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March 10, 2023

Roku, Inc.
1155 Coleman Ave
San Jose
CA 95110 USA

Dear Thien,

Enclosed is the EMC Wireless test report for compliance testing of the Roku, Inc., WiFi Remote Control as tested to the requirements of 15.407/ RSS 247 ISSUE 2 for Intentional Radiators.

Thank you for using the services of Eurofins Electrical and Electronic Testing NA, Inc. If you have any questions regarding these results or if Eurofins Electrical and Electronic Testing NA, Inc. can be of further service to you, please feel free to contact me.

Gary Chau

Documentation Department
Eurofins Electrical and Electronic Testing NA, Inc.

Reference: WIR121849-ROKU-FCC-ISED-DFS_Rev 1.0

ilac-MRA A2LA ACCREDITED CERT #591.02

IC Test Site(s) Reg. #: 2043C



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# FCC/ ISED DFS Test Report

**Applicant name: Roku, Inc.**

**Product: WiFi Remote Control**

**Report: WIR121849-ROKU-FCC-ISED-DFS_Rev 1.0**

**Applicant Address:**

**1155 Coleman Ave., San Jose, CA 95110 USA**

**Manufacturer Address:**

**1155 Coleman Ave., San Jose, CA 95110 USA**

**Prepared By:**
**Eurofins Electrical and Electronic Testing NA, Inc.**
3162 Belick St.
Santa Clara CA, 95054

# FCC/ ISED DFS Test Report

**Applicant name: Roku, Inc.**

**Product: WiFi Remote Control**

**Standard**
**FCC 15.407**
**RSS 247 Issue 2**

Christopher Martin
Christopher Martin Test Engineer, Wireless Laboratory

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements FCC/ ISED Rules under normal use and maintenance.

Gary Chou
Gary Chou
Wireless Engineering Manager, Wireless Laboratory

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## Release Control Record

| Issue No. | Description | Date Issued |
|---|---|---|
| WIR121849-ROKU-FCC-ISED-DFS | Original Release | 03/05/2023 |
| WIR121849-ROKU-FCC-ISED-DFS_Rev 1.0 | Add EUT information | 03/10/2023 |

## 1 General Description of EUT

| | | |
|---|---|---|
| **Product:** | WiFi Remote Control | |
| **Brand:** | Roku | |
| **Model(s) Tested:** | RC-EL1 | |
| **Series Model:** | RC-EL5 | |
| **Sample Status:** | Original | |
| **Series Number:** | 2326000336 | |
| **EUT Specifications:** | Primary Power: | 3Vdc powered by battery |
| | Voltage Frequency: | N/A |
| | Technology / Type of Modulations: | 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDM |
| | Operating Frequency : | 5180 MHz~5240MHz,<br>5260 MHz~5320 MHz<br>5500 MHz~5725 MHz<br>5745 MHz~5825MHz |
| | DFS Band Operational Mode: | Client without radar detection |
| | FCC ID: | TC2-R1028 |
| | ISED ID: | 5959A-R1026 |
| | Antenna Type: Chip Antenna | 5150-5250 MHz: 2.8dBi<br>5250-5725 MHz: 2.4 dBi<br>5745-5825 MHz: 4.4 dBi |
| | Maximum EIRP | 9.157 dBm |
| | Antenna connector: | N/A |
| **Analysis:** | The results obtained relate only to the item(s) tested. | |
| **Environmental Test Conditions:** | Temperature: 20.3° C | |
| | Relative Humidity: 47.5% | |
| | Barometric Pressure: 860-1060 mbar | |
| **Evaluated by:** | Christopher Martin | |
| **Issue Date(s):** | March 10, 2023 | |

NOTE: The following modules can be chosen to be configured in the EUT.

| | Model No. | FCC ID | Note |
|---|---|---|---|
| - | - | - | - |
| - | - | - | - |

### FCC/IC/ CE RF Testing Units Setting

| Model | Hardware (HW) Rev. | Firmware (FW) Rev. | FW operation verification and Instruction |
|---|---|---|---|
| RC-EL1, RC-EL5 | 1.0 | mfg.0114 | Verify by Spectrum Analyzer<br>AmebaD Mptool Userguide (2.0).pdf |

## 2. U-NII DFS Rule Requirements

### 2.1 Working Modes and Required Test Items

This is a DFS test report.

The manufacturer shall state whether the UUT is capable of operating as a Client. If the UUT is capable of operating in more than one operating mode then each operating mode shall be tested separately. See tables 6 and 7 for the applicability of DFS requirements for each of the operational modes.

Table 6: Applicability of DFS Requirements Prior To Use a Channel

| Requirement | Operational Mode | | |
|---|---|---|---|
| | Master | Client without radar detection | Client with radar detection |
| Non-Occupancy Period | ✓ | ✓ note | ✓ |
| DFS Detection Threshold | ✓ | Not required | ✓ |
| Channel Availability Check Time | ✓ | Not required | Not required |
| U-NII Detection Bandwidth | ✓ | Not required | ✓ |
| Note: Per KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02 section (b)(5/6),<br>If the client moves with the master, the device is considered compliant if nothing appears in the client non-occupancy period test. For devices that shut down (rather than moving channels), no beacons should appear. An analyzer plot that contains a single 30-minute sweep on the original channel. | | | |

Table 7: Applicability of DFS Requirements During Normal Operation.

| Requirement | Operational Mode | |
|---|---|---|
| | Master or Client with radar detection | Client without radar detection |
| DFS Detection Threshold | ✓ | Not required |
| Channel Closing Transmission Time | ✓ | ✓ |
| Channel Move Time | ✓ | ✓ |
| U-NII Detection Bandwidth | ✓ | Not required |

| Additional requirements for devices with multiple bandwidth modes | Master or Client with radar detection | Client without radar detection |
|---|---|---|
| U-NII Detection Bandwidth and Statistical Performance Check | All BW modes must be tested | Not required |
| Channel Move Time and Channel Closing Transmission 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 (Section 7.8.4) 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. | | |

## 2.2 Test Limits and Radar Signal Parameters

**Detection Threshold Values**

Table 8: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection

| Maximum Transmit Power | Value (See Notes 1, 2, and 3) |
|---|---|
| EIRP ≥ 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 |
| Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.<br>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.<br>Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01. | |

Table 9: DFS Response Requirement Values

| Parameter | Value |
|---|---|
| Non-occupancy period | Minimum 30 minutes |
| Channel Availability Check Time | 60 seconds |
| Channel Move Time | 10 seconds<br>See Note 1. |
| Channel Closing Transmission Time | 200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period.<br>See Notes 1 and 2. |
| U-NII Detection Bandwidth | Minimum 100% of the U-NII 99% transmission power bandwidth. See Note 3 |
| 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.<br>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.<br>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. | |

**Parameters of DFS Test Signals**

Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

Table 10: 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 $\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{PRI_{\mu sec}}\right)\right\}$ | 60% | 30 |
| | | Test B: 15 unique PRI values randomly selected within the range of 518-3066 $\mu$ sec, with a minimum increment of 1 $\mu$ sec, 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 11: 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 |

Three subsets of trials will be performed with a minimum of ten trials per subset. The subset of trials differ in where the Long Pulse Type 5 Signal is tuned in frequency.

a) the Channel center frequency
b) tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the low edge of the UUT Occupied Bandwidth
c) tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the high edge of the UUT Occupied Bandwidth

It include 10 trails for every subset, the formula as below,

For subset case 1: the center frequency of the signal generator will remain fixed at the center of the UUT Channel.

For subset case 2: to retain 90% frequency overlap between the radar signal and the UUT Occupied Bandwidth, the center frequency of the signal generator will vary for each of the ten trials in subset case 2. The center frequency of the signal generator for each trial is calculated by:

$$FL+(0.4*Chirp\ Width\ [in\ MHz])$$

For subset case 3: to retain 90% frequency overlap between the radar signal and the UUT Occupied Bandwidth, the center frequency of the signal generator will vary for each of the ten trials in subset case 3. The center frequency of the signal generator for each trial is calculated by:

$$FH-(0.4*Chirp\ Width\ [in\ MHz])$$

Table 12: 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 |

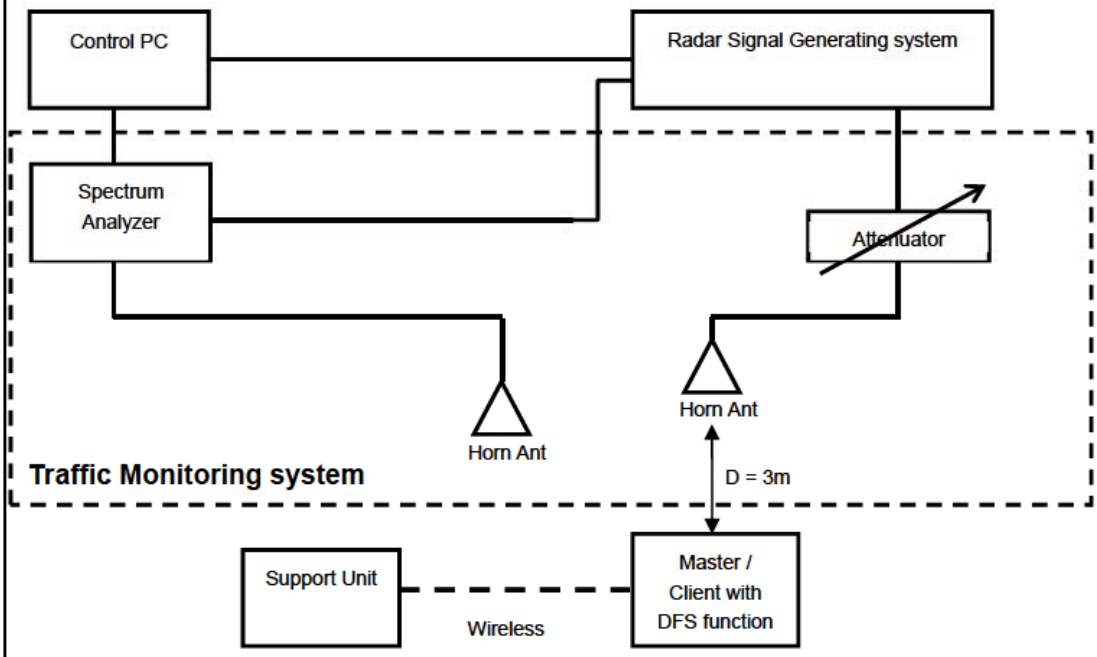
## 2.3 Test Channel List

**802.11n (HT20) mode**

| Test Parameter | Test channel |
|---|---|
| Radar Detection Performance | 5300, 5500 |

## 2.4 Test Setup Configuration

**Radiated Setup Configuration of DFS Measurement System**




The UUT is a RLAN device operating in Client mode. Radar test signals are injected into the UUT.

## 3 Summary of Test Results

The EUT has been tested according to the following specifications:

| FCC 15.407/ RSS 247 | | |
|---|---|---|
| **Clause** | **Test Parameter** | **Results** |
| 4.2.6 | DFS | Pass |

### 3.1 Test Instruments

| Asset # | Equipment | Manufacturer | Model | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| 1S2003 | EMI Test Receiver | Keysight | N9030B | 11/22/2022 | 11/23/2023 |
| 1S2756 | EXG Signal Generator | Keysight | N5172B | 08/27/2022 | 08/27/2024 |
| N/A | Splitter / Combiner | Mini-Circuits | ZFRSC-242-S | See Note | See Note |

Note 1: Verified by calibrated instrumentation at the time of testing

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT:

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| Test Method | Typical Expanded Uncertainty | K | Confidence Level |
|---|---|---|---|
| **RF Frequencies** | ±4.52 Hz | 2 | 95% |
| **RF Power Conducted Emissions** | ±2.32 dB | 2 | 95% |
| **RF Power Conducted Spurious Emissions** | ±2.25 dB | 2 | 95% |
| **RF Power Radiated Emissions** | ±3.01 dB | 2 | 95% |

### 3.2 Modification Record

There were no modifications required for compliance.

# 4 General Information

## 4.1 Description of Test Modes

**FOR 5180 ~ 5320MHz**

1 channels are provided for 802.11a, 802.11n (HT20):

| Channel | Frequency |
|---|---|
| 60 | 5300 MHz |

**FOR 5500 ~ 5700MHz**

1 channels are provided for 802.11a, 802.11n (HT20):

| Channel | Frequency |
|---|---|
| 100 | 5500 MHz |

## 4.2 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

| ID | Product | Brand | Model No. | Serial No. | FCC ID | Remarks |
|---|---|---|---|---|---|---|
| A. | Switch | TP-LINK | AX3000 | 2224282000899 | 2AXJ4AX3000PRO | N/A |
| B. | Laptop | Acer | Aspire A315-51 | N/A | N/A | N/A |
| C. | Switching Power Adapter for Switch | Zebra | FSP025-DYAA3 | N/A | N/A | N/A |
| D. | Switching Power Adapter for EUT | FSP | FSP045-D3MR3 | H00000093 | N/A | N/A |

Note:
1. All power cords of the above support units are non-shielded (1.8m).
2. Items E~F acted as communication partners to transfer data.

| ID | Descriptions | Qty. | Length (m) | Shielding (Yes/No) | Cores (Qty.) | Remarks |
|---|---|---|---|---|---|---|
| 1. | - | - | - | - | 0 | - |

Note: The core(s) is(are) originally attached to the cable(s).

## 4.3 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standard:

**FCC 15.407**
**RSS 247 Issue 2**

All test items have been performed and recorded as per the above standard.

# 5 In-Service Monitoring: Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period

## 5.1 Limit of In-Service Monitoring

The EUT has In-Service Monitoring function to continuously monitor the radar signals, If radar is detected, it must leave the channel (Shutdown). The Channel Move Time to cease all transmissions on the current Channel upon detection of a Radar Waveform above the DFS Detection Threshold within 10 sec. The total duration of *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* changes (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.

Non-Occupancy Period time is 30 minute during which a Channel will not be utilized after a Radar Waveform is detected on that Channel. The non-associated Client Beacon Test is during the 30 minutes observation time. The EUT should not make any transmissions in the DFS band after EUT power up.

## 5.2 Test Procedures

1. The radar pulse generator is setup to provide a pulse at frequency that the Master and Client are operating. A type 0 radar pulse with a 1us pulse width and a 1428 us PRI is used for the testing.
2. The vector signal generator is adjusted to provide the radar burst (18 pulses) at a level of approximately -62dBm at the antenna of the Master device.
3. A trigger is provided from the pulse generator to the DFS monitoring system in order to capture the traffic and the occurrence of the radar pulse.
4. A U-NII device operating as a Client Device will associate with the Master at Channel. The MPEG file "TestFile.mpg" specified by the FCC is streamed from the "file computer" through the Master to the Client Device and played in full motion video using Media Player Classic Ver.

   6.4.8.6 in order to properly load the network for the entire period of the test.
5. 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. At time T0 the Radar Waveform generator sends a Burst of pulse of the radar waveform at Detection Threshold + 1dB.
6. Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel. Measure and record the transmissions from the EUT during the observation time (Channel Move Time). One 12 seconds plot is reported for the Short Pulse Radar Types 0. The plot for the Short Pulse Radar Types start at the end of the radar burst. The Channel Move Time will be calculated based on the zoom in 600ms plot of the Short Pulse Radar Type.
7. Measurement of the aggregate duration of the Channel Closing Transmission Time method. With the spectrum analyzer set to zero span tuned to the center frequency of the EUT operating channel at the radar simulated frequency, peak detection, and max hold, the dwell time per bin is given by: **Dwell (0.4ms)= S (12000ms) / B (30000)**; where Dwell is the dwell time per spectrum analyzer sampling bin, S is the sweep time and B is the number of spectrum analyzer sampling bins. An upper bound of the aggregate duration of the intermittent control signals of Channel Closing Transmission Time is calculated by: **C (ms)= N X Dwell (0.4 ms)**; where C

is the ClosingTime, N is the number of spectrum analyzer sampling bins (intermittent control signals) showing a U-NII transmission and Dwell is the dwell time per bin.

8. Measure the EUT for more than 30 minutes following the channel move time to verify that no transmissions or beacons occur on this Channel.
9. The test frequency , bandwidth and data rate as following table:

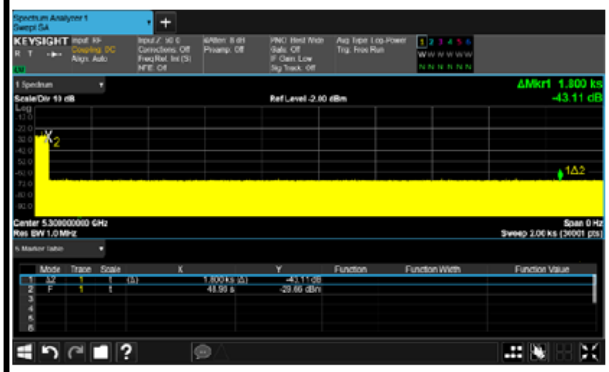
| BW / Channel | Test Data Rate |
|---|---|
| **20 MHz / 5300MHz (CH60)** | MCS0 |
| **20 MHz / 5500MHz (CH140)** | MCS0 |

### 5.3 Result of Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period for Client Beacon Test

| BW / Channel | Test Item | Test Result | Limit | Pass/Fail |
|---|---|---|---|---|
| **20MHz / 5300MHz (CH60)** | Channel Move Time | 643ms | < 10s | Pass |
| | Channel Closing Transmission Time | 200ms + 29.2 ms | < 260ms | Pass |
| | Non-Occupancy Period | ≥ 30 | ≥ 30 min | Pass |
| **BW / Channel** | **Test Item** | Test Result | Limit | Pass/Fail |
| **20MHz / 5500MHz (CH100)** | Channel Move Time | 686.4ms | < 10s | Pass |
| | Channel Closing Transmission Time | 200ms + 26 ms | < 260ms | Pass |
| | Non-Occupancy Period | ≥ 30 | ≥ 30 min | Pass |

**Note:** The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning ofthe 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 seconds period. The aggregate duration ofcontrol signals will not count quiet periods in between transmissions.

## 5.4 Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period for Client Beacon Test Plots

| <20 MHz / 5300MHz (CH60)> In-Service Monitoring | |
|---|---|
| **Channel Move Time &**<br>**Channel Closing Transmission Time** | |
|  | |
| **Non-Occupancy Period** | **Non-associated test**<br>**Master was off. (beacon test)** |
|  |  |

**Note:**

Dwell (0.4 ms)= Sweep Time (12000 ms) / Sweep Point Bins (30000)

Channel Closing Transmission Time (203.2 + 29.3 ms) = 200 + Number (73) X Dwell (0.4 ms) < 260ms

| <20 MHz / 5500MHz (CH100)> In-Service Monitoring | |
|---|---|
| **Channel Move Time & Channel Closing Transmission Time** | |
|  | |
| **Non-Occupancy Period** | **Non-associated test**<br>**Master was off. (beacon test)** |
|  |  |

**Note:**

Dwell (0.4 ms)= Sweep Time (12000 ms) / Sweep Point Bins (30000)

Channel Closing Transmission Time (197.6 + 28 ms) = 200 + Number (65) X Dwell (0.4 ms) < 260ms

**EUT Data Traffic**

| <20 MHz / 5300MHz (CH60)> Data traffic |
| --- |
|  |
| <20 MHz / 5500MHz (CH100)> Data traffic |
|  |

--- END ---