



Report ITU-R M.2115-1
(12/2009)

**Testing procedures for implementation of
dynamic frequency selection**

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REPORT ITU-R M.2115-1

Testing procedures for implementation of dynamic frequency selection

(2007-2009)

1 Introduction

Resolution 229 (WRC-03) invites the ITU-R to undertake studies on suitable test methods and procedures for the implementation of dynamic frequency selection (DFS), taking into account practical experience.

Currently several administrations and/or standards organizations have developed DFS test methodology.

This Report consolidates the DFS test methodology used and findings across several administrations, as shown in several annexes. Information is provided on the test methodologies in place in various administrations and/or regional groups to test compliance with DFS requirements. These procedures may be updated over time, and as technology evolves. As a result, web links are provided (in some cases) to the test methodologies themselves, so that the most up-to-date information may be obtained.

2 Background

The DFS requirements mandated by Resolution 229 (WRC-03) contained in Recommendation ITU-R M.1652 Annex 1 are broken down into three functional areas:

- detection requirements;
- operational requirements;
- response requirements.

From a spectrum management view point, testing for these requirements are quite different than the normal field strength or power flux density requirements and a clear description of the methods and process for testing will ease manufacturers' ability to show compliance with the administrations rules.

Conformance testing provides a means to analyse equipment operations against set functional requirements prior to authorization of devices within an administration.

To successfully develop conformance test procedures certain descriptions are required to enable manufacturers to develop equipment that will meet or exceed administration requirements.

3 Equipment setup

The test procedures for implementation of DFS in the 5 250-5 350 MHz and 5 470-5 725 MHz bands should include a full description of the equipment used to transmit test waveforms and monitor DFS reactions as prescribed in Recommendation ITU-R M.1652.

4 Test methodology

The test procedures for implementation of DFS in the 5 250-5 350 MHz and 5 470-5 725 MHz bands should also include a comprehensive description of the test methodology used for compliance. This should have at a minimum the waveforms to be tested and procedures to be followed during testing.

5 Detection requirements

There should be a clearly defined detection requirement for each test waveform utilized to ensure that manufacturers and test facilities have a clear understanding of the metric to be applied to each. If multiple requirements will be placed on a data set (i.e. individual waveform detection requirement with an overall group of waveforms having an additional requirement) these should also be clearly defined.

Annex 1

Japan

1 Background

In Japan, technical compatibility requirement, including the frequency sharing study and measurement procedures are addressed by the committee formed by the Information and Communications Council (hereinafter “Council”).

With regard to RLAN devices in the 5 GHz band, the Council has set up a technical committee on wireless access systems in the 5 GHz band which has undertaken the role of studying technical requirements for such RLAN devices. Based on the Council Report, MIC (Ministry of Internal Affairs and Communications) regulates technical requirements to facilitate development of type acceptance testing procedures.

2 Scope

DFS requirements were institutionalized in the 5 250-5 350 MHz band in May 2005 and 5 470-5 725 MHz band in January 2007. On the same day, the notification of WAS test procedure was published. The Association of Radio Industries and Businesses (ARIB – the private standards organization in Japan) published the revision of ARIB Standard T-71 based on IEEE 802.11 CSMA/CA standards and incorporates regulatory requirements including DFS functionality in Japan.

DFS requirements in Japan are composed of those given in Recommendation ITU-R M.1652 Annex 1, harmonized international requirements and those for protecting Japan’s specific radars.

3 Procedures

The DFS capability can be verified through the examination of detection probability. It must be repeated many times to obtain accurate test results. It is time consuming and may reflect to the cost impact to WAS devices. Therefore, Japan adopted the method of testing procedures to enable relatively more accurate pass/fail decision under relatively smaller cycle of testing. These

considerations are introduced in following attachment for reference. To achieve further reduction of testing items which conform to DFS function to various kinds of radars, similar radar types are grouped, and random sample testing method within grouped radars was adopted.

The latest version of mandated DFS requirements and test procedures in Japan can be obtained from MIC publications Download Area Website (<http://www.tele.soumu.go.jp/e/equ/tech/5ghz.htm>).

Appendix 1 to Annex 1

An example of DFS test methods and calculation result for DFS detection probability

This Attachment shows an example of DFS test methods and a calculation result of the probability of DFS detection during in-service monitoring. The calculation targets a rotating meteorological radar and WAS devices based on the IEEE 802.11a standard.

1 Parameters in design of DFS test method

The following parameters are required to design DFS test methods, because the probability of DFS detection is largely dependent on them:

- margin to the detection threshold;
- data traffic;
- decision threshold by detected pulses.

1.1 Margin to the detection threshold

There is a margin between the detection threshold defined in Recommendation ITU-R M.1652 Annex 1 and the necessary detection threshold described in Recommendation ITU-R M.1652 Annex 5. Therefore the WAS devices can receive the signal above the threshold out of the main beam of radar. For this reason, the analysis time during in-service monitoring is redefined as the period during which the WAS receives the radar signal above the threshold in one sweep. Consequently, the analysis time is calculated as " $2 \cdot \theta_{offset} / \text{Scan rate}$ ", where θ_{offset} is the off-axis angle and the antenna gain of off-set θ_{offset} is below the peak by the margin.

1.2 Data traffic

Step 3 of Recommendation ITU-R M.1652 Annex 4 defines available time for in-service monitoring as only listening periods; however, idle time during which the WAS devices have no transmitting data is also available for in-service monitoring. Since the idle time depends on data traffic among the WAS devices, the data traffic is an important factor for the detection probability.

It is noted that the data traffic for IEEE 802.11a based devices increases when the packet loss occurs by interference from the radar, because the WAS devices resend the lost packet instead of idling.

Therefore, the important factor will be the radio-transmitting activity ratio such as Talk/Listen timing, because, recently the chipset companies who have 802.11a function, have implemented enhanced functions such as the large packet mode, the fast burst mode, etc., and random back-off timing must be considered additionally.

1.3 Decision threshold by detected pulses

The WAS devices with typical implementations recognize the radar signal by detecting each pulse rise/fall. Therefore, the number of the pulses received in the available time is a key factor for the probability of detection. Such devices use a pulse counter to determine radar detection. To avoid false alarm, a number larger than one is set as a decision threshold by detected pulses.

2 Calculation

2.1 Calculation procedure

Considering the parameters addressed in the above sections, the calculation of the DFS detection probability based on the methodology in Recommendation ITU-R M.1652 Annex 4 is demonstrated as follows.

Step 1: Determine the number of pulses, N_p , received in the analysis time as follows:

$$N_p = 2 \cdot \theta_{\text{offset}} / \text{Scan rate} \cdot \text{Pulse repetition rate}$$

Step 2: For simplicity of calculation, since analysis time is usually much longer than the radar pulse repetition period, the probability of detection, P_d , that one radar pulse falls into a listening period during the radar pulse repetition period is set as the average time ratio of the listening periods to the total time. Then, calculate the probability, $P(m)$, wherein the WAS device detects m pulses within the analysis time as follows:

$$P(m) = \binom{N_p}{m} P_d^m (1 - P_d)^{N_p - m}$$

Step 3: Calculate probability, $P(m, N_p)$, wherein the WAS device detects more than m pulses within the analysis time as follows:

$$P(m, N_p) = 1 - \sum_{i=0}^{m-1} P(i)$$

Step 4: Probability of detection in n rotations:

Q : probability of detection in one rotation

Q_s : probability of detection in n rotations

$$Q = P(m, N_p) (1 - P(m, N_p))^{n-1}$$

$$Q_s = \sum_{i=1}^n Q = 1 - (1 - P(m, N_p))^n$$