

# TEST REPORT

of

FCC Part 15 Subpart E §15.407

FCC ID: TQ8-AVB30D9AN

Equipment Under Test : DISPLAY CAR SYSTEM  
 Model Name : AVB30D9AN (Alt. : AVBA0D9AN)  
 Applicant : Hyundai MOBIS Co., Ltd.  
 Manufacturer : Hyundai MOBIS Co., Ltd.  
 Date of Test(s) : 2015.04.02 ~ 2015.04.20  
 Date of Issue : 2015.04.22

In the configuration tested, the EUT complied with the standards specified above.

Tested By:



Date:

2015.04.22

Jinhyoung Cho

Approved By:



Date:

2015.04.22

Hyunchoe You

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## 1. General information

### 1.1. Testing laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- Wireless Div. 2FL, 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 435-837

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>.

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### 1.2. Details of applicant

Applicant : Hyundai MOBIS Co., Ltd.

Address : 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, Korea

Contact Person : Choi, Seung-Hoon

Phone No. : + 82 31 260 0098

### 1.3. Description of EUT

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kind of Product       | DISPLAY CAR SYSTEM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Model Name            | AVB30D9AN (Alt. : AVBA0D9AN)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Power Supply          | DC 14.4 V (Vehicle Battery)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Frequency Range       | 2 402 MHz ~ 2 480 MHz (BT),<br>2 412 MHz ~ 2 462 MHz (11b/g/n_HT20),<br>5 745 MHz ~ 5 825 MHz (Band 3: 11a/n_HT20, 11ac_VHT20),<br>5 755 MHz ~ 5 795 MHz (Band 3: 11n_HT40, 11ac_VHT40),<br>5 775 MHz (Band 3: 11ac_VHT80),<br>5 180 MHz ~ 5 240 MHz (Band 1: 11a/n_HT20, 11ac_VHT20),<br>5 190 MHz ~ 5 230 MHz (Band 1: 11n_HT40, 11ac_VHT40),<br>5 210 MHz (Band 1: 11ac_VHT80),<br>5 260 MHz ~ 5 320 MHz (Band 2A: 11a/n_HT20, 11ac_VHT20),<br>5 270 MHz ~ 5 310 MHz (Band 2A: 11n_HT40, 11ac_VHT40),<br>5 290 MHz (Band 2A: 11ac_VHT80),<br>5 500 MHz ~ 5 700 MHz (Band 2C: 11a/n_HT20, 11ac_VHT20),<br>5 510 MHz ~ 5 670 MHz (Band 2C: 11n_HT40, 11ac_VHT40),<br>5 530 MHz (Band 2C: 11ac_VHT80) |
| Modulation Technique  | DSSS, OFDM, GFSK, $\pi/4$ DQPSK, 8DPSK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Number of Channels    | 79 channel (BT), 11 channel (11b/g/n_HT20),<br>5 channel (Band 3: 11a/n_HT20, 11ac_VHT20),<br>2 channel (Band 3: 11n_HT40, 11ac_VHT40), 1 channel (Band 3: 11ac_VHT80),<br>4 channel (Band 1: 11a/n_HT20, 11ac_VHT20),<br>2 channel (Band 1: 11n_HT40, 11ac_VHT40), 1 channel (Band 1: 11ac_VHT80),<br>4 channel (Band 2A: 11a/n_HT20, 11ac_VHT20),<br>2 channel (Band 2A: 11n_HT40, 11ac_VHT40), 1 channel (Band 2A: 11ac_VHT80),<br>8 channel (Band 2C: 11a/n_HT20, 11ac_VHT20),<br>3 channel (Band 2C: 11n_HT40, 11ac_VHT40), 1 channel (Band 2C: 11ac_VHT80)                                                                                                                                      |
| Operation Temperature | -20 °C ~ 70 °C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Antenna Type          | Internal type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Antenna Gain          | 2 402 MHz ~ 2 480 MHz: 2.29 dB i,<br>2 412 MHz ~ 2 462 MHz: 4.67 dB i,<br>5 180 MHz ~ 5 320 MHz: 2.89 dB i,<br>5 500 MHz ~ 5 700 MHz: 2.51 dB i,<br>5 745 MHz ~ 5 825 MHz: 5.78 dB i                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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#### 1.4. Declaration by the manufacturer

- EUT is SLAVE without Radar Detection and TPC.
- EUT is not supported TDWR(5.6 - 5.65 GHz) band.

#### 1.5. Test equipment list

| Equipment         | Manufacturer     | Model      | S/N        | Cal Date      | Cal Interval | Cal Due.      |
|-------------------|------------------|------------|------------|---------------|--------------|---------------|
| Spectrum Analyzer | R&S              | FSV30      | 100768     | Mar. 24, 2015 | Annual       | Mar. 24, 2016 |
| Signal Generator  | R&S              | SMBV100A   | 255834     | Jun. 25, 2014 | Annual       | Jun. 25, 2015 |
| Attenuator        | AEROFLEX / INMET | 18N-20 dB  | 2          | Mar. 13, 2015 | Annual       | Mar. 13, 2016 |
| Power Splitter    | Mini-Circuits    | ZFSC-2-10G | 001        | Jun. 10, 2014 | Annual       | Jun. 10, 2015 |
| Power Splitter    | Mini-Circuits    | ZFSC-2-10G | 002        | Jun. 10, 2014 | Annual       | Jun. 10, 2015 |
| DC Power Supply   | Agilent          | U8002A     | MY50060028 | Mar. 23, 2015 | Annual       | Mar. 23, 2016 |

#### ► Support equipment

| Description           | Manufacturer        | Model            | Serial Number / FCC ID          |
|-----------------------|---------------------|------------------|---------------------------------|
| Access Point( master) | Cisco               | AIR-AP1262N-K-K9 | FTX1553K03A<br>FCC ID:LDK102073 |
| Notebook              | LG Electronics Inc. | LGE-DMLGA51      | 012QTHL022697                   |

#### 1.6. Summary of test result

The EUT has been tested according to the following specifications:

| APPLIED STANDARD:FCC Part15 subpart E § 15.407 |                                                                                         |          |
|------------------------------------------------|-----------------------------------------------------------------------------------------|----------|
| Section in FCC 15                              | Test Item                                                                               | Result   |
| 15.407(h)                                      | DFS<br>-Channel closing transmission time<br>-Channel move time<br>-Non occupied period | Complied |

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### 1.7. Test report revision

| Revision | Report number        | Date of Issue | Description |
|----------|----------------------|---------------|-------------|
| 0        | F690501/RF-RTL008628 | 2015.04.22    | Initial     |

### 1.8. Alternative models

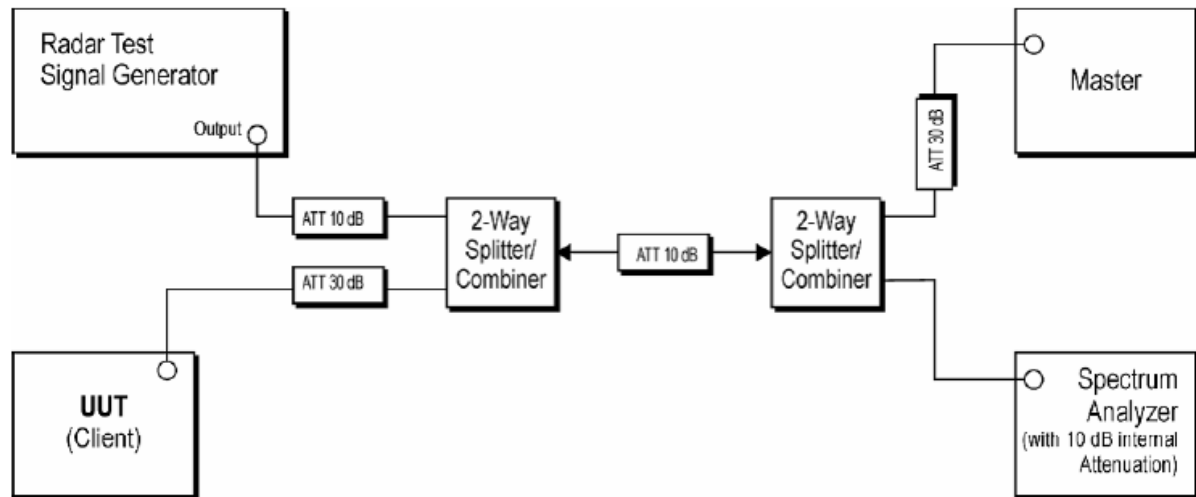
| Model name | Information                                                                       |
|------------|-----------------------------------------------------------------------------------|
| AVB30D9AN  | - Basic model.                                                                    |
| AVBA0D9AN  | - Same as the basic model, but it has different model name for marketing purpose. |

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## 2. DFS (Dynamic Frequency Selection)

### 2.1. System overview

#### 2.1.1. Set up of EUT



The radar signal generation equipment consists of a vector signal generator

The signal monitoring equipment consists of a spectrum analyzer set to display 8 001 bins on the horizontal axis. The time domain resolution is 2 msec/bin with a 16 second sweep time, meeting the 10 second short pulse reporting criteria. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

The Slave is tested separately for compliance with the Channel Shutdown requirements, for the situation when the Slave device vacates the channel in response to detection of a radar by the Master.

All tests were performed at a channel center frequency of 5 310 MHz and 5 510 MHz. Measurements were performed using conducted test methods.

Stream the MPEG test file from the Master Device to the Client Device on the test Channel for the entire period of the test.

The designated MPEG test file and instructions are located at : <http://ntiacsd.ntia.doc.gov/dfs/>

The test file name is 'TestFile.mpg.'

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## 2.2 Limit

§15.407 (h) and FCC 06-96 APPENDIX "COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVICES OPERATING IN THE 5 250 - 5 350 MHz AND 5 470 - 5 725 MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION

**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 requirement for devices with multiple bandwidth modes | Master Device or Client with Radar Detection | Client Without Radar Detection                       |
|------------------------------------------------------------------|----------------------------------------------|------------------------------------------------------|
| U-NII Detection Bandwidth and Statistical Performance Check      | All BT modes must be tested                  | Not required                                         |
| Channel Move Time and Channel Closing Transmission Time          | Test using widest BT 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.

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**Table 3: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection**

| Maximum Transmit Power                                                          | Value (See Note 1, 2, and 3) |
|---------------------------------------------------------------------------------|------------------------------|
| EIRP $\geq$ 200 milliwatt                                                       | -64 dB m                     |
| EIRP < 200 milliwatt and<br>power spectral density < 10 dB m/MH                 | -62 dB m                     |
| EIRP < 200 milliwatt that do not meet the power spectral<br>density requirement | -64 dB m                     |

**Note 1:** This is the level at the input of the receiver assuming a 0 dB i receive antenna.

**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.

**Note3:** EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

#### KDB 905462 D03 Client Without DFS New Rules v01r01 : UNII client devices without radar detection

- The guidance provided in Section 8 (DFS Test Report Guidelines) in KDB Publication 905462 D02
  - Test results demonstrating an associated client link is established with the master on a test frequency; if a client device operates in a “listen only” mode to a master without formally “associating” with it the test report must include tests for such modes.
  - The devices must be tested with a master device operating in the same band and operation modes.
  - If two client devices can communicate directly with each other while maintaining an association with a master or if the client operates on a frequency band while “listening” to a master, such modes must be tested with the master device active.
  - The client and DFS-certified master device are associated, and a movie can be streamed as specified in the DFS Order for a non-occupancy period test.
  - The test frequency has been monitored to ensure no transmission of any type has occurred for 30 minutes.
- Note: 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.

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**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.<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.

**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.

**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.

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**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<br>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 | $\text{Roundup} \left\{ \left( \frac{1}{360} \right) \cdot \left( \frac{19 \cdot 10^6}{\text{PRI}_{\mu\text{sec}}} \right) \right\}$ | 60%                                        | 30                       |
| 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 6 – Long Pulse Radar Test Waveform**

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

**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                       |

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### 2.3. Description of EUT

The EUT operates over the band 2A “5 260 MHz ~ 5 320 MHz (11a/n\_HT20, 11ac\_VHT20), 5 270 MHz ~ 5 310 MHz (11n\_HT40, 11ac\_VHT40), 5 290 MHz (11ac\_VHT80)” and band 2C “5 500 MHz ~ 5 700 MHz (11a/n\_HT20, 11ac\_VHT20), 5 510 MHz ~ 5 670 MHz (11n\_HT40, 11ac\_VHT40), 5 530 MHz (11ac\_VHT80)” ranges.

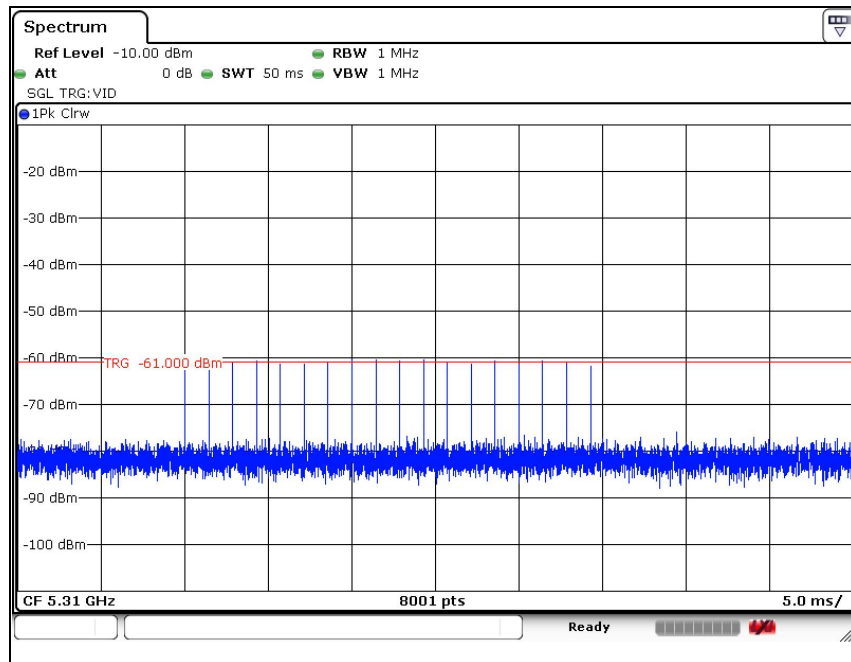
The rated output power of the client unit is < 200 milliwatt. Therefore the required interference threshold level is -61 dB m.

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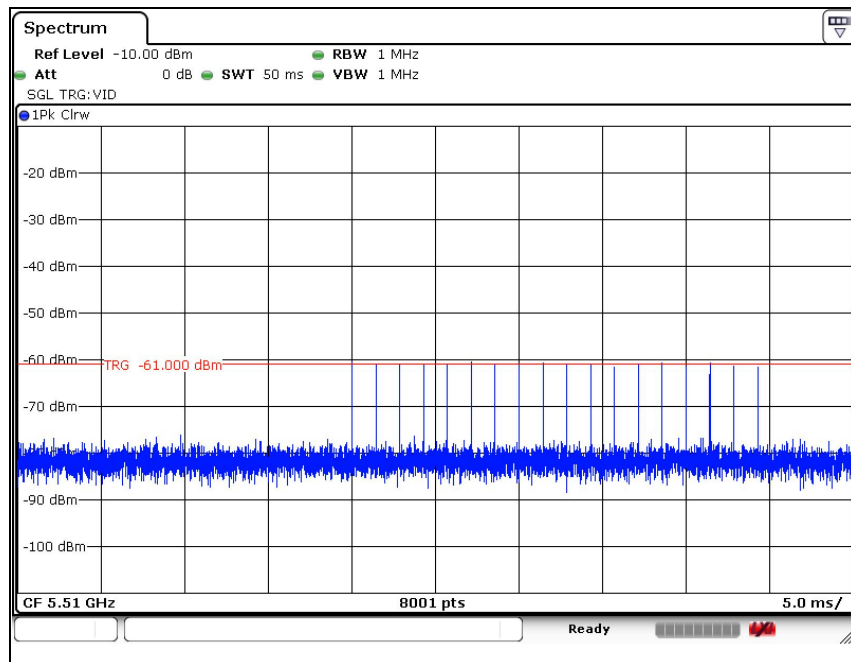
## PLOTS OF RADAR WAVEFORMS AND WLAN TRAFFIC

### Plot of radar waveform type 1

5 310 MHz



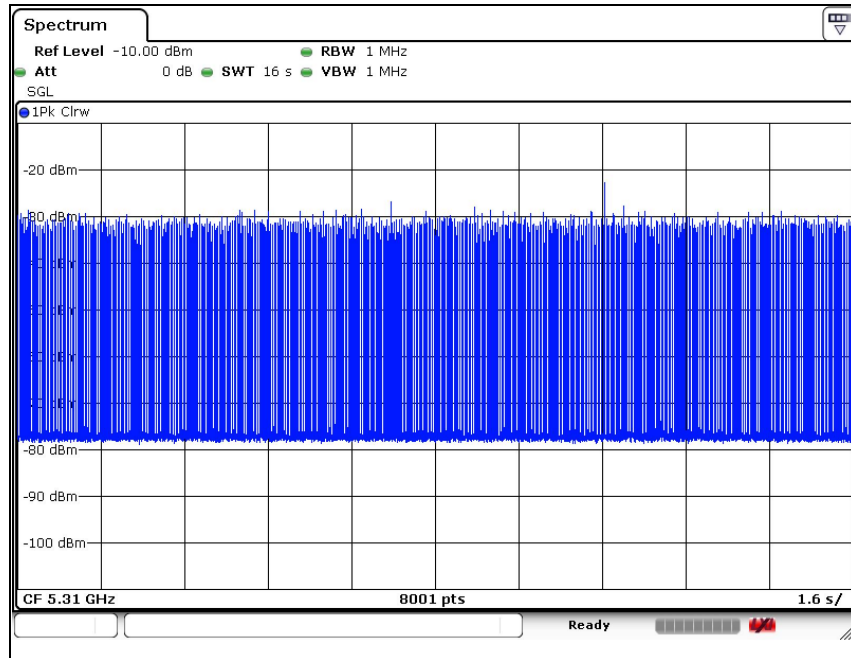
5 510 MHz



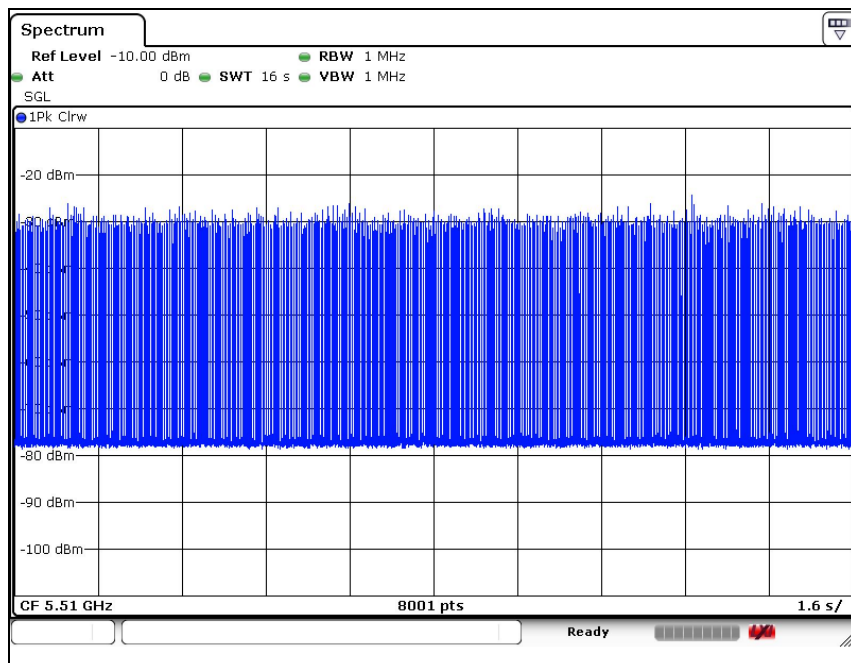
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## Plot of LAN traffic

5 310 MHz



5 510 MHz



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The reference maker is set after 200 ms from the end of Last radar pulse.

The delta is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time within the 10 sec.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time= (Number of analyzer bins showing transmission)\*(dwell time per bin)

The observation period over which the aggregated time is calculated begins at (Reference Maker) and ends no earlier than (Reference Maker +10 sec)

### 2.3. Test result

| Frequency (MHz) | Channel Move Time (sec)                            | Limit              |
|-----------------|----------------------------------------------------|--------------------|
| 5 310           | 3.476                                              | Not exceed 10 sec  |
| 5 510           | 3.508                                              |                    |
| Frequency (MHz) | Aggregate channel closing transmission time (msec) | Limit              |
| 5 310           | 52                                                 | Not exceed 60 msec |
| 5 510           | 4                                                  |                    |

Aggregate channel closing transmission time

[16s (sweep time) / 8001 (sweep point)] × The number of channel bin from 200 ms at the end of radar pulse.

5 310 MHz: (16 / 8001) × 26 = 52 ms

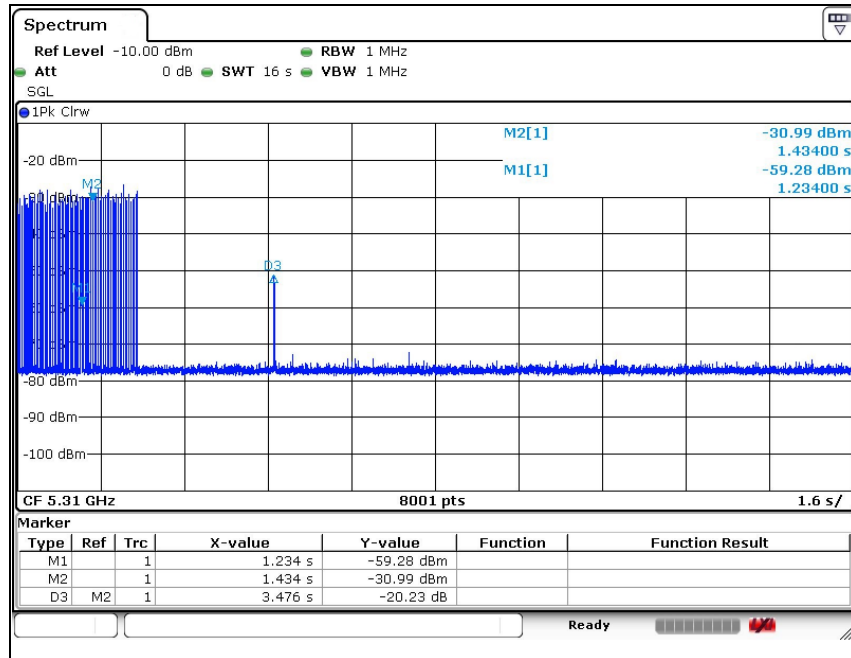
5 510 MHz: (16 / 8001) × 2 = 4 ms

| Frequency (MHz) | Non-occupancy period (min) | Limit                      |
|-----------------|----------------------------|----------------------------|
| 5 310           | Above 30                   | Not be less than 30 minute |
| 5 510           | Above 30                   |                            |

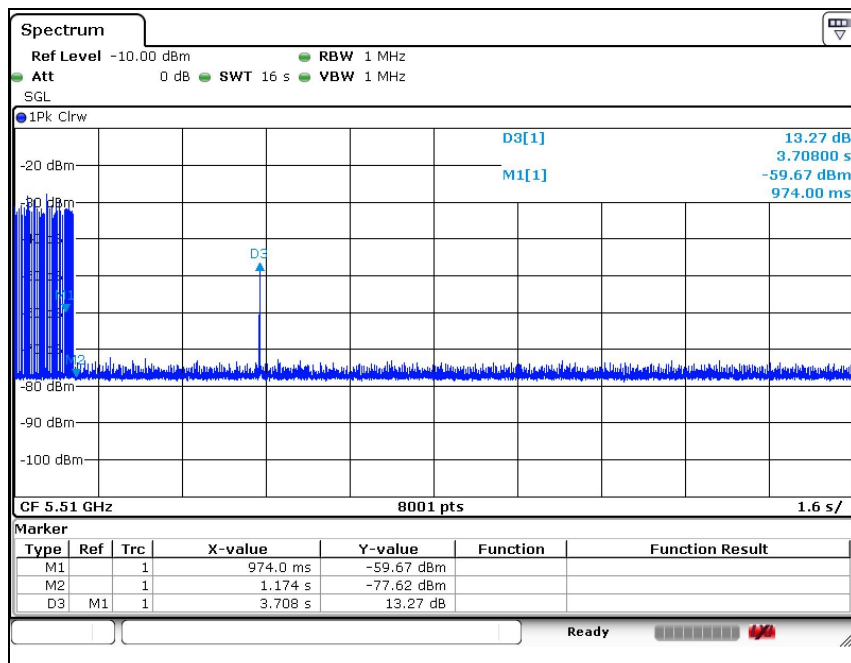
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## Plot of channel move time & aggregate channel closing transmission time

5 310 MHz



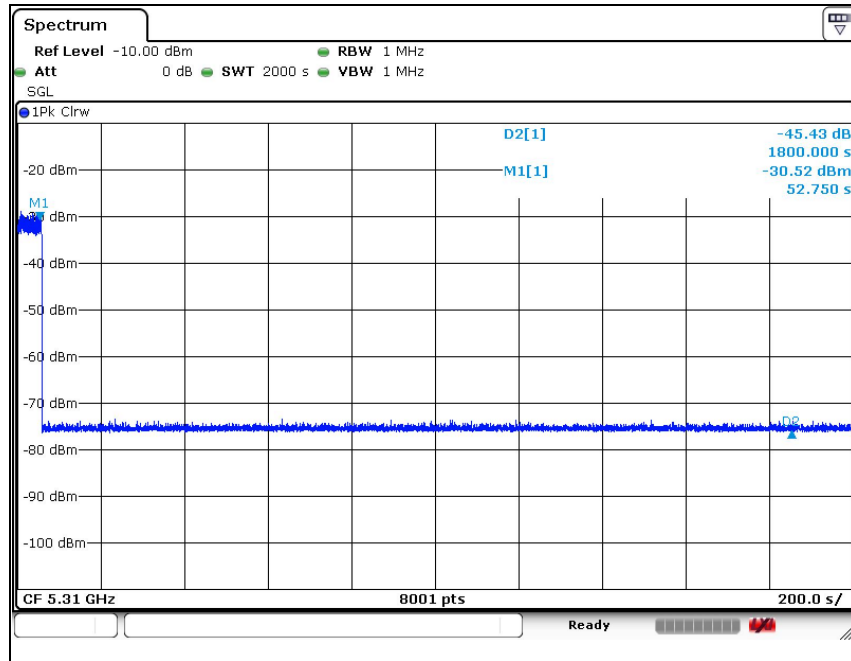
5 510 MHz



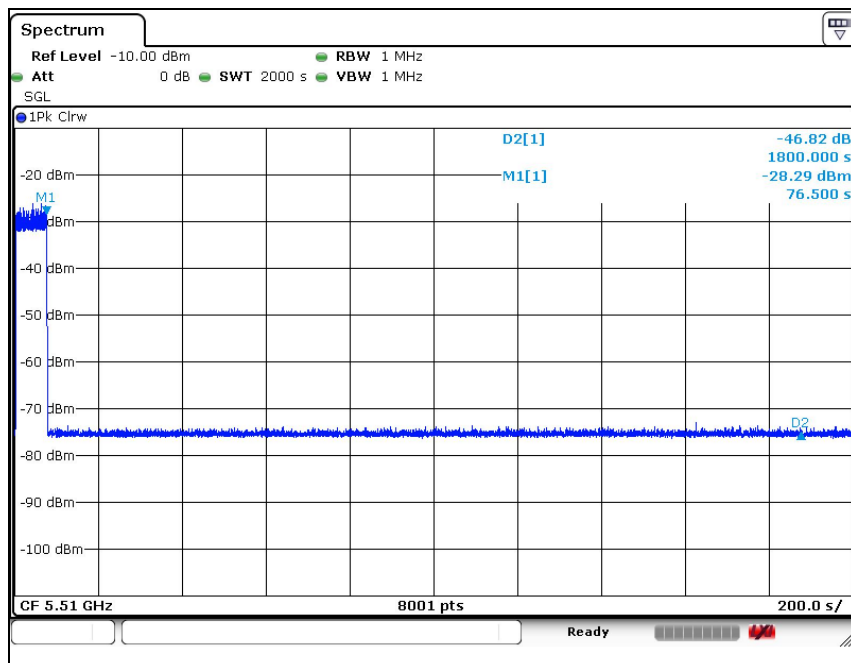
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## Plot of Non-occupancy period

5 310 MHz



5 510 MHz



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