# EMI TEST REPORT

## Test Report No. : 30GE0098-YK-M-R1

| | | |
|---|---|---|
| **Applicant** | : | **RICOH COMPANY, LTD.** |
| **Type of Equipment** | : | **Option(s) for Radiocommunications** |
| **Model No.** | : | **R-WL54C1N** |
| **FCC ID** | : | **BBP-WLRWL542** |
| **Test regulation** | : | **FCC Part 15 Subpart E: 2010<br>Section 15.407(DFS test only)** |
| **Test Result** | : | **Complied** |

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
6. This report is a revised version of 30GE0098-YK-M. 30GE0098-YK-M is replaced with this report.

**Date of test** : March 5, 2010

**Tested by** : Tatsuya Arai
Engineer of EMC Service

**Approved by** : Ichiro Isozaki
Leader of EMC Services

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**CONTENTS** **PAGE**

**SECTION 1: Customer information** ..... 3
**SECTION 2: Equipment under test (E.U.T.)** ..... 3
**SECTION 3: Scope of Report** ..... 4
**SECTION 4: Test specification, procedures & results** ..... 4
**SECTION 5: Operation of E.U.T. during testing** ..... 9
**SECTION 6: In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time** ..... 16
**SECTION 7: In-Service Monitoring for Non-Occupancy Period** ..... 19
**APPENDIX 1: Photographs of test setup** ..... 21
**APPENDIX 2: Data of DFS test** ..... 22
**Parameter Data for Radar Type 5** ..... 22
**APPENDIX 3:Test instruments** ..... 23

# SECTION 1: Customer information

| | | |
|---|---|---|
| Company Name | : | RICOH COMPANY, LTD. |
| Address | : | 1-3-6 Nakamagome, Ohta-ku, Tokyo, 143-8555 Japan |
| Telephone Number | : | +81-3-6890-3804 |
| Facsimile Number | : | +81-3-5742-5489 |
| Contact Person | : | Kazuki Kitazawa |

# SECTION 2: Equipment under test (E.U.T.)

## 2.1 Identification of E.U.T.

| | | |
|---|---|---|
| Type of Equipment | : | Option(s) for Radiocommunications |
| Model No. | : | R-WL54C1N |
| Serial No. | : | 911S0345 |
| Rating | : | DC3.3V |
| Country of Mass-production | | Japan |
| Condition of EUT | : | Production prototype<br>(Not for Sale: This sample is equivalent to mass-produced items.) |
| Modification of EUT | : | No modification by the test lab. |
| Receipt Date of Sample | : | March 5, 2010 |

## 2.2 Product description

Model: R-WL54C1N (referred to as the EUT in this report) is a Option(s) for Radiocommunications.

| | | |
|---|---|---|
| Equipment type | : | Transceiver |
| Frequency of operation | : | [11b/g] 2412-2462MHz<br>[11a] 5180-5320MHz |
| Clock frequency | : | 11MHz, 20MHz |
| Bandwidth & channel spacing | : | [11b/g] 22MHz & 5MHz<br>[11a] 18MHz & 20MHz |
| Type of modulation | : | IEEE802.11a: OFDM (BPSK, QPSK, 16QAM, 64QAM)<br>IEEE802.11b: DSSS (DBPSK, DQPSK, CCK)<br>IEEE802.11g: OFDM (BPSK, QPSK, 16QAM, 64QAM) |
| Antenna type | : | Chip<br>Antenna 1: Transmitting & Receiving<br>Antenna 2: Receiving only |
| Antenna connector type | : | None |
| Antenna gain | : | [11b/g] max +1dBi<br>[11a] max +4dBi |
| ITU code | : | D1D, G1D |
| Operation temperature range | : | 0 ~ +65 deg.C. |

EUT has a similar model, R-WL54M1N.
Differences between R-WL54C1N and R-WL54M1N are as follows.

| Model Name | Antenna Type | Antenna Gain |
|---|---|---|
| R-WL54C1N | Chip | [11b/g] max +1dBi<br>[11a] max +4dBi |
| R-WL54M1N | Monopole | [11b/g] max +3dBi<br>[11a] max +4dBi |

FCC 15.31 (e)
The RF Module has its own regulator.
The RF Module is constantly provided voltage (DC3.3V, 2.9V, 2.8V, and 1.2V) through its own regulator regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC Part15.203 Antenna requirement
The antenna is not removable from the EUT. Therefore, the equipment complies with the antenna requirement of Section 15.203.

## SECTION 3: Scope of Report

The EUT has the channels from 5180 to 5320MHz.
This report only covers DFS requirement subject to 5250-5350MHz bands, as specified by the following referenced procedures.

## SECTION 4: Test specification, procedures & results

### 4.1 Test Specificationv

| | | |
|---|---|---|
| Test Specification | : | FCC Part15 Subpart E: 2010, final revised on January 22, 2010 and effective March 1, 2010 |
| Title | : | FCC 47CFR Part15 Radio Frequency Device<br>Subpart E Unlicensed National Information Infrastructure Devices<br>Section 15.407 General technical requirements |
| Test Specification | : | FCC 06-96 APPENDIX |
| Title<br>UNLICENSED- | : | COMPLIANCE MEASUREMENT PROCEDURES FOR<br>NATIONAL INFORMATION INFRASTRUCTURE DEVICES OPERATING IN THE 5250-5350 MHz AND 5470-5725MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION |

## 4.2 Procedures and results

**Table 1: Applicability of DFS Requirements**

| Requirement | Operating Mode<br>Client without Radar Detection | Test Procedures & Limits | Deviation | Results |
|---|---|---|---|---|
| U-NII Detection Bandwidth | Not required | FCC 06-96 Appendix 7.8.1 | N/A | N/A |
| Initial Channel Availability Check Time | Not required | FCC15.407 (h)<br>FCC 06-96 Appendix 7.8.2.1<br>RSS-210 A9.4 | N/A | N/A |
| Radar Burst at the Beginning of the Channel Availability Check Time | Not required | FCC15.407 (h)<br>FCC 06-96 Appendix 7.8.2.2<br>RSS-210 A9.4 | N/A | N/A |
| Radar Burst at the End of the Channel Availability Check Time | Not required | FCC15.407 (h)<br>FCC 06-96 Appendix 7.8.2.3<br>RSS-210 A9.4 | N/A | N/A |
| In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time | Yes | FCC15.407 (h)<br>FCC 06-96 Appendix 7.8.3<br>RSS-210 A9.4 | N/A | Complied |
| In-Service Monitoring for Non-Occupancy period | Yes * | FCC15.407 (h)<br>FCC 06-96 Appendix 7.8.3<br>RSS-210 A9.4 | N/A | Complied |
| Statistical Performance Check | Not required | FCC15.407 (h)<br>FCC 06-96 Appendix 7.8.4 | N/A | N/A |

*Although this test was not required in FCC 06-96, it was performed as additional test.

**Table 2: DFS Detection Thresholds for Master Devices and Client Devices With Radar**

| Maximum Transmit Power | Value (See Notes 1 and 2) |
|---|---|
| ≥ 200 milliwatt | -64 dBm |
| < 200 milliwatt | -62 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. | |

**Table 3 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 80% of the U-NII 99% transmission power bandwidth<br>See Note 3 |

**Note 1:** The instant that the Channel Move Time and the Channel Closing Transmission Time begins is as follows:

- For the Short Pulse Radar Test Signals this instant is the end of the *Burst*.
- For the Frequency Hopping radar Test Signal, this instant is the end of the last radar *Burst* generated
- For the Long Pulse Radar Test Signal this instant is the end of the 12 second period defining the *Radar Waveform*.

**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 signal will not count quiet periods in between transmissions.

**Note 3:** During the U-NII Detection Bandwidth detection test, radar type 1 is used and for each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

**Table 4 Short Pulse Radar Test Waveform**

| Radar Type | Pulse Width (µsec) | PRI (µsec) | Number of Pulses | Minimum Percentage of Successful Detection | Minimum Number of Traials |
|---|---|---|---|---|---|
| 1 | 1 | 1428 | 18 | 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 (Rader Types 1-4) | | | | 80% | 120 |

**Table 5 Long Pulse Radar Test Waveform**

| Radar Type | Pulse Width (µsec) | Chip 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 6 Frequency Hopping Radar Test Waveform**

| Radar Type | Pulse Width (µsec) | PRI (µsec) | Pulse per Hop (kHz) | 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 |

### 4.3 Test Location

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JAB Accreditation No. : RTL02610

No.1/ No.2/ No.3 anechoic chamber has been fully described in a report submitted to FCC office, and accepted on April 17, 2009 (Registration No.: 697847).
IC Registration No. : 2973D-1 (No1 anechoic chamber)
2973D-2 (No2 anechoic chamber)
2973D-3 (No3 anechoic chamber)

| Test room | Width x Depth x Height (m) | Test room | Width x Depth x Height (m) |
|---|---|---|---|
| No.1<br>Semi-anechoic chamber | 20.6 x 11.3 x 7.65<br>Maximum measurement distance: 10m | No.1 Shielded room | 6.8 x 4.1 x 2.7 |
| No.2<br>Semi-anechoic chamber | 20.6 x 11.3 x 7.65<br>Maximum measurement distance: 10m | No.2 Shielded room | 6.8 x 4.1 x 2.7 |
| No.3<br>Semi-anechoic chamber | 12.7 x 7.7 x 5.35<br>Maximum measurement distance: 5m | No.3 Shielded room | 6.3 x 4.7 x 2.7 |
| No.4<br>Full-anechoic chamber | 8.1 x 5.1 x 3.55 | No.4 Shielded room | 4.4 x 4.7 x 2.7 |
| | | No.5 Shielded room | 7.8 x 6.4 x 2.7 |
| | | No.6 Shielded room | 7.8 x 6.4 x 2.7 |

### 4.4 Test set up, Data of DFS test, and Test instruments of DFS

Refer to APPENDIX 1 to 3.

# SECTION 5: Operation of E.U.T. during testing

## 5.1 Operating Modes

The EUT, which is a Client Device without Radar detection capability, operates over the 5260-5320MHz.

The highest power level is 15.91dBm EIRP in the 5250-5350MHz band.
The lowest power level is 15.29dBm EIRP in the 5250-5350MHz band.

Power level(EIRP) of the EUT[dBm]

| Antenna | Antenna Gain [dBi] | 5250-5350MHz Band | |
|---|---|---|---|
| | | Output Power (Min) | Output Power(Max) |
| chip antenna *1) | 4.00 | 15.29 | 15.91 |
| monopole antenna *2) | 4.00 | 15.35 | 15.57 |

*1) Refer to 30GE0098-YK-B, FCC Part 15E (FCC 15.407) report for other parts than DFS.
*2) Refer to 30GE0098-YK-D, FCC Part 15E (FCC 15.407) report for other parts than DFS.

The lowest antenna assembly gain of all available antenna assemblies is 4.00dBi.

The EUT uses one transmitter connected to two 50-ohm coaxial antenna ports via a diversity switch. Both antenna ports are connected to the test system via a power divider to perform conducted tests.

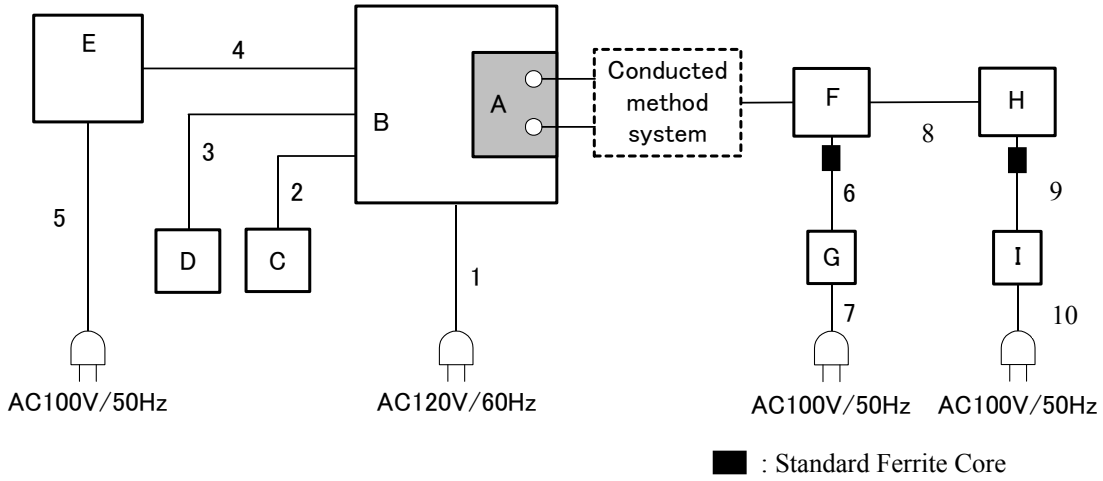
WLAN traffic is generated by streaming the MPEG Test file "6 ½ Magic Hours" from the Master to the Client in full motion video mode using the media player with the V2.61 Codec package.

The EUT utilizes the 802.11a architecture, with a nominal channel bandwidth of 18MHz.

The FCC ID for the Master Device used with EUT for DFS testing is LDK102061.

The rated output power of the Master unit is >200mW(23dBm). Therefore the required interference threshold level is –64 dBm. After correction for antenna gain and procedural adjustments, the required conducted threshold at the antenna port is –64 + 1 + 3.5=-59.5 dBm (threshold level + additional 1dB + antenna gain).

## 5.2 Configuration and peripherals




**Description of EUT and Support equipment**

| No. | Item | Model number | Serial number | Manufacturer | Remarks |
|---|---|---|---|---|---|
| A | Option(s) for Radiocommunications | R-WL54C1N | 911S0345 | RICOH | EUT |
| B | PC | - | - | RICOH | - |
| C | Mouse | PN96483 | 5024505-10000 | Microsoft | - |
| D | Keyboard | SKB-112SL | 040201623 | SANWA SUPPLY | - |
| E | Monitor | RDT178V | 43316255TJ | MITSUBISHI | - |
| F | Wireless LAN access point (Master Device) | AIR-AP1252AG-A-K9 | FTX130390F4 | Cisco Systems | FCC ID: LDK102061 |
| G | AC Adapter | EADP-45BB | DTH1241908P | Cisco Systems | - |
| H | Note PC | DELL Vostro V1510 | 29090510205 | Dell | - |
| I | ACAdapter | LA65NS1-00 | 71615-93B-385D | Dell | - |

**List of cables used**

| No. | Name | Length (m) | Shield | |
|---|---|---|---|---|
| | | | Cable | Connector |
| 1 | PC AC Power Cable | 2.5 | Unshielded | Unshielded |
| 2 | Mouse Cable | 1.5 | Unshielded | Unshielded |
| 3 | Keyboard Cable | 1.9 | Unshielded | Unshielded |
| 4 | PC Monitor RGB Cable | 2.0 | Unshielded | Unshielded |
| 5 | PC Monitor AC Power Cable | 1.8 | Unshielded | Unshielded |
| 6 | Access Point DC Power Cable | 1.8 | Unshielded | Unshielded |
| 7 | Access Point AC Power Cable | 2.0 | Unshielded | Unshielded |
| 8 | NIC Cable | 3.0 | Unshielded | Unshielded |
| 9 | Note PC DC Power Cable | 1.8 | Unshielded | Unshielded |
| 10 | Note PC AC Power Cable | 0.7 | Unshielded | Unshielded |

## 5.3 Test and Measurement System

**SYSTEM OVERVIEW**

The measurement system is based on a conducted test method.

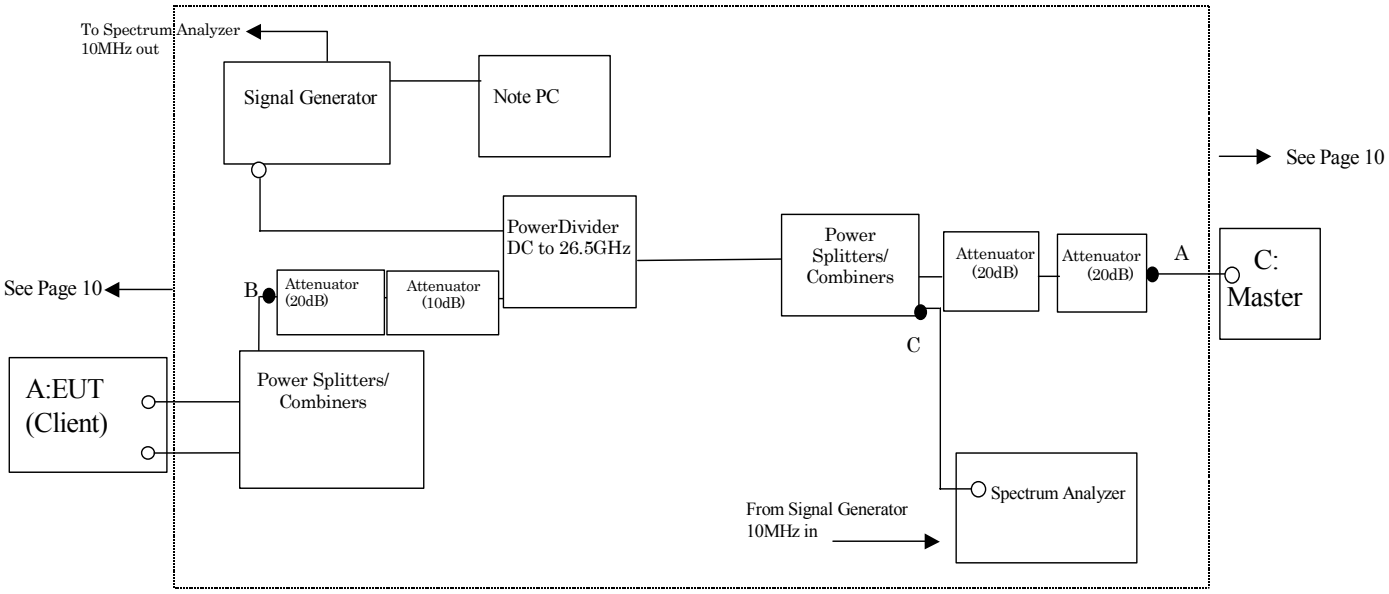
The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution. The short pulse types 2, 3, and 4, the long pulse type 5, and the frequency hopping type 6 parameters are randomized at run-time.

The signal monitoring equipment consists of a spectrum analyzer with the capacity to display 8192 bins on the horizontal axis. A time-domain resolution of 2 msec/bin is achievable with a 16 second sweep time, meeting the 10 seconds 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. A time-domain resolution of 3 msec/bin is achievable with a 24 second sweep time, meeting the 22 second long pulse reporting criteria and allowing a minimum of 10 seconds after the end of the long pulse waveform.

**FREQUENCY HOPPING RADAR WAVEFORM GENERATING SUBSYSTEM**

The first 100 frequencies are selected out of the hopping sequence of the randomized 475 hop frequencies.
Only a *Burst* that has the frequency falling within the receiver bandwidth of the tested U-NII device is selected among those frequencies. (Frequency-domain simulation). The radar waveform generated at the start time of the selected *Burst* (Time-domain simulation) is download to the Signal Generator.
If all of the randomly selected 100 frequencies do not fall within the receiver bandwidth of the U-NII device, the radar waveform is not used for the test.

## CONDUCTED METHODS SYSTEM BLOCK DIAGRM




## MEASUREMENT SYSTEM FREQUENCY REFERENCE

Lock the signal generator and the spectrum analyzer to the same reference sources as follows: Connect the 10MHz OUT on the signal generator to the 10MHz IN on the spectrum analyzer and set the spectrum analyzer 10MHz In to On.

## SYSTEM CALIBRATION

**Step 1**: Set the system as shown in Figure 3 of FCC 06-96 7.2.1.

**Step 2**: Adjust each attenuator to fulfill the following three conditions:
- WLAN can be communicated, and
- Rader detection threshold level is bigger than Client Device traffic level on the spectrum analyzer, and
- Master Device traffic level is not displayed on the spectrum analyzer.

**Step 3**: Terminate 50 ohm at B and C points, and connect the spectrum analyzer to the point A. (See the figure on page 12)
At the point A, adjust the signal generator and spectrum analyzer to the center frequency of the channel to be measured.
Download the applicable radar waveforms to the signal generator. Select the radar waveform, trigger a burst manually and measure the amplitude on the spectrum analyzer. Readjust the amplitude of the signal generator as required so that the peak level of the waveform is at a displayed level equal to the required or desired interference detection threshold.
Separate signal generator amplitude settings are determined as required for each radar type.

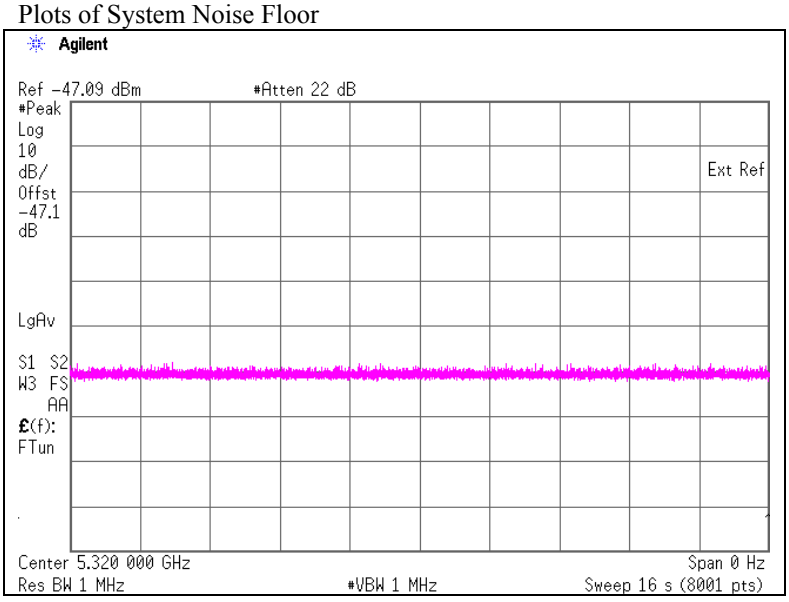
**Step 4**: Without changing any of the instrument settings, restore the system setting to Step 2 and adjust the Reference Level Offset of the spectrum analyzer to the level at Step 3.

By taking the above steps 1 to 4, the spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device.

See Clause 5.4 for Plots of Noise, Rader Waveforms, and WLAN signals.

### 5.4 Plots of Noise, Rader Waveforms, and WLAN signals

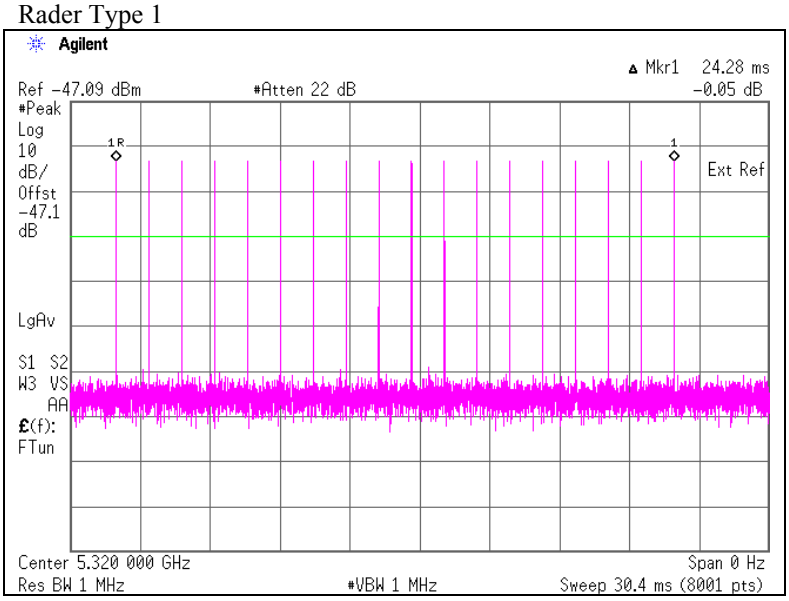
Plots of System Noise Floor



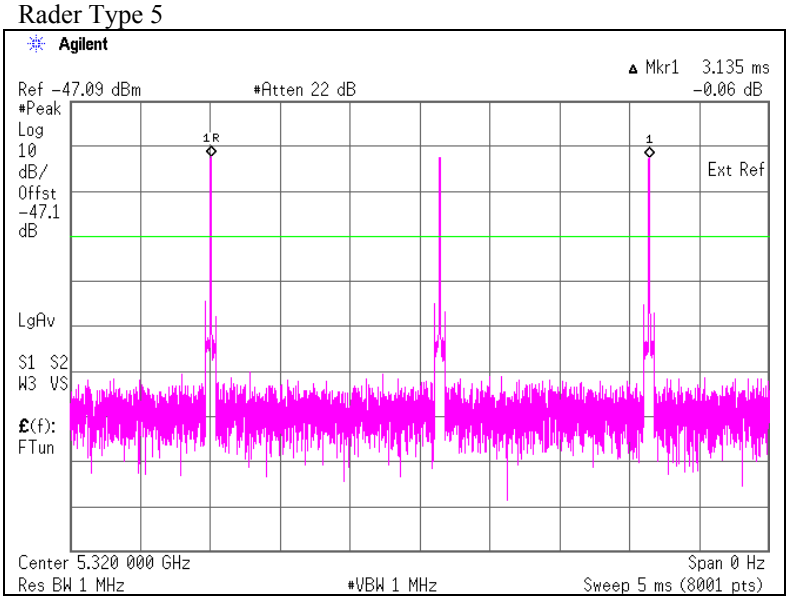

It was confirmed that the EUT did not transmit before having received appropriate control signals from a Master Device.

Plots of Radar Waveforms

Rader Type 1




Rader Type 5

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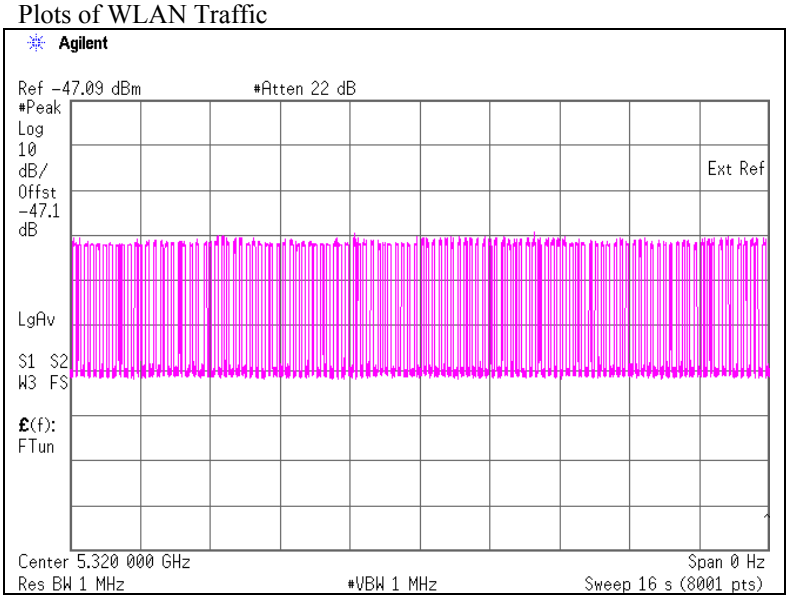
Plots of WLAN Traffic



# SECTION 6: In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time

## 6.1 Operating environment

Test place : No.5 Shielded room
Temperature : 21 deg.C.
Humidity : 51 %

## 6.2 Test Procedure

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 Radar Waveform generator sends a Burst of pulses for one of the Short Pulse Radar Types 1-4 at levels defined , 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.
Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds.

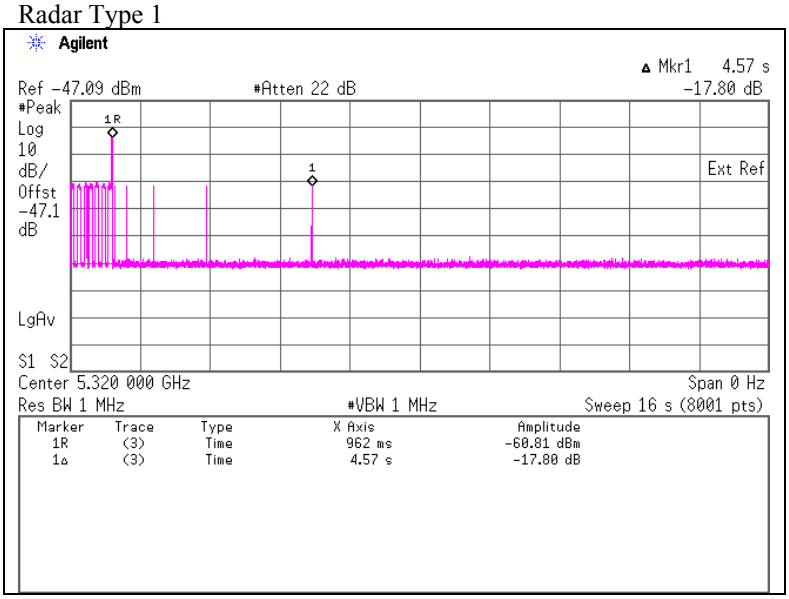
## 6.3 Test data

| Test Item | Unit | Measurement Time | Limit | Results |
|---|---|---|---|---|
| Channel Move Time *1) | [sec] | 4.570 | 10.000 | Pass |
| Channel Closing Transmission Time *2) | [msec] | 26 | 60 | Pass |

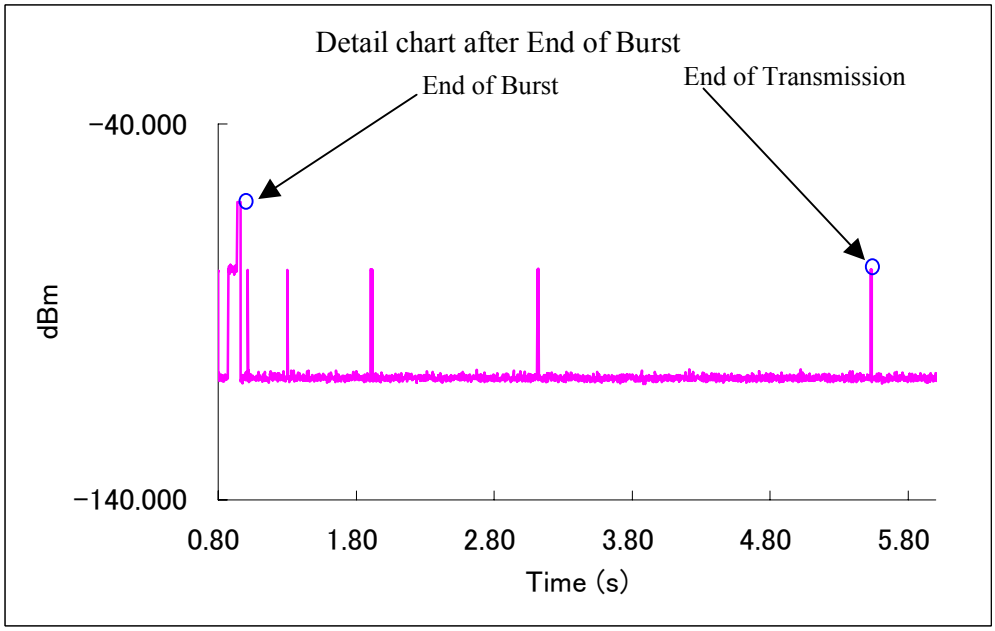
*1) Channel Move Time is calculated as follows:
(Channel Move Time) = (End of Transmission) - (End of Burst) = 4.570

*2) Channel Closing Transmission Time is calculated from (End of Burst + 200msec) to (End of Burst + 10sec )
(Channel Closing Transmission Time) = (Number of analyzer bins showing transmission) * (dwell time per bin)
= 13 * 2(msec)

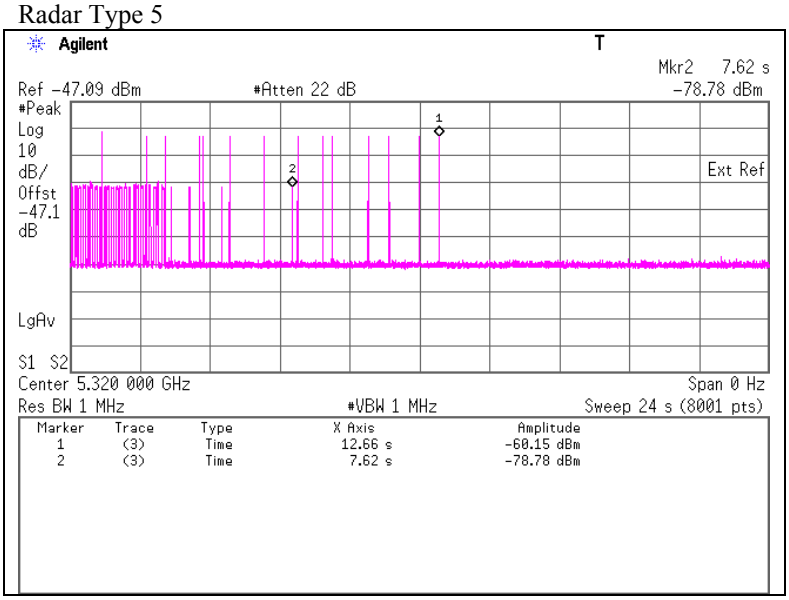
Radar Type 1




**End of Transmission - End of Burst (Delta Marker 1): 4570 ms**



Radar Type 5




**Marker 1 : End of Burst : 12660 ms**
**Marker 2 : End of Transmission : 7620 ms**

## 6.4 Test result

Test result: Pass

Date :March 5, 2010 Test engineer : Tatsuya Arai

# SECTION 7: In-Service Monitoring for Non-Occupancy Period

## 7.1 Operating environment

Test place : No.5 Shielded room
Temperature : 21 deg.C.
Humidity : 51 %

## 7.2 Test Procedure

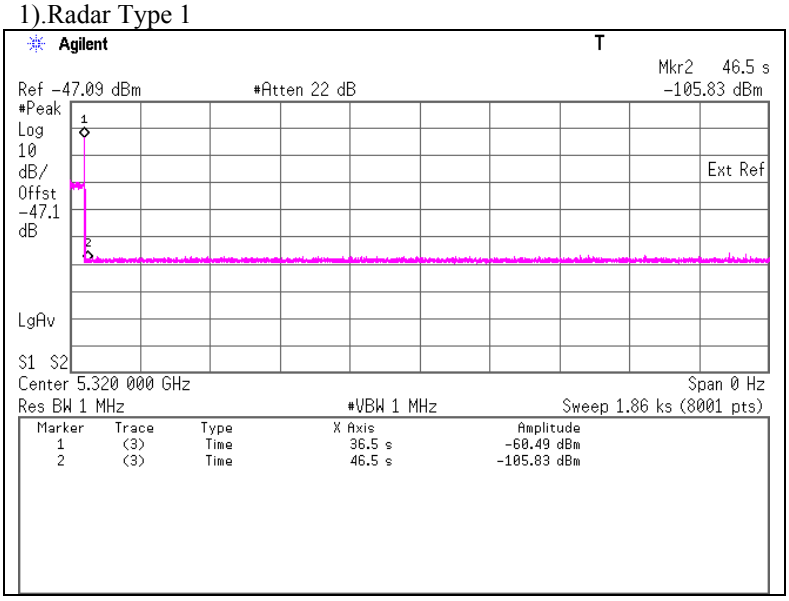
The following two tests are performed:

1).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 Radar Waveform generator sends a Burst of pulses for one of the Radar Types 1-6 at levels defined 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.
Observe the transmissions of the EUT after the Channel Move Time on the Operating Channel for duration greater than
30 minutes.

2). Stream the MPEG test file from the Master Device to the Client Device on the test Channel for the entire period of the test.
Observe the transmissions of the EUT on the Operating Channel for duration greater than 30 minutes after the Master Device is shut off.

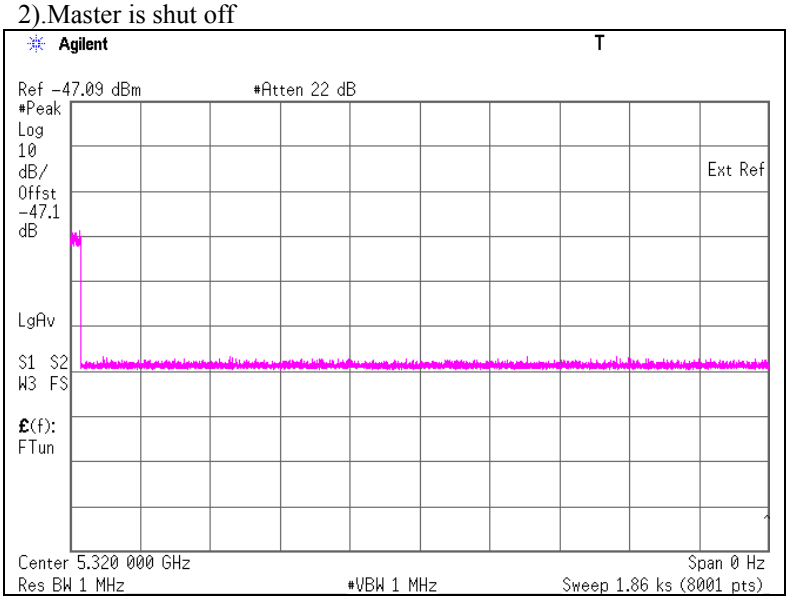
## 7.3 Test data

1).Radar Type 1




**Marker 1 : End of Burst : 36.5 sec**
**Marker 2 : End of Burst +10sec : 46.5 sec**

2).Master is shut off




### 7.4 Test result

Test result: Pass

Date :March 5, 2010 Test engineer : Tatsuya Arai