH420-bq
Report No. R2212A1269-R5
Issue Date January 12, 2023

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15E (2022)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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Summary of Measurement Results

| Number | Test Case | Clause in FCC rules | Verdict |
|--|-----------------------------------|-------------------------|---------|
| 1 | DFS Detection Threshold | 15.407/KDB 905462 5.2 | Pass |
| 2 | Channel Move Time | 15.407/KDB 905462 7.8.3 | Pass |
| 3 | Channel Closing Transmission Time | 15.407/KDB 905462 7.8.3 | Pass |
| 4 | Non-Occupancy Period(NOP) | 15.407/KDB 905462 7.8.3 | Pass |
| Date of Testing: December 12, 2022~December 13, 2022 | | | |
| Date of Sample Received: December 12, 2022 | | | |
| Note: PASS: The EUT complies with the essential requirements in the standard. FAIL: The EUT does not comply with the essential requirements in the standard. All indications of Pass/Fail in this report are opinions expressed by TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. | | | |



1. Test Laboratory

1.1. Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Test Facility

FCC (Designation number: CN1179, Test Firm Registration Number: 446626)

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

A2LA (Certificate Number: 3857.01)

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

1.3. Testing Location

Company: TA Technology (Shanghai) Co., Ltd.
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City: Shanghai
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E-mail: xukai@ta-shanghai.com

1. General Description of Equipment Under Test

2.1. Applicant and Manufacturer Information

| | |
|-----------------------------|---|
| Applicant | Shanghai Smawave Technology Co. ,Ltd |
| Applicant address | 3/F, Building 8, 1001 North Qinzhou Road, Xuhui District, Shanghai, China |
| Manufacturer | Shanghai Smawave Technology Co. ,Ltd |
| Manufacturer address | 3/F, Building 8, 1001 North Qinzhou Road, Xuhui District, Shanghai, China |

2.2. General Information

| EUT Description | |
|---|---|
| Model | SPH420-bq |
| IMEI | 862165041023688 |
| Hardware Version | V1.0.2 |
| Software Version | 20230106_01_SPHX20-aq_NDAC_V1.0.23 |
| Power Supply | Battery / AC adapter |
| Antenna Type | Internal Antenna |
| Operating Frequency Range(s) | U-NII-2A: 5250MHz-5350MHz U-NII-2C: 5470MHz-5725MHz without 5600MHz -5650MHz |
| Modulation Type | 802.11a(HT20) : OFDM 802.11n(HT20/HT40) : OFDM 802.11ac (VHT20/VHT40/VHT80):OFDM |
| Operating Mode | <input type="checkbox"/> Master <input type="checkbox"/> Client with radar detection <input checked="" type="checkbox"/> Client without radar detection |
| EUT Accessory | |
| Adapter | Manufacturer: Zhuzhou Dachuan Electronic Technology Co.,Ltd Model: DCT12W050200ZZ-H1 (Adapters: 94001-00001-EU; 94001-00002-UK;94001-00003-US) |
| Battery | Manufacturer: GuangDong FengHua New Energy Co., Ltd. Model: FHPK626263P |
| Note: The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant. | |

Wireless Technology and Frequency Range

| Wireless Technology | | Bandwidth | Channel | Frequency |
|--|----------|-----------|---------|-----------|
| Wi-Fi | U-NII-2A | 20 MHz | 52 | 5260MHz |
| | | | 56 | 5280MHz |
| | | | 60 | 5300MHz |
| | | | 64 | 5320MHz |
| | | 40 MHz | 54 | 5270MHz |
| | | | 62 | 5310MHz |
| | | 80 MHz | 58 | 5290MHz |
| | U-NII-2C | 20 MHz | 100 | 5500MHz |
| | | | 104 | 5520MHz |
| | | | 108 | 5540MHz |
| | | | 112 | 5560MHz |
| | | | 116 | 5580MHz |
| | | | 132 | 5660MHz |
| | | | 136 | 5680MHz |
| | | | 140 | 5700MHz |
| | | | 144 | 5720MHz |
| | | 40 MHz | 102 | 5510MHz |
| | | | 110 | 5550MHz |
| | | | 134 | 5670MHz |
| | | | 142 | 5710MHz |
| | | 80 MHz | 106 | 5530MHz |
| | | | 138 | 5690MHz |
| Does this device support TPC Function? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Does this device support TDWR Band? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |



3. Applied Standards

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

Test standards:

FCC CFR47 Part 15E (2022) Unlicensed National Information Infrastructure Devices

Reference standard:

FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02

FCC KDB 905462 D03 Client Without DFS New Rules v01r02

4. DFS Technical Requirements and Radar Test Waveforms

4.1. DFS Overview

Table 1 Applicability of DFS Requirements Prior to Use of a Channel

| Requirement | Operational Mode | | |
|---------------------------------|------------------|--------------------------------|-----------------------------|
| | Master | Client Without Radar Detection | Client With Radar Detection |
| Non-Occupancy Period | Yes | Not required | Yes |
| DFS Detection Threshold | Yes | Not required | Yes |
| Channel Availability Check Time | Yes | Not required | Not required |
| U-NII Detection Bandwidth | Yes | Not required | Yes |

Table 2 Applicability of DFS Requirements during Normal Operation

| Requirement | Operational Mode | |
|--|---|--|
| | Master Device or Client with Radar Detection | Client Without Radar Detection |
| DFS Detection Threshold | Yes | Not required |
| Channel Closing Transmission Time | Yes | Yes |
| Channel Move Time | Yes | Yes |
| U-NII Detection Bandwidth | Yes | Not required |
| Additional Requirements for Devices with Multiple Bandwidth Modes | Master Device or Client with Radar Detection | Client Without Radar Detection |
| U-NII Detection Bandwidth | All BW modes must be tested | Not required |
| Statistical Performance Check | All BW modes must be tested | Not required |
| Channel Closing Transmission Time | Test using widest BW mode available | Test using the widest BW mode available for the link |
| Channel Move Time | Test using widest BW mode available | Test using the widest BW mode available for the link |
| All other tests | Any single BW mode | Not required |
| Note: Frequencies selected for statistical performance check should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency. | | |

4.2. DFS Detection Thresholds

Table 3 DFS Detection Thresholds for Master Devices and Client Devices with Radar Detection

| Maximum Transmit Power | Value (See Notes 1, 2, and 3) |
|---|----------------------------------|
| EIRP \geq 200 milliwatt | -64 dBm |
| EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz | -62 dBm |
| EIRP < 200 milliwatt that do not meet the power spectral density requirement | -64 dBm |
| <p>Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.</p> <p>Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.</p> <p>Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.</p> | |

Table 4 DFS Response Requirement Values

| Parameter | Value |
|---|---|
| Non-occupancy Period | Minimum 30 minutes |
| Channel Availability Check Time | 60 seconds |
| Channel Move Time | 10 seconds See Note 1. |
| Channel Closing Transmission Time | 200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2. |
| U-NII Detection Bandwidth | Minimum 100% of the U-NII 99% transmission power bandwidth. See Note 3. |
| <p>Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.</p> <p>Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.</p> <p>Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic</p> | |

4.3. Radar Test Waveforms

Table 5 Short Pulse Radar Test Waveforms

| Radar Type | Pulse Width (μsec) | PRI (μsec) | Number of Pulses | Minimum Percentage of Successful Detection | Minimum Number of Trials |
|---|--------------------|---|------------------|--|--------------------------|
| 0 | 1 | 1428 | 18 | See Note 1 | See Note 1 |
| 1 | 1 | Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a | Roundup | 60% | 30 |
| | | Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A | | | |
| 2 | 1-5 | 150-230 | 23-29 | 60% | 30 |
| 3 | 6-10 | 200-500 | 16-18 | 60% | 30 |
| 4 | 11-20 | 200-500 | 12-16 | 60% | 30 |
| Aggregate (Radar Types 1-4) | | | | 80% | 120 |
| Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests. | | | | | |

Table 5a Pulse Repetition Intervals Values for Test A

| Pulse Repetition Frequency Number | Pulse Repetition Frequency (Pulses Per Second) | Pulse Repetition Interval (Microseconds) |
|-----------------------------------|--|--|
| 1 | 1930.5 | 518 |
| 2 | 1858.7 | 538 |
| 3 | 1792.1 | 558 |
| 4 | 1730.1 | 578 |
| 5 | 1672.2 | 598 |
| 6 | 1618.1 | 618 |
| 7 | 1567.4 | 638 |
| 8 | 1519.8 | 658 |
| 9 | 1474.9 | 678 |
| 10 | 1432.7 | 698 |
| 11 | 1392.8 | 718 |
| 12 | 1355 | 738 |
| 13 | 1319.3 | 758 |
| 14 | 1285.3 | 778 |
| 15 | 1253.1 | 798 |
| 16 | 1222.5 | 818 |
| 17 | 1193.3 | 838 |
| 18 | 1165.6 | 858 |
| 19 | 1139 | 878 |
| 20 | 1113.6 | 898 |
| 21 | 1089.3 | 918 |
| 22 | 1066.1 | 938 |
| 23 | 326.2 | 3066 |

The aggregate is the average of the percentage of successful detections of Short Pulse Radar Types 1-4. For example, the following table indicates how to compute the aggregate of percentage of successful detections.

| Radar Type | Number of Trials | Number of Successful Detections | Minimum Percentage of Successful Detection |
|--|------------------|---------------------------------|--|
| 1 | 35 | 29 | 82.9% |
| 2 | 30 | 18 | 60% |
| 3 | 30 | 27 | 90% |
| 4 | 50 | 44 | 88% |
| Aggregate $(82.9\% + 60\% + 90\% + 88\%)/4 = 80.2\%$ | | | |

Table 6 Long Pulse Radar Test Waveform

| Radar Type | Pulse Width (μsec) | Chirp Width (MHz) | PRI (μsec) | Number of Pulses per Burst | Number of Bursts | Minimum Percentage of Successful Detection | Minimum Number of Trials |
|------------|--------------------|-------------------|------------|----------------------------|------------------|--|--------------------------|
| 5 | 50-100 | 5-20 | 1000-2000 | 1-3 | 8-20 | 80% | 30 |

The parameters for this waveform are randomly chosen. Thirty unique waveforms are required for the Long Pulse Radar Type waveforms. If more than 30 waveforms are used for the Long Pulse Radar Type waveforms, then each additional waveform must also be unique and not repeated from the previous waveforms.

Table 7 Frequency Hopping Radar Test Waveform

| Radar Type | Pulse Width (μsec) | PRI (μsec) | Pulses per Hop | Hopping Rate (kHz) | Hopping Sequence Length (msec) | Minimum Percentage of Successful Detection | Minimum Number of Trials |
|------------|--------------------|------------|----------------|--------------------|--------------------------------|--|--------------------------|
| 6 | 1 | 333 | 9 | 0.333 | 300 | 70% | 30 |

For the Frequency Hopping Radar Type, the same Burst parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected from the hopping sequence defined by the following algorithm: The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724 MHz. Next, the frequency that was just chosen is removed from the group and a frequency is randomly selected from the remaining 474 frequencies in the group. This process continues until all 475 frequencies are chosen for the set. For selection of a random frequency, the frequencies remaining within the group are always treated as equally likely.

4.4. Test Set-ups

We test the data stream using MPEG-X files.

Channel loading is based on IP.

Setup for Master with Injection at the Master

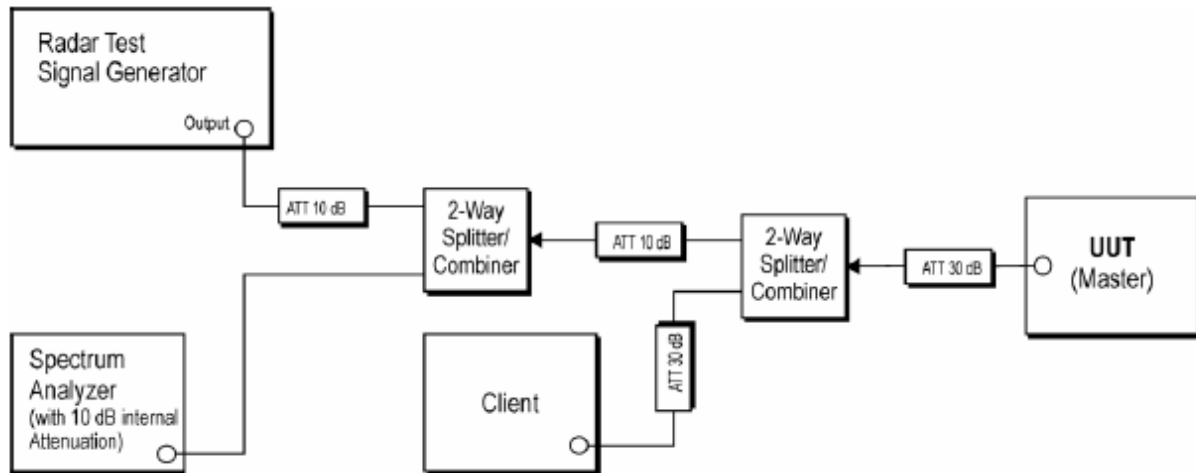


Figure 2: Example Conducted Setup where UUT is a Master and Radar Test Waveforms are injected into the Master

Setup for Client with Injection at the Master

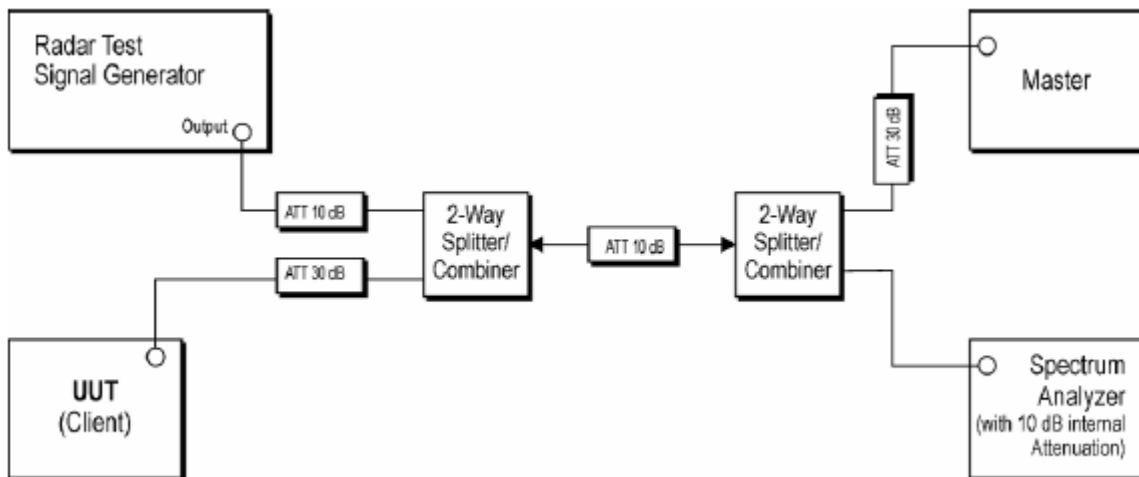


Figure 3: Example Conducted Setup where UUT is a Client and Radar Test Waveforms are injected into the Master

Setup for Client with Injection at the Client

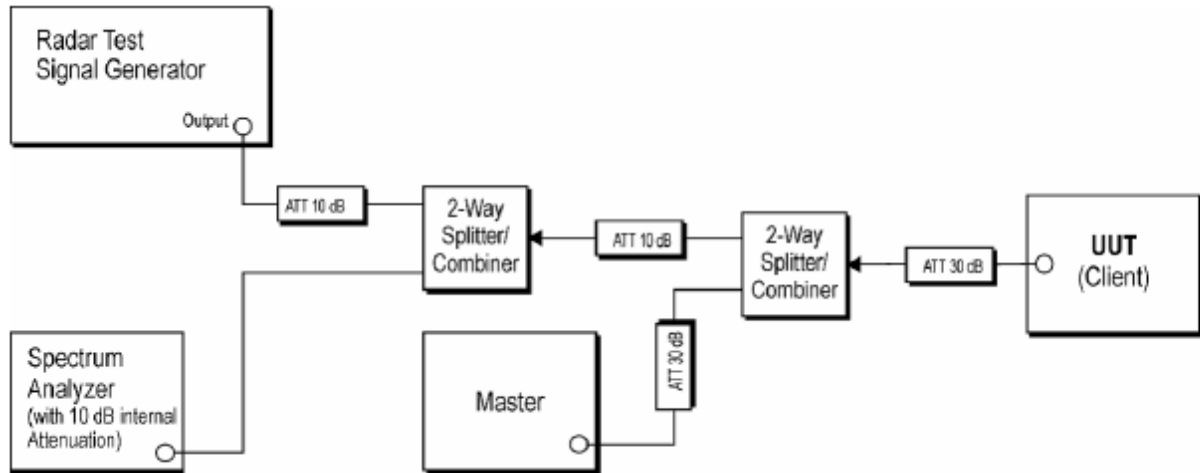


Figure 4: Example Conducted Setup where UUT is a Client and Radar Test Waveforms are injected into the Client

5. Test Case

5.1. DFS Detection Thresholds

Ambient Condition

| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C | 45%~50% | 101.5kPa |

Methods of Measurement

Client with injection at the Master.

For a detection threshold level of -64dBm, the required signal strength at EUT antenna location is -64dBm, the tested level is lower than required level hence it provides margin to the limit.

| Frequency of Calibration | |
|--------------------------|-------------------|
| Bandwidth | Central Frequency |
| 20MHz | 5300MHz |
| | 5500MHz |
| 40MHz | 5270MHz |
| | 5550MHz |
| 80MHz | 5290MHz |
| | 5530MHz |

Calibration Result

Refer to the section 6.1 of this report for test data.

5.2. Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period

Ambient Condition

| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C | 45%~50% | 101.5kPa |

Methods of Measurement

These tests define how the following DFS parameters are verified during In-Service Monitoring;

- Channel Closing Transmission Time
- Channel Move Time
- Non-Occupancy Period

The steps below define the procedure to determine the above mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold + 1dB is generated on the Operating Channel of the U-NII device (In- Service Monitoring).

1. One frequency will be chosen from the Operating Channels of the EUT within the 5250-5350 MHz or 5470-5725 MHz bands. For 802.11 devices, the test frequency must contain control signals. This can be verified by disabling channel loading and monitoring the spectrum analyzer. If no control signals are detected, another frequency must be selected within the emission bandwidth where control signals are detected.
2. In case the EUT is a U-NII device operating as a Client Device (with or without DFS), a U-NII device operating as a Master Device will be used to allow the EUT (Client device) to Associate with the Master Device. In case the EUT is a Master Device, a U-NII device operating as a Client Device will be used and it is assumed that the Client will Associate with the EUT (Master). In both cases for conducted tests, the Radar Waveform generator will be connected to the Master Device. For radiated tests, the emissions of the Radar Waveform generator will be directed towards the Master Device. If the Master Device has antenna gain, the main beam of the antenna will be directed toward the radar emitter. Vertical polarization is used for testing.
3. Stream the channel loading test file from the Master Device to the Client Device on the test Channel for the entire period of the test.
4. At time T_0 the Radar Waveform generator sends a Burst of pulses for one of the Radar Type 0 in Table 5 at levels defined in Table 3, on the Operating Channel. An additional 1 dB is added to the radar test signal to ensure it is at or above the DFS Detection Threshold, accounting for equipment variations/errors.
5. Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the EUT during the observation time (Channel Move Time). Measure and record the Channel Move Time and Channel Closing Transmission Time if radar detection occurs. Figure 17 illustrates Channel Closing

Transmission Time.

6. When operating as a Master Device, monitor the EUT for more than 30 minutes following instant T_2 to verify that the EUT does not resume any transmissions on this Channel. Perform this test once and record the measurement result.

7. In case the EUT is a U-NII device operating as a Client Device with In-Service Monitoring, perform steps 1 to 6.

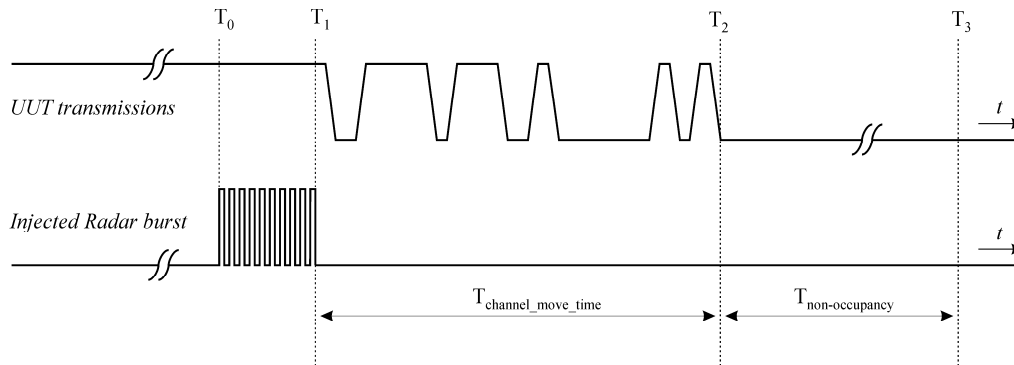


Figure 17: Example of Channel Closing Transmission Time & Channel Closing Time

Limits

| | |
|-----------------------------------|---|
| Channel Move Time | $\leq 10s$ |
| Channel Closing Transmission Time | $\leq 200ms + 60ms$ (over remaining 10s period) |
| Non-Occupancy Period | $\geq 30min$ |

Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.

Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Measurement Uncertainty

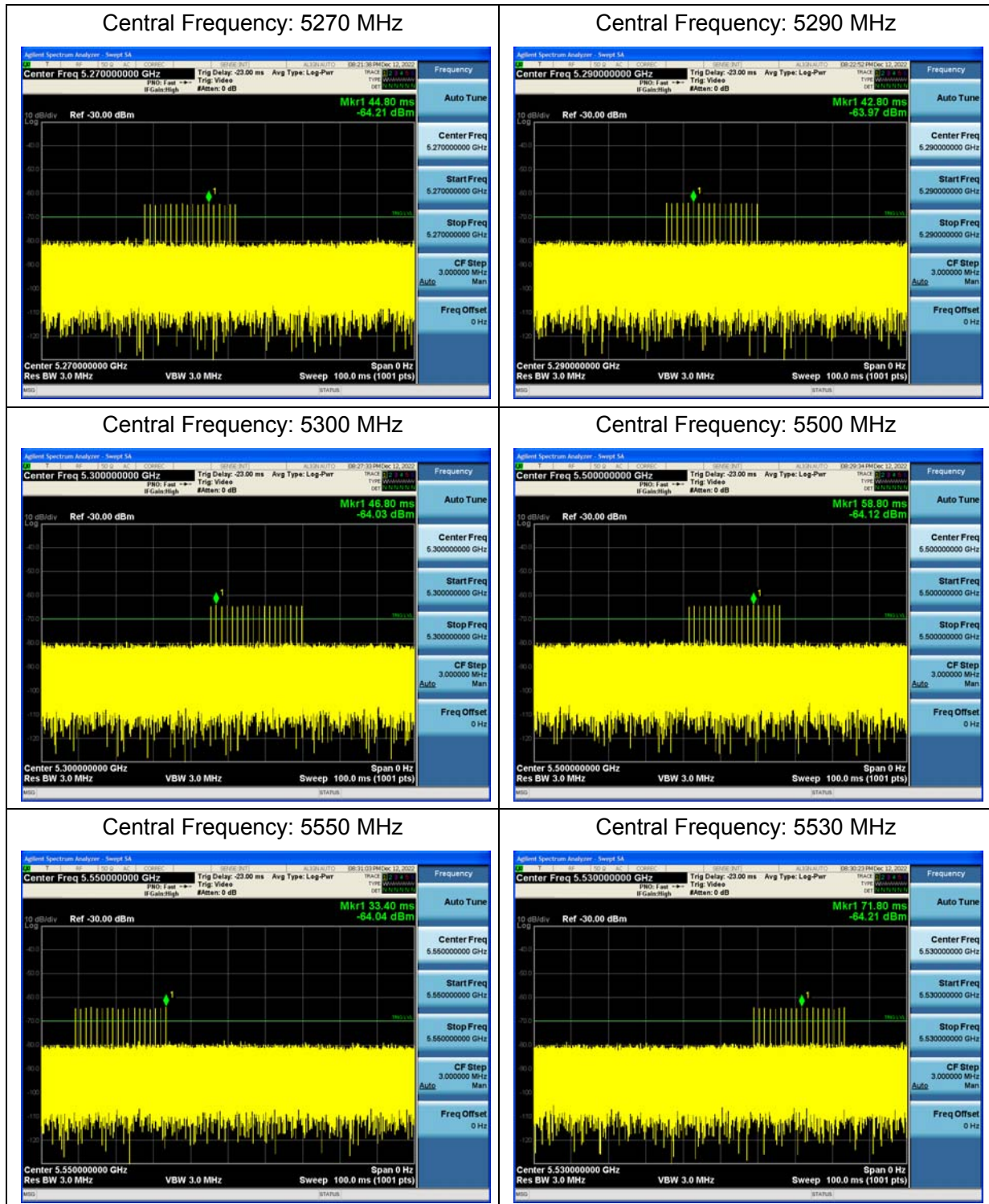
The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$, $U = 2.69$ dB.

Test Results

Refer to the section 6.2 of this report for test data.

6. Test Results

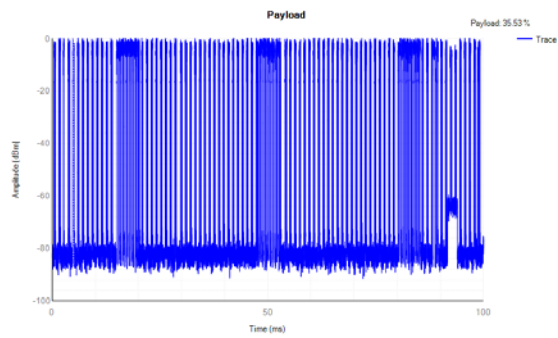
6.1. DFS Detection Thresholds





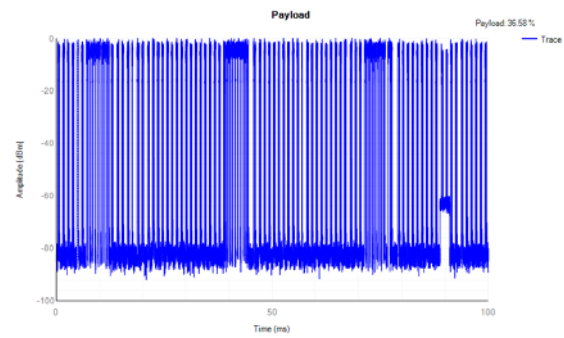
Timing plot

Bandwidth 20MHz



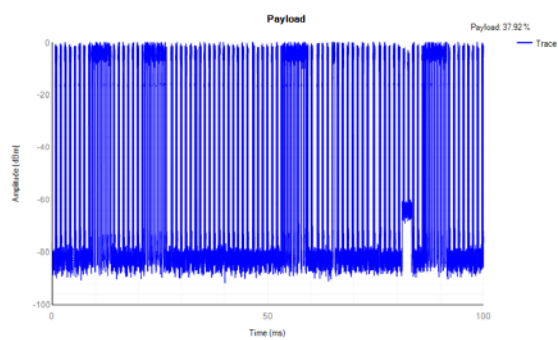
Duty Cycle (%): 35.53

Bandwidth 40MHz



Duty Cycle (%): 36.58

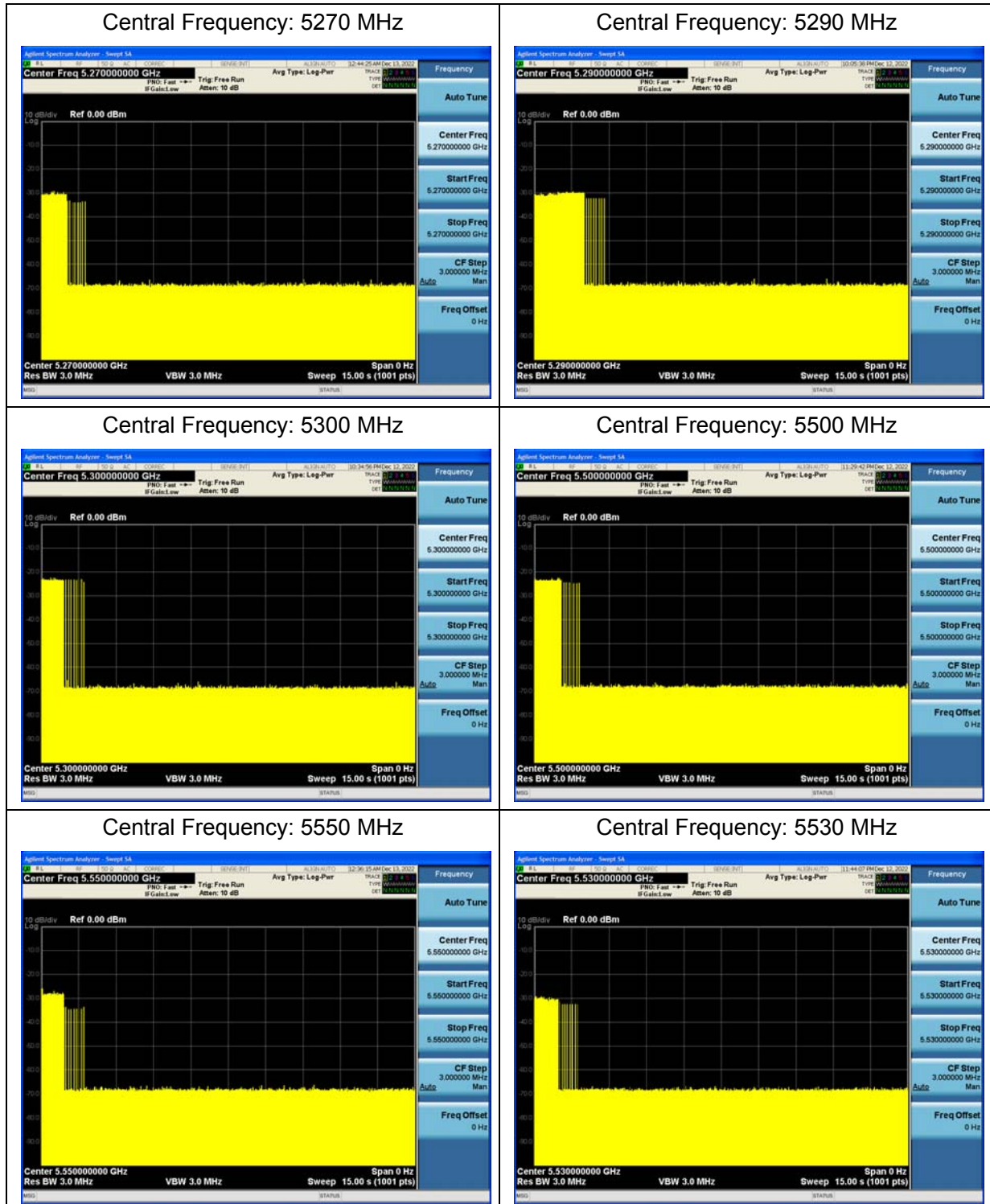
Bandwidth 80MHz



Duty Cycle (%): 37.92

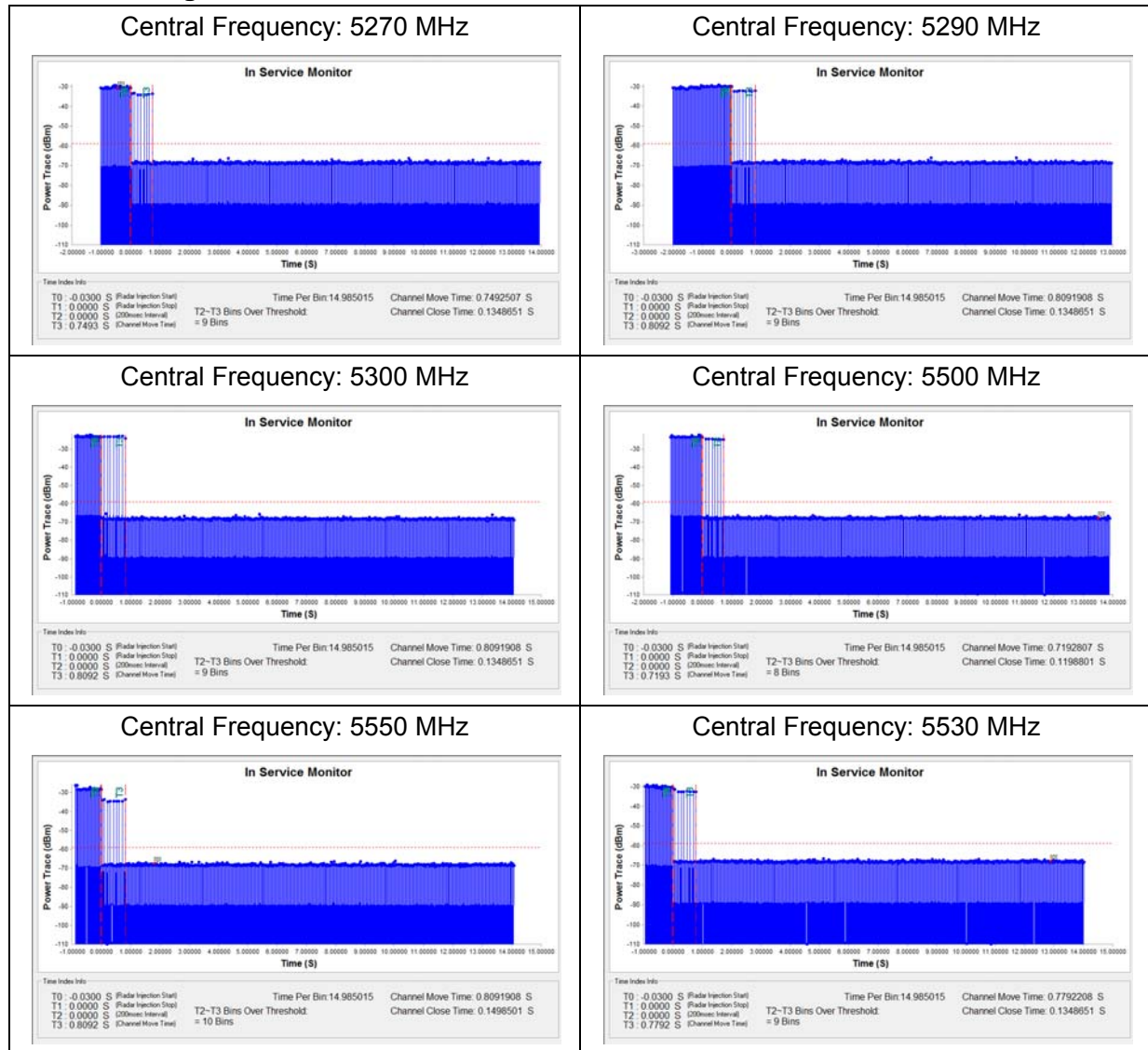
5.3. Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period

Channel Move Time



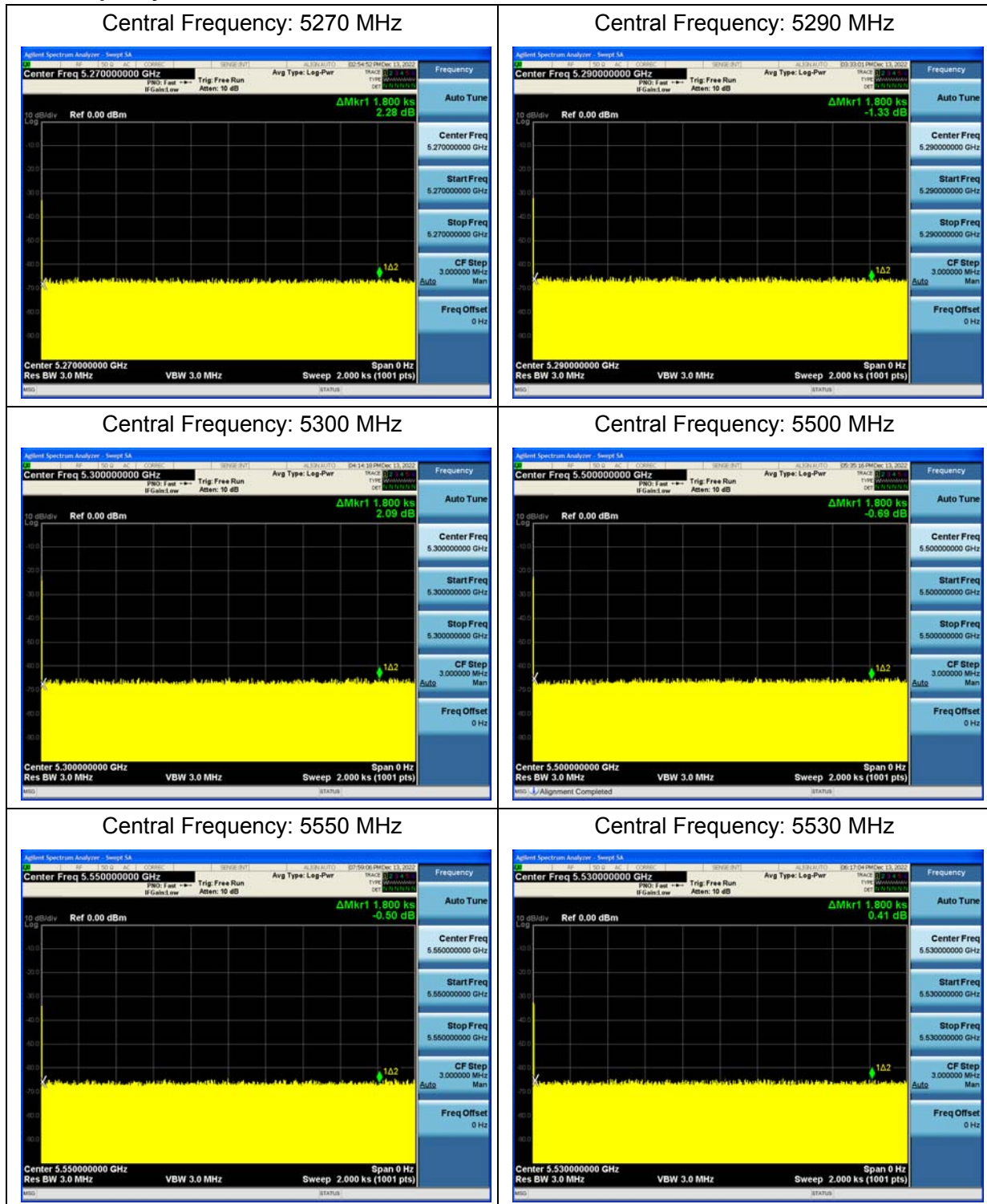


Channel Closing Transmission Time





Non-Occupancy Period



6. Main Test Instruments

| Name | Manufacturer | Type | Serial Number | Calibration Date | Expiration Date |
|-------------------------|---------------|----------|---|------------------|-----------------|
| Vector Signal Generator | KEYSIGHT | N5172B | MY53050900 | 2022-12-10 | 2023-12-09 |
| Spectrum Analyzer | Agilent | N9010A | MY50210259 | 2022-12-10 | 2023-12-09 |
| Splitter | UCL Microwave | 2 way | UCL-PD0512-2S | / | / |
| Splitter | UCL Microwave | 2 way | UCL-PD0512-2S | / | / |
| RF Cable | Agilent | SMA 15cm | 0001 | / | / |
| RF Cable | Agilent | SMA 15cm | 0002 | / | / |
| RF Cable | Agilent | SMA 15cm | 0003 | / | / |
| RF Cable | Agilent | SMA 15cm | 0004 | / | / |
| Software | KEYSIGHT | N7607C | / | / | / |
| WLAN AP | ASUS | RT-AX82U | LBICI4000943 (FCC ID: MSQ-RTAXJ300) | / | / |

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



ANNEX A: The EUT Appearance

The EUT Appearance is submitted separately.



ANNEX B: Test Setup Photos

The Test Setup Photos is submitted separately.