Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Revision of Parts 2 and 15 of the Commission's	)	ET Docket No. 03-122
Rules to Permit Unlicensed National	)	RM - 10371
Information Infrastructure (U-NII) Devices in	)	
the 5 GHz Band	)	
	)	

COMMENTS OF THE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

Michael D. Gallagher
Acting Assistant Secretary for
Communications and Information

Kathy D. Smith
Chief Counsel

Fredrick R. Wentland
Associate Administrator
Office of Spectrum Management

Charles T. Glass
Telecommunications Specialist
Office of Spectrum Management

Edward F. Drocella
Robert L. Sole
Electronics Engineers
Office of Spectrum Management

National Telecommunications and
Information Administration
U.S. Department of Commerce
Room 4713
1401 Constitution Avenue, N.W.
Washington, DC 20230
(202) 482-1816

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EXECUTIVE SUMMARY

The National Telecommunications and Information Administration (NTIA) commends the Federal Communications Commission (Commission) for initiating this proceeding to expand the options for unlicensed device use, and particularly, linking such expanded use to adoption of new technologies for active interference-avoidance. NTIA agrees with the Commission regarding the significant benefits to the economy, businesses, consumers, and government agencies that could be gained by allowing unlicensed devices to operate in the 5.47-5.725 GHz frequency range, provided that such operation is tied to effective implementation of active interference-avoidance techniques. NTIA would also like to commend the Commission for its careful consideration and review of existing Part 15 Rules in the 5.25-5.35 GHz band as well as consideration of the federal government and private sector spectrum requirements in the 5 GHz frequency range. NTIA provides the following comments to specific issues raised in the Unlicensed-National Information Infrastructure (U-NII) Notice of Proposed Rulemaking (NPRM) that may have an impact on critical federal systems used for scientific research, aviation, and national defense.

NTIA supports the Commission's proposals to upgrade the frequency allocations of federal government Radiolocation Service, and federal and non-federal government Space Research Service (active) and the Earth Exploration-Satellite Service (active) in the 5 GHz frequency range. Upgrading these allocations is consistent with the allocations adopted internationally, and will provide the necessary protection to federal systems supporting national defense as well as federal and non-federal commercial and scientific operations. In addition to the allocation upgrades in the 5 GHz frequency range, several footnotes were adopted at the World Radiocommunication Conference 2003 (WRC-2003). There were also modifications made to several existing footnotes in the 5 GHz frequency range. The Commission's proposal to modify the U.S. Table of Frequency Allocations did not include the new footnotes or the modifications to existing footnotes that were adopted at WRC-2003. NTIA believes that the modifications to the U.S. Table of Frequency Allocations should include the appropriate new footnotes and modifications to existing footnotes adopted at WRC-2003. NTIA believes that the inclusion of these new footnotes and the modifications to existing footnotes are necessary because of the complex sharing arrangements that exist between the diverse federal and non-federal government radio services operating in the 5 GHz frequency range.

NTIA supports the Commission's proposal to modify the Part 15 Rules to allow U-NII devices to operate in the 5.47-5.725 GHz band on a non-interference basis. Utilization of the mitigation measures proposed in the NPRM along with the additional 255 MHz of spectrum for U-NII devices to spread across will provide protection to vital government systems. The Commission's proposal will also meet current industry needs as well as future growth in the radio local area network radio local area network (RLAN) industry which has proven to be one of the few technology success stories in the current economy.

NTIA concurs with the Commission's proposal that Dynamic Frequency Selection (DFS) should be required in the existing 5.25-5.35 GHz U-NII band as well as the proposed U-NII 5.47-5.725 GHz band. NTIA also concurs with the technical limits on DFS proposed by the Commission. Comprehensive studies carried out jointly between NTIA, Department of Defense, and private industry with Commission representatives has proven the requirement for these technical limits. Specifically, NTIA considers the proposed power limits, detection threshold, move time, and non-occupancy period as fundamental for the protection of government radars and no relaxation in the proposed values can be accepted based on the studies cited above. DFS is an integral part of the protection measures that allows for sharing between the U-NII devices and existing primary government users. NTIA is of the opinion that the DFS mechanism should be required to detect a single radar pulse present during coincidence of the transmitted radar pulse and the dedicated listen period of the DFS mechanism between each packet/frame. The requirement should be for detection of a single pulse during this coincidence period. In addition, the DFS mechanism should be allowed to average received power over successive 1 microsecond periods during the dedicated listen period. Given the typical pulse widths and pulse repetition rates of the radars operating in these bands, as well as the average power levels transmitted by these radars, the DFS mechanism should have no problems detecting single radar pulses during coincidence. This will not allow for radar signal detection and instead forces the DFS to rely on signal detection above the DFS detection threshold no matter the source. This provides further protection of radar systems given the high probability of masking of radar signals from adjacent, competing U-NII devices.

NTIA's Office of Spectrum Management is leading a government/industry project team to develop proposed compliance measurement procedures for DFS equipped U-NII devices. This project team will be responsible for addressing technical issues related to the generation of radar signals and the techniques to reliably measure these signals. NTIA believes that this government/industry project team has the expertise to provide guidance to the Commission in the development of the compliance measurement procedures for DFS equipped U-NII devices. A first draft of the proposed compliance measurement procedures is provided as part of these comments. There are plans in the November 2003 timeframe for manufacturers to bring DFS equipped devices to NTIA's Institute for Telecommunication Sciences to validate the draft measurement procedures. This testing will be dependent on the availability of DFS equipped U-

NII devices. NTIA will submit a report to the Commission documenting the results of these measurements and any modifications to the draft procedures. NTIA believes that providing the draft measurement procedures to the Commission as part of the public record will allow other parties that are not participating in the government/industry project team to review and provide comments on the proposed measurement procedures.

The current Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards require Transmitter Power Control (TPC) in both the 5.25-5.35 GHz and 5.47-5.725 GHz bands as a means to facilitate sharing among U-NII devices. Therefore, NTIA believes that it should not create a burden on industry to implement TPC in both bands. NTIA believes that TPC will provide a mitigation factor of at least 3 dB within the EESS/SRS satellite footprint providing additional protection for these critical government operations.

NTIA agrees with the Commission's transition schedule for domestically manufactured U-NII devices operating in the 5.25-5.35 GHz band. NTIA believes that this approach will lessen the burden on manufacturers by allowing them adequate time to redesign their devices to comply with the DFS and TPC requirements necessary to protect federal systems. NTIA recommends that the Commission require that imported U-NII devices operating in the 5.25-5.35 GHz band adhere to the Commission's Rules (e.g., DFS and TPC), one year after the date of publication of the Report and Order in the Federal Register.

Finally, NTIA recommends that the Commission include additional definitions in their rules for U-NII devices. The additional definitions proposed by NTIA are consistent with the terminology employed by the RLAN industry, and will help to avoid confusion that may arise when developing compliance measurement procedures for U-NII devices.

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COMMENTS OF THE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

The National Telecommunications and Information Administration (NTIA), an Executive Branch agency within the Department of Commerce, is the President's principal adviser on domestic and international telecommunications policy, including policies relating to the Nation's economic and technological advancement in telecommunications. Accordingly, NTIA makes recommendations regarding telecommunications policies and presents Executive Branch views on telecommunications matters to the Congress, the Federal Communications Commission (Commission), and the public. NTIA, through the Office of Spectrum Management, is also responsible for managing the Federal Government's use of the radio frequency spectrum. NTIA respectfully submits the following comments in response to the Commission's Notice of Proposed Rulemaking (NPRM) in the above-captioned proceeding.[1]

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1 *Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, ET Docket No. 03-122, (released June 4, 2003) ("U-NII NPRM").

I. INTRODUCTION

The U-NII NPRM is seeking comments on the feasibility of allowing unlicensed devices to operate in additional frequency bands. Specifically, the NPRM proposes to amend Part 15 of the Commission's Rules governing the operation of Unlicensed National Information Infrastructure (U-NII) devices, including Radio Local Area Networks (RLANs), to make available an additional 255 megahertz of spectrum in the 5.47–5.725 GHz band, and on the technical requirements that would be necessary to ensure that such devices do not cause interference to authorized services operating within the 5.25-5.35 GHz and 5.47-5.725 GHz bands.[2] The Commission also proposes other changes to the United States (U.S.) Table of Frequency Allocations to accommodate the needs of other radio services operating in the 5 GHz region of the spectrum. Finally, the Commission proposes to modify certain technical requirements for U-NII devices in the Part 15 Rules to protect various radio services against harmful interference.[3] These proposals are consistent with the outcome of the World Radiocommunication Conference 2003 (WRC-2003) and the subsequent changes to the international Radio Regulations.

NTIA commends the Commission for initiating this proceeding to expand the options for unlicensed device use and particularly, linking such expanded use to adoption of new technologies for active interference avoidance. NTIA agrees with the Commission regarding the significant benefits to the economy, businesses, consumers, and government agencies that could

[2] *See* 47 C.F.R. Part 15 Subpart E – Unlicensed National Information Infrastructure Devices. U-NII devices are "[i]ntentional radiators operating in the frequency bands 5.15-5.35 GHz and 5.725-5.825 GHz that use wideband digital modulation techniques and provide a wide array of high data rate mobile and fixed communications for individuals, businesses, and institutions." 47 C.F.R. §15.403(i).

[3] The rules being proposing are those deemed necessary to protect incumbent users from interference. Industry standards being developed by the Institute for Electrical and Electronics Engineers (IEEE) or others may contain more detailed technical requirements.

be gained by allowing unlicensed devices to operate in the 5.47-5.725 GHz frequency range, provided that such use is tied to effective implementation of active interference avoidance techniques. NTIA would also like to commend the Commission for its careful consideration and review of existing Part 15 Rules in the 5.25-5.35 GHz band as well as consideration of the federal government and private sector spectrum requirements in the 5 GHz frequency range. NTIA provides the following comments in response to specific issues raised in the U-NII NPRM.

II. NTIA SUPPORTS THE COMMISSION'S PROPOSAL TO CHANGE THE U.S. TABLE OF FREQUENCY ALLOCATIONS TO ACCOMMODATE THE NEEDS OF FEDERAL AND NON-FEDERAL GOVERNMENT RADIO SERVICES OPERATING IN THE 5 GHZ FREQUENCY RANGE.

In the U-NII NPRM, the Commission proposes to modify the U.S. Table of Frequency Allocations to upgrade the status of the federal government Radiolocation Service to primary in the 5.46–5.65 GHz band.[4] The Commission further proposes to add primary allocations for the federal government and secondary allocations for the non-federal government Space Research Service (active) (SRS) in the 5.35-5.57 GHz band and the Earth Exploration-Satellite Service (active) (EESS) in the 5.46-5.57 GHz band.[5] The Commission also proposes to upgrade the allocation status of non-federal government Radiolocation to primary in the 5.47-5.65 GHz band.[6]

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[4] The U.S. Table of Frequency Allocations is set forth in Section 2.106 of the Commission's Rules, 47 C.F.R. § 2.106.

[5] The Commission previously proposed primary Federal Government EESS (active) and SRS (active) allocations in the 5.25-5.35 GHz band and a Federal Government EESS (active) allocation in the 5.35-5.46 GHz band. *See Amendment of Parts 2, 25, and 87 of the Commission's Rules to Implement Decisions from World Radio Communication Conferences Concerning Frequency Bands Between 28 MHz and 36 GHz and to Otherwise Update the Rules in this Frequency Range*, Notice of Proposed Rulemaking, ET Docket No. 02-305, 17 F.C.C. Rcd. 19756 (2003).

[6] U-NII NPRM at ¶ 13.

The Department of Defense (DoD) operates numerous radars in the 5.25-5.925 GHz frequency range in support of national defense, military test range surveillance and instrumentation operations, airborne radar transponders, battlefield missile surveillance and tracking, weather radar observations, shipborne missile and gunfire control, and navigational aids to assist precision positioning of ships.[7] Non-military government radar operations in the 5.25-5.925 GHz frequency range include support for airborne weather and navigation, weather phenomena research studies, and airport terminal Doppler weather radars.[8] Appendix A provides a description of radar usage in the 5 GHz frequency range.

The primary factors driving the need for additional radar spectrum include changes in requirements, missions, and technology which result in the use of narrow pulse widths, and wide emission bandwidths to achieve the resolution necessary to detect smaller and less reflective targets in the presence of background clutter.[9] Given the increasing demands for spectrum in the 5.25-5.925 GHz frequency range to support radar system development, there is a need to upgrade the allocations of the federal government radiolocation spectrum allocated on a secondary basis to primary. Upgrading the allocation from secondary to primary in the 5.46-5.65 GHz frequency range will provide the same regulatory protection throughout the entire tuning range of these radar systems. This upgrade to primary allocation is necessary to safeguard the operation of existing and future radar operations in the 5 GHz frequency range from potential interference resulting from the increased sharing demands to accommodate new licensed and unlicensed radio services.

[7] NTIA Special Publication 00-40, *Federal Radar Spectrum Requirements*, National Telecommunications and Information Administration, at 19 (May 2000).

[8] *Id.*

[9] To detect smaller targets narrower pulse widths are necessary. The bandwidth of a pulsed signal is related to the inverse of the pulse width (*e.g.*, smaller pulse widths result in wider emission bandwidths).

Active sensing is the measurement on board a spacecraft of signals transmitted by a sensor and then reflected, refracted, or scattered by the Earth's surface or its atmosphere. Prior to WRC-2003, the U.S. Government identified a requirement to expand the bandwidth available for spaceborne altimeters and synthetic aperture radars (SARs) operating in the EESS (active) in the 5.25-5.46 GHz band from 210 MHz to 320 MHz (5.25-5.57 GHz). This increase in spectrum is necessary to satisfy a requirement for altimeter height measurements with a standard deviation of 1 to 2.5 centimeters and a SAR requirement for measurements with enhanced ground resolution of 1 meter. The higher quality data collected using wideband SARs will allow scientist to gain new insights into the prediction of climatic changes. These wideband SARs will also provide the higher resolution necessary for commercial applications, such as high-resolution surface mapping. For example, by increasing the bandwidth available to SARs it will be possible to precisely map the boundary of oil spills to a resolution of 1 meter.

NTIA supports the Commission's proposals to upgrade the frequency allocations of federal government Radiolocation, and federal and non-federal government SRS (active) and EESS (active) in the 5 GHz frequency range. Upgrading these allocations is consistent with the allocations adopted internationally, and will provide the necessary protection to federal systems supporting national defense as well as federal and non-federal commercial and scientific operations. NTIA notes that the U-NII NPRM does not include the new footnotes or the modifications to existing footnotes that were adopted at WRC-2003.[10] NTIA believes that the modifications to the U.S. Table of Frequency Allocations should include the appropriate new footnotes and modifications to existing footnotes adopted at WRC-2003. NTIA recommends that the Commission include the following new footnotes in the U.S. Table of Frequency

[10] *World Radiocommunication Conference 2003 (WRC-03) Final Acts (Provisional) as published on 4 July 2003*, International Telecommunication Union (Revision 1), at 28 (Sept. 4, 2003).

Allocations:

> **USXXX--**Federal Government stations in the radiolocation service operating in the band 5350-5470 MHz, shall not cause harmful interference to, nor claim protection from, Federal stations in the aeronautical radionavigation service operating in accordance with No. 5.449.
>
> **USYYY--**Federal Government stations in the radiolocation service operating in the band 5470-5650 MHz, with the exception of ground based radars used for meteorological purposes operating in the band 5600-5650 MHz, shall nor cause harmful interference to, nor claim protection from, Federal Government stations in the maritime radionavigation service.
>
> **USZZZ**--Federal Government stations in the space research service (active) operating in the band 5350-5460 MHz shall not cause harmful interference to nor claim protection from Federal Government and non-Federal Government stations in the aeronautical radionavigation service nor Federal Government stations in the radiolocation service.

NTIA also recommends that the following modifications adopted at WRC-2003 to international footnotes 5.448A and 5.448B be reflected in the U.S. Table of Frequency Allocations:

> **5.448A--**~~The use of the frequency band 5250-5350 MHz by the earth exploration-satellite (active) and space research (active) services shall not constrain the future development and deployment of the radiolocation service.~~ **The Earth exploration-satellite (active) and space research (active) services in the frequency band 5250-5350 MHz shall not claim protection from the radiolocation service.**
>
> **5.448B--**~~The earth exploration-satellite (active) service operating in the band 5350-5460 MHz shall not cause harmful interference to, or constrain the use and development of, the aeronautical radionavigation service.~~ **The Earth exploration-satellite service (active) operating in the band 5350-5570 MHz and space research service (active) operating in the band 5460-5570 MHz shall not cause harmful interference to the aeronautical radionavigation service in the band 5350-5460 MHz, the radionavigation service in the band 5460-5470 MHz and the maritime radionavigation service in the band 5470-5570 MHz.**

NTIA believes that the inclusion of these new footnotes and the modifications to existing footnotes are necessary because of the complex sharing arrangements that exist between the diverse federal and non federal government radio services operating in the 5 GHz frequency range. These new footnotes and modifications to the existing footnotes were supported as the U.S. position for WRC-2003.

III. NTIA SUPPORTS THE COMMISSION'S PROPOSAL TO MODIFY THE PART 15 RULES TO ACCOMMODATE EXPANDED USE OF U-NII DEVICES.

The Commission is proposing to modify the Part 15 rules to allow U-NII devices to operate in the 5.47-5.725 GHz band on a non-interference basis. This proposal will increase the available spectrum available for U-NII devices by 255 MHz, facilitating the development of a wide range of new and innovative unlicensed devices. The Commission seeks comment on this proposal.[11]

NTIA supports the Commission's proposal to modify the Part 15 Rules to allow U-NII devices to operate in the 5.47-5.725 GHz band on a non-interference basis. Utilization of the mitigation measures proposed in the NPRM along with the additional 255 MHz of spectrum for U-NII devices to spread across will provide protection of the vital government systems. The Commission's proposal will also meet current industry needs as well as future growth in the RLAN industry which has proven to be one of the few technology success stories in the current economy.

IV. NTIA SUPPORTS THE COMMISSION'S PROPOSAL TO REQUIRE U-NII DEVICES OPERATING IN THE 5.25-5.35 GHZ AND 5.47-5.725 GHZ FREQUENCY BANDS TO EMPLOY DFS TO AVOID INTERFERING WITH CRITCAL FEDERAL RADAR OPERATIONS.

In order to ensure protection of existing radar operations, the Commission is proposing that U-NII devices authorized to operate in the 5.25-5.35 GHz and 5.47-5.725 GHz bands employ a listen-before-talk mechanism referred to as Dynamic Frequency Selection

[11] U-NII NPRM at ¶ 14.

(DFS). DFS is an interference avoidance mechanism, that when employed in a U-NII device, will monitor the radio environment for the presence of a radar.[12] For systems, where multiple devices operate under a central controller, the Commission is proposing that only the central controller have DFS capability. The Commission is seeking comment on requiring U-NII devices to have DFS and how to identify remote units that operate under the control of a central controller.[13] The Commission is also seeking comment on the minimum number of pulses needed for a DFS system to reliably detect a radar signal.[14]

NTIA concurs with the Commission's proposal that DFS should be required in the existing 5.25-5.35 GHz U-NII band as well as the proposed U-NII 5.47-5.725 GHz band. NTIA also concurs with the technical limits on DFS proposed by the Commission. Comprehensive studies carried out jointly between NTIA, DoD, and private industry with Commission representatives have proven the requirement for these technical limits. Specifically, NTIA considers the proposed power limits, detection threshold, move time, and non-occupancy period as fundamental for the protection of government radars and no relaxation in the proposed values can be accepted based on the studies cited above. DFS is an integral part of the protection measures that allows for sharing between the U-NII devices and existing primary government users. NTIA is of the opinion that the DFS mechanism should be required to detect a single radar pulse present during coincidence of the transmitted radar pulse and the dedicated listen period of the DFS mechanism between each packet/frame. Setting a specific hard number of pulses before detection is difficult given that coincidence between a radar pulse and listen period is statistical in nature based on packet/frame length and probability of a radar pulse being present

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[12] *Id.* at ¶ 20.

[13] *Id.* at ¶ 22.

[14] *Id.* at ¶ 23.

during the listen period as based on radar pulse width and pulse repetition rate as well as antenna pointing angle (radar antenna scan function) with respect to the U-NII device. The requirement should be for detection of a single pulse during this coincidence period. In addition, the DFS mechanism should be allowed to average received power over successive 1 microsecond periods during the dedicated listen period. Given the typical pulse widths and pulse repetition rates of the radars operating in these bands, as well as the average power levels transmitted by these radars, the DFS mechanism should have no problem detecting single radar pulses during coincidence. This will not allow for radar detection and instead forces the DFS to rely on signal detection above the DFS detection threshold no matter the source. This provides further protection of radar systems given the high probability of masking of radar signals from adjacent, competing U-NII devices.

Internationally, there is also a requirement for a dedicated 10 minute monitoring period as part of the required non-occupancy period for channels on which the detection threshold is exceeded in the 5.6-5.65 GHz band. NTIA concurs with the Commission in excluding this from the domestic rulemaking. The joint studies clearly show that the required 30 minute non-occupancy period that was included in the U-NII NPRM is sufficient to provide protection to circular scanning weather radars that require protection using the non-occupancy period.

V. NTIA IS LEADING A PROJECT TEAM WITH GOVERNMENT AND INDUSTRY REPRESENTATIVES TO DEVELOP COMPLIANCE MEASUREMENT PROCEDURES FOR DFS ENABLED U-NII DEVICES.

Determining whether or not a U-NII device with DFS capability can reliably detect a radar signal will require very specialized compliance measurement procedures, that are beyond the measurement procedures currently found in the Commission's Part 15 Rules. In order to address this issue the Commission is seeking comment on the appropriate measurement procedures to ensure compliance with the requirements for DFS.[15]

NTIA recognizes the difficulties encountered in reliably detecting radar signals. NTIA's Institute for Telecommunication Sciences (ITS) has many years of experience in detecting and measuring radar signals. These measurements require very specialized measurement instruments and measurement techniques that take into account the characteristics of the signals being measured (*e.g.*, pulse width, pulse repetition frequency, antenna scan rate). The test facilities that perform the Commission's equipment compliance measurements will in all likelihood not have this specialized measurement equipment or have experience in generating the radar signals that are necessary to determine whether or not DFS equipped U-NII devices comply with the Commission's Rules. NTIA believes that the measurement procedures developed must correctly determine compliance with the Commission's Rules without undermining the protection effects of DFS. However, the measurement procedures should not unnecessarily cause manufacturers to incur undue costs or delays in the deployment of equipment.

In preparing for WRC-2003, the government (NTIA, Commission, and DoD) worked closely with industry representatives to reach agreement on the United States' 5 GHz proposals for the conference. A similar approach will be employed to develop a proposal for the compliance measurement procedures for DFS equipped U-NII devices. NTIA's Office of Spectrum Management is leading a government/industry project team to develop proposed compliance measurement procedures. This project team will be responsible for addressing technical issues related to the generation of radar signals and the techniques to reliably measure these signals. NTIA believes that this government/industry project team has the expertise to provide guidance to the Commission in the development of the compliance measurement

[15] *Id*. at ¶ 25.

procedures. A first draft of the compliance measurement procedures is provided in Appendix B. There are plans in the November 2003 timeframe for manufacturers to bring DFS equipped devices to ITS to validate the draft measurement procedures in Appendix B. This testing will be dependent on the availability of DFS equipped U-NII devices. NTIA will submit a report to the Commission documenting the results of these measurements and any modifications to the draft procedures in Appendix B. NTIA believes that providing the draft measurement procedures to the Commission as part of the public record will allow other parties that are not participating in the government/industry project team to review and provide comments on the measurement procedures. A schedule of the project team's projected milestones is provided in Appendix C.

VI. NTIA SUPPORTS IMPLEMENTING TPC IN BOTH THE 5.25-5.35 GHZ AND 5.47-5.725 GHZ FREQUENCY BANDS.

The Commission is proposing to require a transmit power control (TPC) mechanism in the 5.47-5.725 GHz frequency band to further reduce the potential impact on EESS and SRS operations. Consistent with the U.S. proposals to the WRC-03, the Commission is proposing that U-NII devices employ a TPC mechanism that will ensure a 6 dB drop in power when triggered. The Commission seeks comment the appropriate triggering mechanism and whether TPC should keep a receiver parameter such as received signal strength, bit error rate, or block error rate below a certain threshold. The Commission also seeks comment on whether it will be necessary to require U-NII devices to employ TPC if their maximum power is 3 dB or more below the maximum permitted under the rules.[16]

[16] *Id*. at ¶ 24.

In the U-NII NPRM the Commission proposes that U-NII devices employ a TPC mechanism that will ensure a 6 dB drop in the transmit power when triggered.[17] However, NTIA believes that the correct amount of reduction should be a 3 dB drop in system power when triggered. Further, NTIA is of the opinion that recent changes to the international regulations regarding TPC suggest that a 3 dB drop in system power should be considered for both the 5.25-5.35 GHz band and the 5.47-5.725 GHz band. The international regulations require:

> *that in the bands 5250-5350 MHz and 5470-5725 MHz, systems in the mobile service shall either employ transmitter power control to provide, on average, a mitigation factor of at least 3 dB on the maximum average output power of the systems, or, if transmitter power control is not in use, then the maximum mean e.i.r.p. shall be reduced by 3 dB.*[18]

An analysis of this language, taken in context of likely RLAN deployment shows that for domestic regulations there should be a requirement for devices to have TPC capability or, a maximum power no greater than 3 dB below the standard maximum transmit power, for both bands. Any further definition or requirement with respect to TPC is not required given that the great preponderance of U-NII devices operate at power levels greater than 6 dB below the maximum transmit power and this will always provide, on average, a mitigation factor of at least 3 dB within the EESS/SRS satellite footprint. Moreover, NTIA believes that since the current Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards require TPC in both of these bands as a means to facilitate sharing among U-NII devices it should not create a burden on industry to implement TPC in both the 5.25-5.35 GHz and 5.47-5.725 GHz frequency bands.

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[17] *Id.*

[18] World Radio Conference Resolution 229 Resolves 7 (2003).

VII. NTIA RECOMMENDS THAT U-NII DEVICES OPERATING IN THE 5.25-5.35 GHZ BAND THAT ARE IMPORTED SHOULD ADHERE TO THE COMMISSION'S PROPOSED TRANSITION SCHEDULE FOR DOMESTIC DEVICES.

The NPRM acknowledges that U-NII devices are currently operating in the 5.25-5.35 GHz band without DFS capability. To address this issue the Commission proposes that all U-NII devices certified one year after the Report and Order is published in the Federal Register must employ DFS. The Commission also proposes that all U-NII devices operating in the 5.25-5.35 GHz band that are imported or shipped in the interstate commerce on or after two years from the date of publication in the Federal Register must comply with these standards.[19]

NTIA agrees with the Commission's transition schedule for domestically manufactured U-NII devices operating in the 5.25-5.35 GHz band. NTIA believes that this approach will lessen the burden on manufacturers by allowing them adequate time to redesign their devices to comply with the DFS and TPC requirements that are necessary to protect federal systems. NTIA recommends that the Commission require that imported U-NII devices operating in the 5.25-5.35 GHz band also adhere to the Commission's Rules (*e.g.*, DFS and TPC), one year after the date of publication of the Report and Order in the Federal Register.

VIII. IN ORDER TO AVOID CONFUSION, NTIA RECOMMENDS THAT ADDITIONAL DEFINITIONS BE INCLUDED IN THE COMMISSION'S RULES FOR U-NII DEVICES.

In the U-NII NPRM, the Commission proposes that when multiple devices operate under a central control that only the central controller be required to employ DFS capability, however, the Commission does not provide a definition for the controller.[20] In §15.407(h)(2)(a)(i) and (ii)

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[19] U-NII NPRM at ¶ 26.

[20] *Id.* at ¶ 22.

of the proposed rules, the Commission makes reference to master and slave operational modes of the U-NII devices, without providing definitions for either operational mode.[21] NTIA believes that based on the terminology used by the RLAN industry that the controller is a Master Device. The RLAN industry uses very specific terminology to describe U-NII devices and the operating relationship between these devices. Understanding the relationship between the different operational modes of U-NII devices is important when applying the DFS technical requirements specified in the Commission's Rules. NTIA believes that in order to avoid confusion, the following definitions should be included in the Commission's Rules in Section 15.403 for U-NII devices:

> **Channel:** amount of spectrum used by a single U-NII device operating on one of the specific carrier frequencies.
>
> **Client Device:** a U-NII device operating in Client mode.
>
> **Client Mode:** operating mode in which the transmissions of the U-NII device are under the control of the Master. A U-NII device in Client mode is not able to initiate a network.
>
> **Master Device:** a U-NII device operating in Master mode.
>
> **Master Mode:** operating mode in which the U-NII device has the capability to transmit without receiving an enabling signal. In this mode it is able to select a channel and initiate a network by sending enabling signals to other U-NII devices. A U-NII network has at least one device operating in Master mode.

NTIA also believes that Section 15.407(h)(2)(a)(i) and (ii) of the Commission's Rules should be amended as follows:

> a) Operational Modes. The DFS requirement applies to the following operational modes:
>
> > i) The requirement for channel availability check time applies in the ~~master operational mode~~ **Master Mode**.
> > ii) The requirement for channel move time applies in both the ~~master and slave operational modes~~ **Master Mode and Client Mode.**

[21] *Id*. at Appendix B.

NTIA believes that these definitions are consistent with the terminology employed by the RLAN industry, and including them in the Commission's Rules will help to avoid confusion that may arise when applying the DFS technical requirements.

IX. CONCLUSION

NTIA commends the Commission for initiating this proceeding to expand the options for unlicensed device use. NTIA agrees with the Commission regarding the significant public benefits that could be gained by increasing the spectrum available for unlicensed devices, provided that such use is tied to effective implementation of active interference avoidance techniques. NTIA will continue to work with the Commission and industry to resolve the technical issues surrounding the successful implementation of DFS equipped U-NII devices in an effort to continue the workable arrangement of facilitating the development and deployment of unlicensed wireless devices while protecting critical federal systems.

Respectfully submitted,

Michael D. Gallagher
Acting Assistant Secretary for
Communications and Information

Fredrick R. Wentland
Associate Administrator
Office of Spectrum Management

Charles T. Glass
Telecommunications Specialist
Office of Spectrum Management

Edward F. Drocella
Robert L. Sole
Electronics Engineers
Office of Spectrum Management

Kathy D. Smith
Chief Counsel

National Telecommunications
and Information Administration
U.S. Department of Commerce
Room 4713
1401 Constitution Avenue, N.W.
Washington, DC 20230
(202) 482-1816

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APPENDIX A

DESCRIPTION OF RADAR USAGE IN THE 5 GHZ FREQUENCY RANGE

INTRODUCTION

There is a presumption that all Federal Government radar systems operating in the 5 GHz frequency bands have the same technical characteristics and operate on military installations geographically separated from heavily populated areas. This section of the report provides a description of the federal radar usage in the 5 GHz frequency bands. To describe the radar usage in the 5 GHz frequency range, the four distinct frequency bands will be considered. The four frequency bands are: 5250-5350 MHz, 5470-5600 MHz, 5650-5670 MHz, and 5650-5725 MHz. The spectral occupancy and the anticipated future development of radars in the 5250-5725 MHz frequency range are also discussed.

FEDERAL RADARS OPERATING IN THE 5250-5350 MHZ BAND

The Federal Government radar systems operating in the 5250-5350 MHz band are primarily used by the military. These military radars have the operational capability to tune across the entire 5250-5725 MHz frequency range. The military radars that operate in this include both target search and tracking radars that can use a single frequencies or can employ frequency hopping using frequencies across the entire band. In the past these radars have been limited to operating on or near military installations. However, this was based on the military's usage prior to the terrorist attacks on September 11, 2001. One of the areas of concern in assessing interference to military radars regards future radar deployments and the expanding role of military radars in support of homeland defense. This expanded role could result in a requirement to deploy military radars in cities and near highways.

FEDERAL RADARS OPERATING IN THE 5470-5600 MHZ BAND

The radars that operate in the 5470-5500 MHz band used by military systems that are capable of tuning across the entire 5400-5900 MHz frequency range. The 5470-5600 MHz frequency band is also used by marine radars that are used for maritime navigation. The marine radar provides ships with surface search, navigation capabilities, and tracking services, particularly in inclement weather. These navigation radars are used by all categories of commercial and Government vessels, including foreign and U.S. flagged cargo, oil tankers and passenger ships operating in U.S. waters, and is vital sensor for safe navigation of waterways. The marine navigation radar provides indications and data on surface craft, obstructions, buoy markers, and navigation marks to assist in navigation and collision avoidance. Emissions from maritime radionavigation radars are observable at distances of at least several kilometers inland. The emissions are strong in the vicinity of the shoreline, on bridges near waterways, and coastlines.

FEDERAL RADARS OPERATING IN THE 5600-5650 MHZ BAND

The 5600-5650 MHz band is used by Terminal Doppler Weather Radar (TDWR) which provides quantitative measurements of gusts, wind shear, micro bursts, and other weather hazards for improving the safety of operations at major airports in the United States. In addition to TDWR, non-Government meteorological radars operate throughout the 5350-5625 MHz frequency range. In general weather surveillance radars operate near populated areas.

FEDERAL RADARS OPERATING IN THE 5650-5725 MHZ BAND

The radars that operate in the 5650-5725 MHz band are used primarily by military systems that are capable of tuning across the entire 5400-5900 MHz frequency range. The radars operating in this band segment can be either mobile or transportable and are used for surveillance and test range instrumentation. Test range instrumentation radars are used for to provide highly accurate position data on space launch vehicles and aeronautical vehicles undergoing developmental and operational testing. Periods of operation can last from minutes up to 4-5 hours, depending upon the test program that is being supported. Operations are conducted at scheduled times 24 hours per day, 7 days a week. One of the areas of concern in assessing interference to military radars regards future radar deployments and the expanding role of military radars in support of homeland defense. This expanded role could result in a requirement to deploy military radars in cities and near highways.

SPECTRUM OCCUPANCY IN THE 5250-5725 MHZ BAND

Spectrum occupancy measurements in the 5250-5925 MHz band were performed by NTIA near the cities of San Diego, Los Angles, San Francisco, and Colorado.[1] The activity in the 5250-5925 MHz band in all of these areas was highly dynamic. Radar measurement personnel have noted that, during the past 25 years of spectrum survey measurements in the band 5250-5925 MHz, weather and diurnal cycles have had a strong effect on the levels of occupancy in the band. Based on the measured spectral occupancy measurements, it is clear that in the frequency range between 5470-5725 MHz, the maximum observed signal levels are much higher as compared to levels in the other parts of the 5 GHz frequency range.

ANTICIPATED FUTURE RADAR DEVELOPMEMT TRENDS AT 5 GHZ

It is not currently known what new radar systems will be developed for use in the 5250-5725 MHz frequency range in the next few decades. But the limited amounts of spectrum available for future radar development makes it likely that new radar systems will be developed in the 5 GHz frequency range. Current trends in advanced radar design can provide some guidance as to the likely emission characteristics of such radar systems. To the extent that these

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[1] NTIA Report 97-334, *Broadband Spectrum Survey at San Diego, California,* National Telecommunications and Information Administration (Dec. 1996); NTIA Report 97-336, *Broadband Spectrum Survey at Los Angeles, California* National Telecommunications and Information Administration (May 1997); NTIA Report 99-367, *Broadband Spectrum Survey at San Francisco, California May-June 1995*, National Telecommunications and Information Administration (July 1999); NTIA Report 95-321, *Broadband Spectrum Survey at Denver, Colorado,* National Telecommunications and Information Administration (Sept. 1995).

new designs can be anticipated new services should be designed to be electromagnetically compatible with future radar systems.

Advanced radar designs are tending toward increased use of modulated compressed-pulse waveforms. These approaches include various types of phase coding (e.g., Barker codes, minimum shift keying, etc.) and frequency modulation (e.g., chirping). Assuming that this trend toward incorporating larger amounts of information in radar pulses continues, it can be expected that even compressed pulse lengths will increase. Already, some 3 GHz radars are transmitting pulse lengths on the order of 50 microseconds and 100 microseconds pulses are foreseeable. Longer pulses will tend to increase the average power output of the advanced radar transmitters. The trend is also toward solid state power output devices which will have lower peak power levels, resulting in lower detected power in the receiver systems.

APPENDIX B

DRAFT MEASUREMENT PROCEDURES FOR DFS EQUIPPED U-NII DEVICES

Introduction

The purpose of this appendix is to define procedures for testing of the radar detection capability referred to as Dynamic Frequency Selection (DFS) of unlicensed U-NII equipment operating in the frequency bands 5250 MHz to 5350 MHz and 5470 MHz to 5725 MHz. These procedures will be used to test the efficacy of DFS as an interference mechanism as formulated by the International Telecommunication Union-Radiocommunications Sector (ITU-R) and documented in Recommendation ITU-R M.1652 and called for in the U-NII Notice of Proposed Rulemaking (NPRM).[1] A major source for the content of this document is the European Telecommunication Standards Institute (ETSI) draft EN 301 893 version 1.2.2, which is the approved final European conformance standard for 5GHz operation. Using ETSI EN 301 893 and its associated reference documents as baseline for developing this test plan does not infer that the United States confers with all of the standards, practices, procedures, and tolerances set within them.

Scope

The scope of this document includes an overview of DFS operational requirements, the detection and response criteria and methods of measuring compliance with these criteria. The methods include calibration and test procedures for conducted and radiated measurements. Conducted measurements are preferred over radiated measurements because they are more precise and contain less measurement errors. Equipment with an integral antenna may be equipped with a temporary antenna connector in order to facilitate the conducted tests. When the antenna can not be separated from the device and a radio frequency (RF) test port is not provided, radiated measurements may be performed.

General information about test sites and measurement techniques are assumed to be known and not covered here.

Procedures for equipment submission; certification and other regulatory aspects are not covered in this document.

References

[1] Draft New Recommendation ITU-R M.1652

[2] Draft EN 301 893 ETSI (RLAN Radio Conformance Test standard)

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[1] *Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, ET Docket No. 03-122, (released June 4, 2003) ("U-NII NPRM").

Definitions, symbols and abbreviations

Definitions

For the purposes of the present document, following terms and definitions apply.

5 GHz U-NII bands: Frequency ranges: 5150 - 5250 MHz, 5250 - 5350 MHz, 5470 - 5725 MHz and 5725 – 5825 MHz.

Association: an active relationship between two wireless devices in which one device (referred to as “Master device” in this document) exercises certain control functions to which the other device (referred to as “Client device” in this document) has to respond.

Burst: a period during which radio waves are intentionally transmitted, preceded and succeeded by periods during which no intentional transmission is made.

Channel: amount of spectrum used by a single unlicensed U-NII device operating on one of the specified carrier frequencies

Channel Availability Check Time: the time during which a channel shall be checked for the presence of a radar signal with a level above the Interference Detection Threshold. No transmissions shall occur during this time.

Channel Closing Transmission Time: the aggregate duration of transmissions of control information by unlicensed U-NII devices during the Channel Move Time which starts upon detection of an interfering signal above the Interference Detection Threshold. The aggregate duration of all transmissions shall not count quiet periods in between transmissions.

Channel Move Time: the time taken by an unlicensed U-NII device to cease all transmissions on the current channel upon detection of an interfering signal above the Interference Detection Threshold.

Client Device: an unlicensed U-NII device operating in Client mode.

Client mode: operating mode in which the transmissions of the unlicensed U-NII device are under control of the Master. An unlicensed U-NII device in Client mode is not able to initiate a network.

In-Service Monitoring: a mechanism to check a channel in use by the unlicensed U-NII device for the presence of a radar signal with a level above the Interference Detection Threshold.

Interference Detection Threshold is the level to be used by the DFS function to detect radar interference.

Master Device: an unlicensed U-NII device operating in Master mode.

Master mode: operating mode in which the unlicensed U-NII device has the capability to transmit without receiving an enabling signal. In this mode it is able to select a channel and initiate a network by sending enabling signals to other unlicensed U-NII devices. An unlicensed U-NII network always has at least one unlicensed device operating in Master mode.

Simulated Radar burst: a series of periodic radio wave pulses, separated by a period during which no pulses are transmitted.

Symbols

For the purposes of the present document, the following symbols apply:

A	Measured power output (dBm)
B	Radar burst period
Ch_f	Channel free from radars
Ch_r	Channel occupied by a radar
D	Measured power density
E	Field strength
E_o	Reference field strength
f_c	Carrier frequency
G	Antenna gain (dBi)
L	Radar burst length
n	Number of channels
P_H	Calculated EIRP at highest power level
P_L	Calculated EIRP at lowest power level
PD	Calculated power density
R	Distance
R_o	Reference distance
S0	Signal power
T0	Time instant
T1	Time instant
T2	Time instant
T3	Time instant
W	Radar pulse width
x	Observed duty cycle

Abbreviations

For the purposes of the present document, the following abbreviations apply:

DFS	Dynamic Frequency Selection
EMC	Electro-Magnetic Compatibility
EIRP	Equivalent Isotropic Radiated Power
LV	Low Voltage
PRF	Pulse Repetition Frequency
RE	Radio Equipment

UUT Unit Under Test

Technical Requirements for DFS

DFS Overview

An unlicensed U-NII network shall employ a DFS function to:

- detect interference from other systems and to avoid co-channel operation with these systems, notably radar systems.
- provide on aggregate a uniform loading of the spectrum across all devices by selecting at startup, at random, on one of the channels that the unlicensed device is capable of operating.

The DFS function as described in the present document is not tested for its ability to detect frequency agile radars. Within the context of the operation of the DFS function, an unlicensed U-NII device shall operate in either Master mode or Client mode. Unlicensed devices operating in Client mode (Client device) can only operate in a network controlled by a unlicensed U-NII device operating in Master mode (Master device).

The operational behavior and individual DFS requirements that are associated with these modes are as follows:

Master Devices

a) The Master device shall use a Radar Interference Detection function in order to detect radar signals with a level above the *Interference Detection Threshold* in the frequency ranges 5250 – 5350 MHz and 5470 – 5725 MHz. Radar detection is not required in the frequency range 5150 – 5250 MHz or 5725 – 5825 MHz.

b) The Master device initiates an unlicensed U-NII network by transmitting control signals that will enable other unlicensed U-NII devices to Associate (participate in a wireless network) with the Master device.

c) Before initiating a network on a Channel, the master shall perform a C*hannel Availability Check* for a certain duration (*Channel Availability Check Time*) to ensure that there is no radar operating on the Channel, using the Radar Interference Detection function described under a).

d) During normal operation, the Master shall monitor the operating channel *(In-Service Monitoring)* to ensure that there is no radar operating on the channel, using the Radar Interference Detection function described under a).

e) If the Master device has detected a radar signal, during In-Service Monitoring as described under d), the operating Channel of the unlicensed U-NII network is made unavailable. The Master shall instruct all Associated devices to stop transmitting on this Channel, which they shall do within the *Channel Move Time*. The Aggregate Transmissions during the *Channel Move Time* should be limited to the *Channel Closing Transmission Time*.

f) A Master device shall not attempt to initiate a network on a Channel in the frequency range 5600-5650 MHz during a period defined as the *Non-Occupancy Period* after a radar has been detected in that Channel, regardless of the outcome of any In-Service Monitoring or Channel Availability Check procedures. The *Non-Occupancy Period* commences at the time the radar was detected in the Channel.

Client devices

a) An unlicensed U-NII Client device shall not transmit before having received an appropriate enabling signal from a Master device.

b) An unlicensed U-NII Client device shall stop all its transmissions whenever instructed by a Master device to which it is associated. The device shall not resume any transmissions until it has again received enabling signals from a Master device.

c) An unlicensed U-NII Client device that incorporates a Radar Interference Detection function shall inform the Master device and stop its networks transmission if it detects a radar.

The Master device may implement the Radar Interference Detection function referred to under a) using another device Associated with the Master. In such a case, the combination should be tested against the requirements applicable to the Master.

Applicability

In Tables 1 and 2 shown below, the applicability of DFS requirements prior to use of a channel *(Channel Availability Check)* and during normal operation *(In-Service Monitoring)* for each of the above mentioned operational modes.

The manufacturer shall state whether the UUT is capable of operating as a Master and/or as a Client. If the UUT is capable of operating in more than one operating mode then each operating mode shall be tested separately.

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 (required for band 5600-5650 MHz)	✓	Not required	✓
Interference Detection Threshold	✓	Not required	✓
Channel Availability Check Time	✓	Not required	Not required
Uniform Spreading	✓	Not required	Not required

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode		
	Master	**Client** (without radar detection)	**Client** (with radar detection)
Interference Detection Threshold	✓	Not required	✓
Channel Closing Transmission Time	✓	✓	✓
Channel Move Time	✓	✓	✓

Detection Threshold values

The following tables give the DFS thresholds for Master devices and for Client devices.

Table 3A: Interference Threshold values, Master

Maximum Transmit Power	Value (see note)
≥200 mW	-64 dBm
<200 mW	-62 dBm
Note: This is the level at the input of the receiver assuming a 0 dBi receive antenna	

Table 3B: Interference Threshold values, Client

Maximum Transmit Power	Value
≥200 mW	-64 dBm
<200 mW	-62 dBm
Note: This is the level at the input of the receiver assuming a 0 dBi receive antenna	

Response Requirements

The following table gives the response requirements for DFS implementation.

Table 4: DFS Response requirement values

Parameter	Value
Non-occupancy period	30 minutes
Channel Availability Check Time	60 s
Channel Move Time	10 s
Channel Closing Transmission Time	260 ms

Testing for Compliance with Technical Requirements

Radar Test Signals

The DFS test signals shown in Table 5 shall be used.

Table 5: Parameters of DFS test signals

Radar test signal	Pulse repetition frequency PRF [pps]	Pulse width W [µs]	Burst length L [ms] / No. of pulses (Note 1)	Burst Period B [sec] (Note 2)	Hopping Rate (Note 4)
Fixed Frequency Radar signal 1	700	1	26 / 18	10	Na
Fixed Frequency Radar signal 2	1800	1	5 / 10	2	Na
Frequency Hopping Radar	3000	1	100/300	10	1 kHz

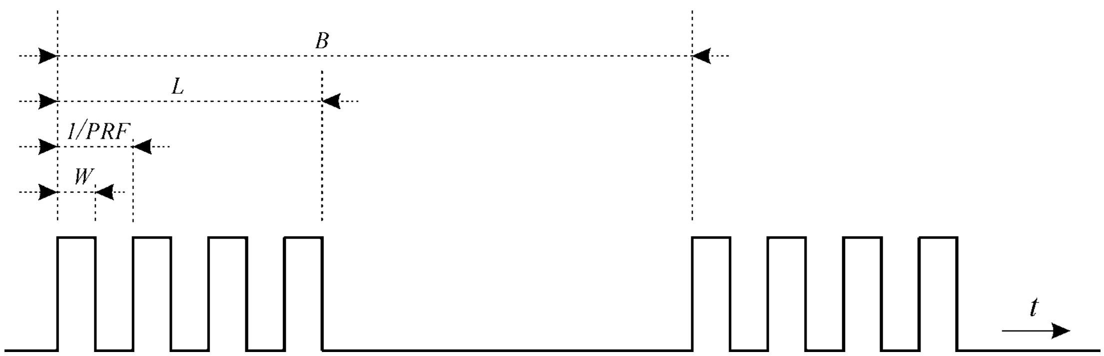
Note 1: This represents the number of pulses seen at the unit under test (UUT) per radar scan N = [{antenna beamwidth (deg)} x {pulse repetition rate (pps)}] / [{scan rate (deg/s)}]

Note 2: Burst period represents the time between successive scans of the radar beam
B = 360/{scan rate (deg/s)}

Note 3: Radar bandwidth is less than that of the unlicensed U-NII device.

Note 4: The characteristics of this frequency hopping radar do not correspond to any specific system. It can hop across the 5250-5725 MHz band. The frequencies will be selected by using a random without replacement algorithm until all 475 frequencies have been used. After all have been used, the pattern is reset and a new random set is generated.

Figure 1: General structure of the DFS test transmission sequences



Test Procedures

DFS Testing

Conducted Test conditions

The conformance requirements given in the section on Technical Requirements for DFS shall be verified under normal operating conditions, and in each of the stated frequency range(s), and with each of the applicable radar signals defined in Table 5.

For a UUT with antenna connector(s) and using external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector provided, conducted measurements shall be used. In this case, and if the UUT has a Radar Interference Detection Function, the output power of the signal generator producing the radar test signals shall provide a received signal power at the antenna connector of the UUT with a level equal to (*Interference Detection Threshold* + G), see Tables 3A and 3B. Parameter G [dBi] corresponds to the gain of the antenna assembly stated by the manufacturer. If more than one antenna assembly is intended, the gain of the antenna assembly with the lowest gain shall be used.

For a UUT with integral antenna(s) and without temporary antenna connector, radiated measurements shall be used. In this case, and if the UUT has a Radar Interference Detection Function, the output power of the signal generator shall provide a signal power at the antenna with a level equal to *Interference Detection Threshold.*

Some of the tests may be performed more readily if the channel selection mechanism for the uniform spreading requirement can be disabled, for example, to ensure selection of a channel outside the 5150-5250 MHz and 5725-5825 MHz bands.

It should be noted that once a UUT is powered on, it will not start its normal operating functions immediately, as it will have to finish its power-up cycle first (T_{power_up}). As such, the UUT, as well as any other device used in the set-up, may be equipped with a feature that will indicate its status during the testing, including, for example, power-up mode, normal operation mode, channel check status and radar detection event.

Conducted Test Configurations

The sections below contain simplified block diagrams that focus on the radar signal injection path for each of the different conducted set-ups to be used. The basic set-up is identical for all cases. Full details of this setup, including calibration, can be found in Annex B to this document.

Test of the DFS functions of the Master

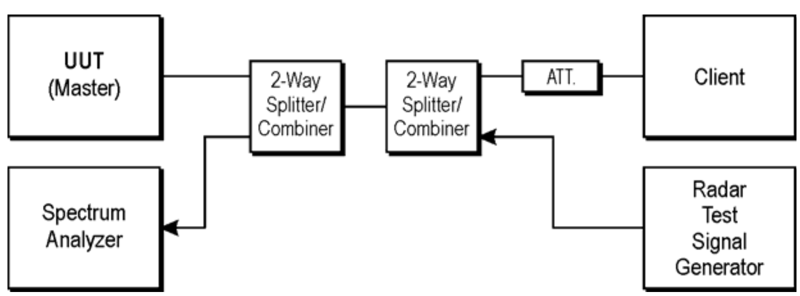
Set-up A: Master with injection at the Master

When the UUT is an unlicensed device operating as a Master, the test set-up, further referred to as *'Set-up A'* shall be used.

'Set-up A' consists of a signal generator connected to the UUT and an unlicensed device operating as a Client. The latter is assumed to Associate with the UUT (Master).

Figure 2 shows a block diagram for *'Set-up A.'*

Figure 2: Conducted Set-Up where UUT is a Master and Radar Test Signals are injected into the Master



Test of DFS functions of the Client

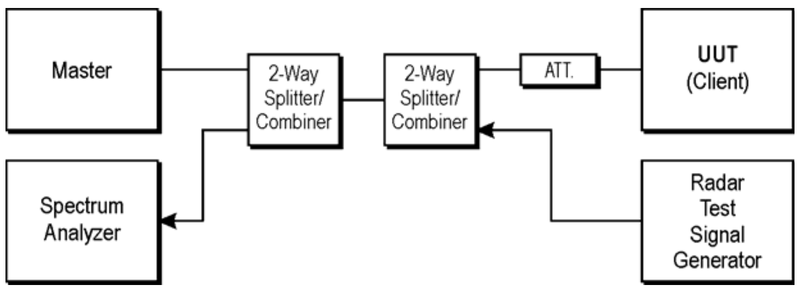
Set-up B: Client with injection at the Master

When the UUT is an unlicensed device operating as a Client, with or without a Radar Interference Detection Function (RIDF), the test set-up, further referred to as '*Set-up B'* shall be used.

'Set-up B' consists of a signal generator connected to a unlicensed device operating as a Master and the UUT. The latter is assumed to Associate with the Master.

Figure 3 shows an example for *'Set-up B.'* The set-up used shall be documented in the test report.

Figure 3: Conducted Set-Up B where UUT is a Client and Radar Test Signals are injected into the Master

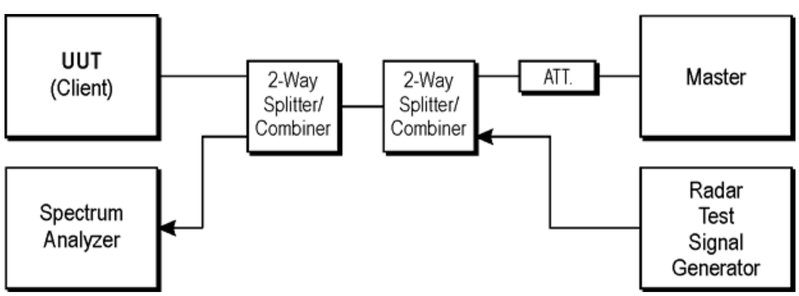


Set-up C: Client with injection at the Client

When the UUT is an unlicensed device operating as a Client with a Radar Interference Detection Function (RIDF), the tests described in the section on Test of DFS Function of the Client need to be repeated using a set-up, further referred to as '*Set-up C.'*

'Set-up C' consists of a signal generator connected to the UUT (Client).
Figure 4 shows an example for *'Set-up C.'*

Figure 4: Conducted Set-Up C - where UUT is a Client and Radar Test Signals are injected into the Client



For the purposes of the test, the UUT as well as other unlicensed U-NII devices used in the set-up may be equipped with a specific user interface to allow monitoring of the behavior of the different devices of the set-up during the tests.

The UUT is capable of transmitting a test transmission sequence. The signal generator is capable of generating any of the radar test signals defined in Table 5. Adequate measurement equipment, *e.g.*, spectrum analyzer, shall be used to measure the aggregate transmission time of the UUT.

Radiated Test conditions

The conformance requirements given in the section on Technical Requirements for DFS shall be verified under normal operating conditions, and in each of the stated frequency range(s), and with each of the applicable radar signals defined in Table 5.

For a UUT with integral antenna(s) and without temporary antenna connector, radiated measurements shall be used. In this case, and if the UUT has a Radar Interference Detection Function, the output power of the signal generator shall provide a signal power at the antenna with a level equal to *Interference Detection Threshold* .

Some of the tests may be performed more readily if the channel selection mechanism for the uniform spreading requirement can be disabled, for example, to ensure selection of a channel outside the 5150-5250 MHz and 5725-5825 MHz bands. It should be noted that once a UUT is powered on, it will not start its normal operating functions immediately, as it will have to finish its power-up cycle first (T_{power_up}). As such, the UUT, as well as any other device used in the set-up, may be equipped with a feature that will indicate its status during the testing, including, for example, power-up mode, normal operation mode, channel check status and radar detection event.

Radiated Test Configurations

The sections below contain simplified block diagrams that focus on the radar signal injection path for each of the different radiated set-ups to be used. The basic set-up is identical for all cases. Full details of this setup, including calibration, can be found in Annex C to this document.

Test of the DFS functions of the Master

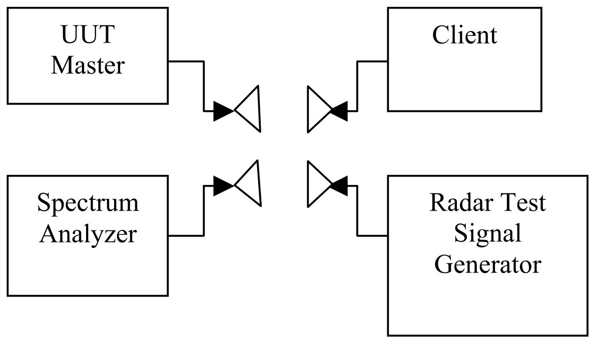
Set-up A: Master with injection at the Master

When the UUT is an unlicensed U-NII device operating as a Master, the test set-up, further referred to as *'Set-up A'* shall be used.

'Set-up A' consists of a signal generator connected to the UUT and an unlicensed U-NII device operating as a Client. The latter is assumed to be associated with the UUT (Master).

Figure 5 shows a block diagram for *'Set-up A.'*

Figure 5: Radiated Set-Up where UUT is a Master and Radar Test Signals are injected into the Master



Test of DFS functions of the Client

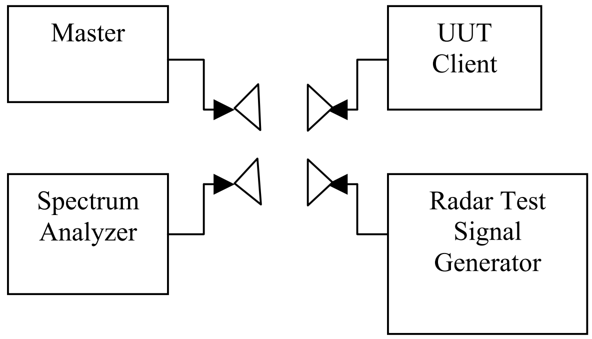
Set-up B: Client with injection at the Master

When the UUT is an unlicensed U-NII device operating as a Client, with or without a RIDF, the test set-up, further referred to as '*Set-up B'* shall be used.

'Set-up B' consists of a signal generator connected to an unlicensed U-NII device operating as a Master and the UUT. The latter is assumed to be associated with the Master.

Figure 6 shows an example for *'Set-up B.'* The set-up used shall be documented in the test report.

Figure 6: Radiated Set-Up B where UUT is a Client and Radar Test Signals are injected into the Master

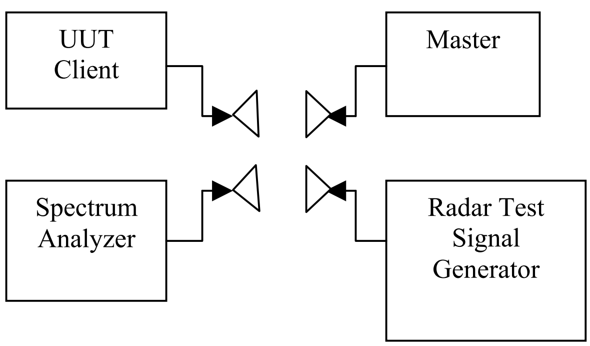


Set-up C: Client with injection at the Client

When the UUT is an unlicensed U-NII device operating as a Client with a RIDF, the tests described in Test of DFS Functions as the Client need to be repeated using a set-up, further referred to as '*Set-up C.'*

'Set-up C' consists of a signal generator connected to the UUT (Client). Figure 7 shows an example for *'Set-up C.'*

Figure 7: Radiated Set-Up C - where UUT is a Client and Radar Test Signals are injected into the Client



For the purposes of the test, the UUT as well as other unlicensed U-NII devices used in the set-up may be equipped with a specific user interface to allow monitoring of the behavior of the different devices of the set-up during the tests.

The UUT is capable of transmitting a test transmission sequence. The signal generator is capable of generating any of the radar test signals defined in Table 5.

Adequate measurement equipment, *e.g.*, spectrum analyzer, shall be used to measure the aggregate transmission time of the UUT.

Radar Signal Generation and Calibration

Detailed set-up and instructions for calibration are given in Annexes B and C.

Unlicensed U-NII device initialization

This section describes the verification procedure for the Channel Availability Check to be performed at initialization of an unlicensed U-NII device. See section on DFS overview.

One channel, outside the 5150-5250 MHz and 5725-5825 MHz range, is selected from the stated operating frequency range(s) of the UUT. This channel is designated as Ch_r (channel occupied by a radar).

The UUT shall be configured to select Ch_r as the first operating channel.
$T_{ch\_avail\_check}$ is the minimum Channel Availability Check Time as specified in Table 4.

The different steps below define the procedure to verify the response behavior parameters when a radar burst is generated on the selected channel at the beginning or at the end of the Channel Availability Check Time.

Radar burst at the beginning of the Channel Availability Check Time

The steps below define the procedure to verify successful radar detection on the selected channel during a period equal to the *Channel Availability Check Time* and avoidance of operation on that channel when a radar burst with a level equal to the *Interference Detection Threshold* occurs at the beginning of the Channel Availability Check Time.

a) The signal generator and UUT are connected using the applicable test set-ups described in section on Conducted Tests and the power of the UUT is switched off.

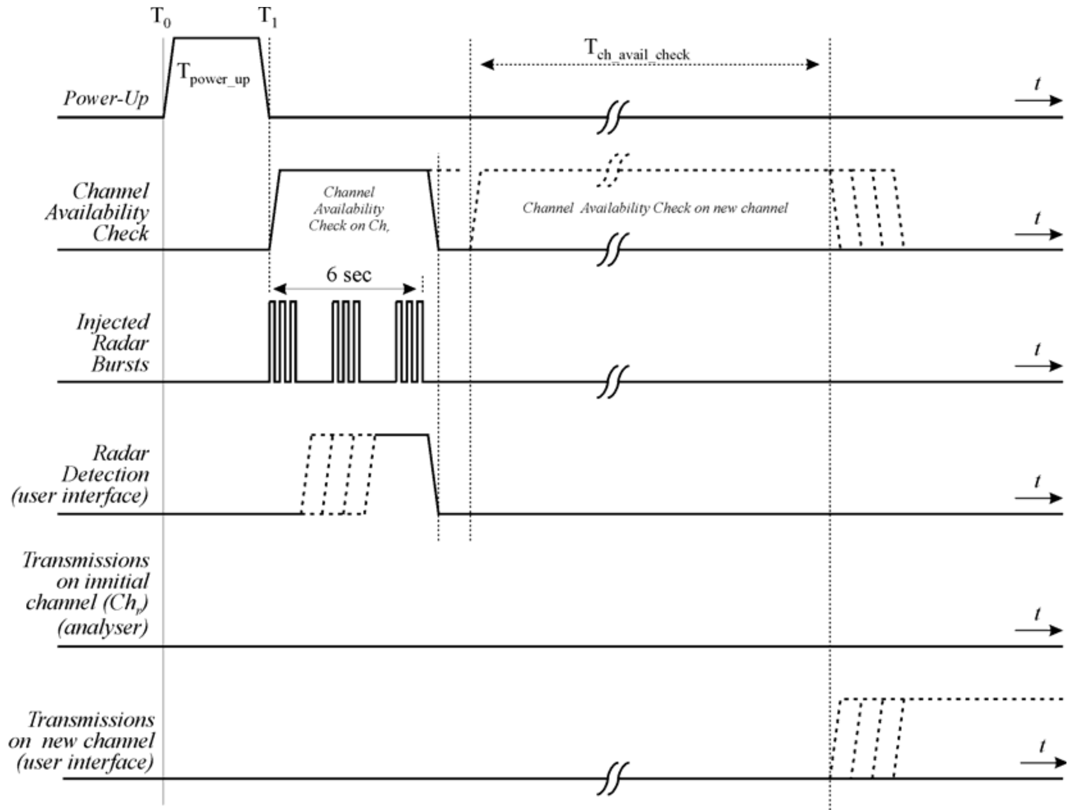
b) The UUT is powered on at T0. T1 denotes the instant when the UUT has completed its power-up sequence (T_{power_up}). The channel availability check is expected to commence on Ch_r at instant T1 and is expected to end no sooner than T1 + $T_{ch\_avail\_check}$ unless a radar is detected sooner.

c) Radar bursts are generated on Ch_r using one of the test patterns defined in Table 5. Radar bursts should commence at time T1 and should continue for approximately 6 seconds.

d) Visual indication on the UUT of successful detection of the radar burst (if indication is available) should be recorded. Observation of Ch_r shall continue until the UUT starts transmitting on another channel. *(In the example given below, the UUT performs a channel availability check on a new channel after it has detected a radar on Ch_r).* It shall be verified and recorded that during the above steps no transmissions occurred on Ch_r.

e) A timing trace or description of the observed timing and behavior of the UUT should be reported.

Figure 8: Example of timing for radar testing at the beginning of the Channel Availability Check Time



Radar burst at the end of the Channel Availability Check Time

The steps below define the procedure to verify successful radar detection on the selected channel during a period equal to the *Channel Availability Check Time* and avoidance of operation on that channel when a radar burst with a level equal to the *Interference Detection Threshold* occurs at the end of the Channel Availability Check Time.

a) The signal generator and UUT are connected using the applicable test set-ups referred to in section on Conducted Test Configurations and the power of the UUT is switched off.

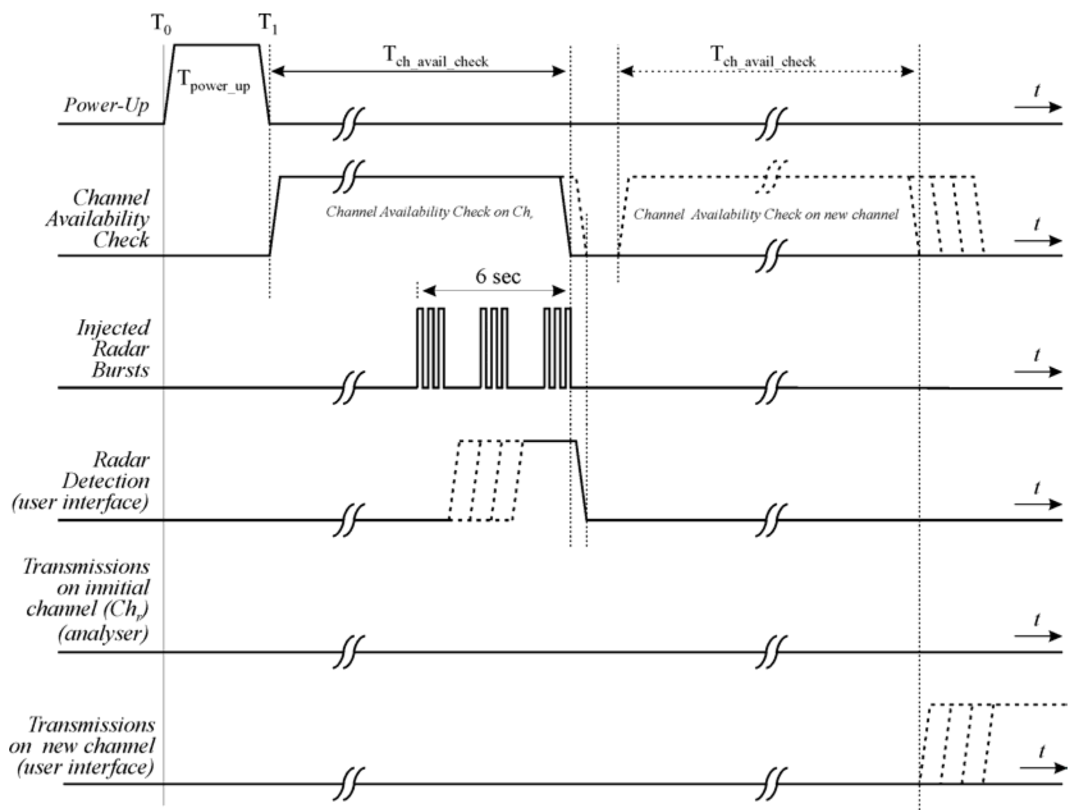
b) The UUT is powered up at T0. T1 denotes the instant when the UUT has completed its power-up sequence (T_{power_up}). The channel availability check is expected to commence on Ch_r at instant T1 and is expected to end no sooner than T1 + $T_{ch\_avail\_check}$ unless a radar is detected sooner.

c) Radar bursts are generated on Ch_r using one of the test patterns defined in section 5.1 at a level defined in the DFS Overview section. Radar bursts should commence near the end of the minimum required Channel Availability Check Time at time T1 + $T_{ch\_avail\_check}$ – 6 [sec] and should continue for the duration of this test.

d) Visual indication on the UUT of successful detection of the radar burst (if indication is available) should be recorded. Observation of Ch_r shall continue until the UUT starts transmitting on another channel. *(In the example given below, the UUT performs a channel availability check on a new channel after it has detected a radar on Ch_r).* It shall be verified and recorded that during the above steps no transmissions occurred on Ch_r.

e) A timing trace or description of the observed timing and behavior of the UUT should be recorded.

Figure 9: Example of timing for radar testing towards the end of the Channel Availability Check Time



In-Service Monitoring

These tests define how the following DFS parameters can be verified during In-Service Monitoring

- Interference Detection Threshold
- 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 *Interference Detection Threshold* is generated on the channel of operation of the unlicensed U-NII device *(In- Service Monitoring).*

a) A channel outside 5150-5250 MHz and 5725-5825 MHz bands is selected from the stated operating frequency range(s).

b) In case the UUT is an unlicensed U-NII device operating as a Client (with or without Radar Interference Detection Function), an unlicensed U-NII device operating as a Master will be used to allow the UUT to associate with the Master. In case the UUT is a Master, an unlicensed U-NII device operating as a Client will be used and it is assumed that the Client will associate with the UUT (Master). In both cases, the signal generator shall be connected to the Master.

c) The UUT transmits a test transmission sequence on the selected channel.

d) At a certain time T0 the signal generator starts generating one of the radar test patterns defined in Table 5 at a level defined in the section on Response Requirements on the selected channel. T1 denotes the end of the first radar burst.

e) The transmissions of the UUT following instant T1 on the selected channel shall be observed for a duration of at least 10 seconds. The aggregate duration of all transmissions from the UUT during the observation time (*Channel Closing Transmission Time)* shall be noted and compared to the limit defined in Table 4. Note: the aggregate duration of all transmissions of the UUT does not include quiet periods in between transmissions of the UUT.

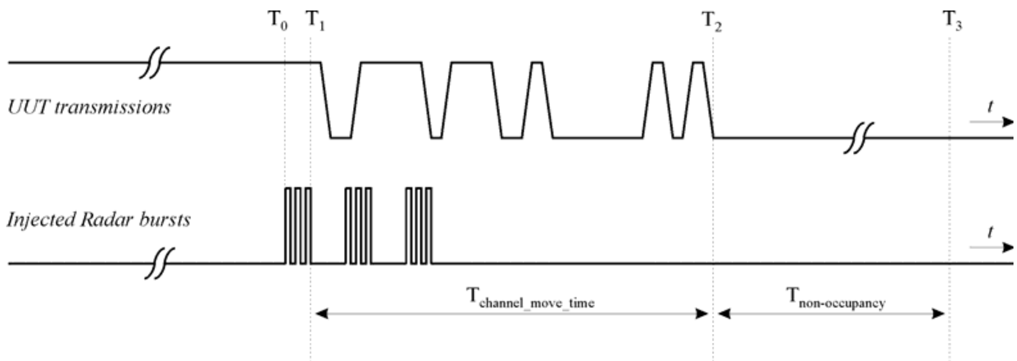
f) T2 denotes the instant when the UUT has ceased all transmissions on the channel. The time difference between T1 and T2 shall be measured. This value *(Channel Move Time*) shall be noted and compared with the limit defined in Table 4.

g) When the UUT is an unlicensed U-NII device operating as a Master, following instant T2, the selected channel shall be monitored for an additional 30 minutes (*Non-Occupancy Period*) until instant T3, to verify that the UUT does not resume any transmissions on this channel.

h) The test shall be repeated using each of the radar signals defined in the section on Testing for Compliance with Technical Requirements;

i) In case the UUT is an unlicensed U-NII device operating as a Client with a Radar Interference Detection Function, the steps a) to h) shall be repeated with the generator connected to the UUT.

Figure 10: Channel Closing Transmission Time & Channel Clearing Time



Annex A

General Requirements

Product information

The following information shall be stated by the manufacturer in order to facilitate the execution of the test suites:

a) the operating frequency range(s) of the equipment;

b) the operating modes (Master and/or Client)

c) the highest and the lowest possible power level (equivalent isotropically radiated power (EIRP)) of the equipment;

d) the intended antenna assemblies and their corresponding gains;

e) the test sequences or messages used for communication between Master and Client devices.

Interpretation of the measurement results

The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in Table A.1;
- the shared risk approach shall be applied for the interpreting of all measurement results.

Table A.1: Maximum measurement uncertainty

Parameter	Uncertainty
RF frequency	$\pm 1 \times 10^{-5}$
RF power conducted	±1.5 dB
RF power radiated	±2 dB
Spurious emissions, conducted	±3 dB
Spurious emissions, radiated	±2 dB
Time	±5 %

Channel Loading

The data test file that is used for transmissions to/from the master and the client should be constructed so that the data packets are representative of the weighting factors shown in Table A2 for packet size and data rate (Annex 4 Table 4 of Recommendation ITU-R M. 1652).

Table A2
Weighting of data test file

Packet size (bytes)	Weight
64	0.6
538	0.2
1 500	0.2

Data rate (Mbit/s)	Weight
6	0.1
12	0.1
18	0.1
24	0.3
36	0.3
54	0.1

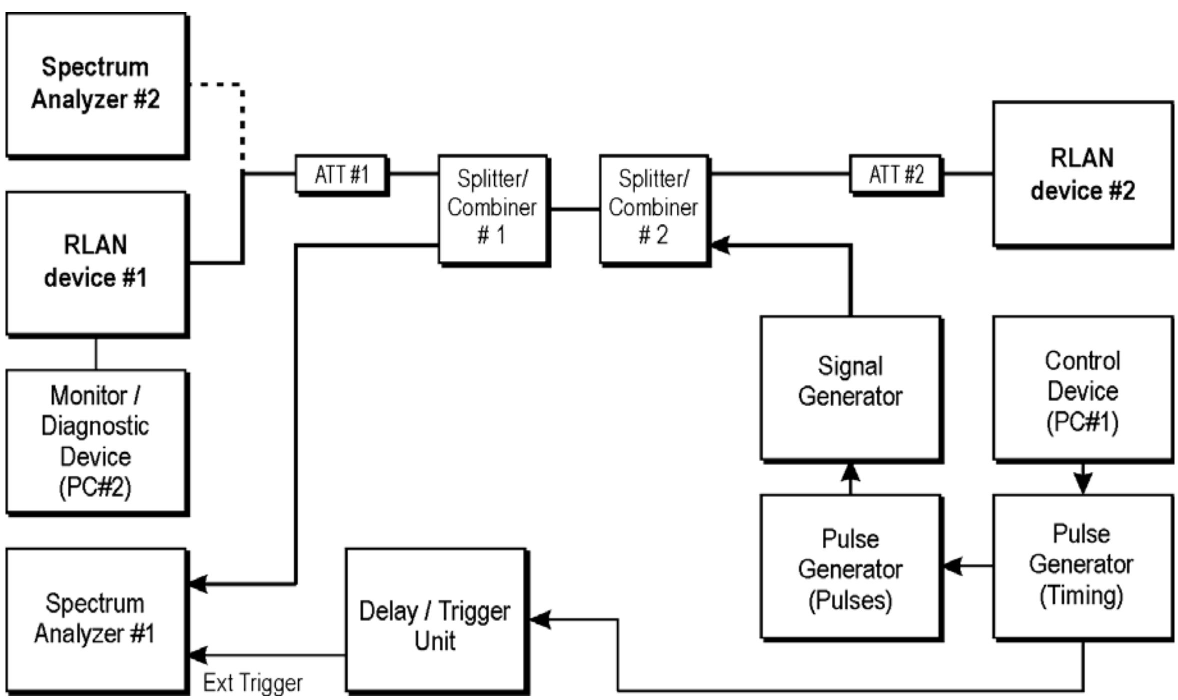
Annex B

Conducted Test Set-up and Calibration

Block Diagram

Conducted measurements are the preferred method to perform these tests. In this method, cables are used to supply the unlicensed U-NII device signals to/from the devices under test and the test equipment. Equipment with an integral antenna may be equipped with a temporary antenna connector in order to facilitate the conducted tests. Figure B1 shows a detailed set-up for performing conducted measurements.

Figure B1: Conducted DFS Measurements - Test Set-Up



It is important to note that the Signal Generator used should have the 'Short Pulse' option to guarantee that the Automatic Level Control circuitry can also deal with short pulses (this will be verified during the calibration part.). It might be possible that the function of the Delay/Trigger unit is part of the features of Spectrum Analyzer #1.

The value of the attenuator #1 and attenuator #2 are chosen in such a way that the received unlicensed U-NII signal (unlicensed U-NII device #2) at the input of the UUT (unlicensed U-NII device #1) is minimum about 20 dB above the threshold level to be tested (the received unlicensed U-NII device signal should be much stronger as the radar test signals). The duty cycle of the unlicensed U-NII device transmissions should be sufficiently high. Also the duration of the unlicensed U-NII device transmissions should be sufficiently high to allow the measurements to be repeated a number of times (*e.g.*, 10 times). In order to allow some of the tests to be repeated on the same channel, it may be required for the diagnostic software to disable the 'move to a new channel feature' after a radar pulse was detected the first time, otherwise the whole set-up need to be re-calibrated on the new frequency.

Calibration procedure

1) During this calibration, there are no transmissions initiated by the UUT.
2) For calibrating the test set-up (exact threshold level at the UUT, unlicensed device #1), the UUT is replaced by a Spectrum Analyzer with an accurate power level measurement feature.
3) The Spectrum Analyzer #2 is switched to Zero Span' mode and to the 'Time Domain' mode and it shall be verified if the level of each of the Radar pulses is identical. This is required to verify the proper functioning of ALC circuit of the Signal Generator for short pulses. For each of the tests (different radar test signals), the level of the Signal Generator is adjusted until the appropriate level (e.g. -62 dBm) is measured by the Spectrum Analyzer #2.
4) The Spectrum Analyzer #1 is switched to 'Zero Span' mode and to the 'Time Domain' mode with an adaptive sweep time. The time base of the Spectrum Analyzer is externally triggered by the Pulse Generator through a delay circuit so that the sweep is already started a few ms before the first pulse of the Signal Generator appears. This will bring the radar burst clearly within the view window of the analyzer.
5) A reference point, indicating the start of the first pulse of the radar test signal (often equal to the time of the external trigger) should be set (marker T1) before any UUT transmissions are initiated.
6) The Radar Test Signal is switched off.

Taking Measurements

- The Monitor/Diagnostic Device (PC#2) starts transmissions between the 2 unlicensed U-NII devices.
- The Control Device #2 will switch on the Radar Test Signal at the instances indicated in the procedures in section 5
- The screen will now show the behavior of the unlicensed U-NII devices to the Radar Test Signal.

Note: it should be possible, with the above described set-up, to distinguish (on the spectrum analyzer screen) (1) the Radar Test Signals, (2) U-NII

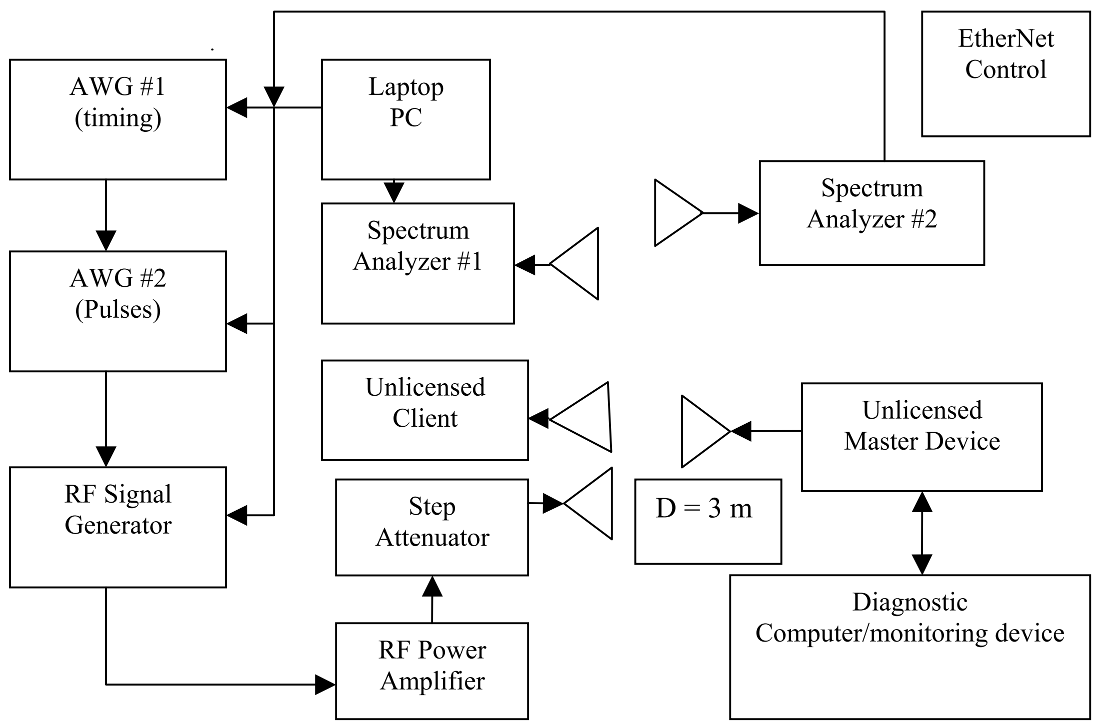
Annex C

Radiated Test Set-up and Calibration

Block Diagram

Radiated tests may be performed when the antenna of the unlicensed U-NII device is integral (i.e., the antenna cannot be separated from the device) and an external antenna port is not provided. Figure C1 shows a detailed set-up for performing the radiated test measurements.

Figure C-1.



Calibration procedure

During this calibration, there are no transmissions initiated by the UUT.

1) For calibrating the test set-up (exact threshold level at the UUT) Spectrum analyzer #2 will be used to measure the power output of the radar signal simulator for each type of signal in Table 5.

2) Spectrum Analyzer #2 will be set to zero span mode with the RMS detector at the frequency of the chosen unlicensed device channel. The resolution and video bandwidth will be set to 1 MHz. The unlicensed device integration time as defined by the ITU is 1 microsecond. In order to achieve this integration time, the sweep time of the analyzer must be set

appropriately as follows. If the analyzer has 1000 points or "bins" across its display, the sweep time is equal to that number multiplied by 1 microsecond, or 1 millisecond. For 8000 points (the maximum on the Agilent E440 analyzer) the sweep time would be set to 8 milliseconds.

3) The radar signal generator will be turned on (for each radar type) and be allowed to "free run." The pulses will be constantly on and not generated in bursts. Note that the frequency hopping radar will be set to a fixed frequency.

4) The step attenuator will be used to adjust the power level at Spectrum Analyzer #2 to the level that is required for the tests.

   This value must be adjusted for the gain of the horn antenna connected to the analyzer and adjusted once again if the antenna on the unlicensed U-NNII device has gain.
   The techniques for measuring pulsed emissions from radars can be found in ITU-R M.1177-2.

5) After the attenuator has been adjusted to achieve the proper power level the RF output of the simulator will be turned off.

Taking Measurements

Fixed Frequency Radar Simulator

1) The power level (-64, -62, -55 dBm) of the radar signal will be calibrated for the appropriate radar signal type in Table 5 at the antenna of the unlicensed U-NII device. The higher power level (-55 dBm) will be used to test the DFS functionality of the unlicensed device before the ITU detection thresholds are tested.

2) The unlicensed U-NII devices will be turned on and be instructed to operate on the appropriate unlicensed U-NII channel that must incorporate DFS functions. Attenuators or some type of power control will be used to set the power of the unlicensed link [to be determined] dB above the radar simulator power.

3) The radar simulator will be turned on and emulate one of the two fixed frequency radars in Table 5 with the appropriate parameters (pulsewidth, burst length, and burst period).

4) Spectrum analyzer #1 and a diagnostic computer/monitor will be used to monitor the output of the unit under test (UUT) to observe that its behavior is consistent with the channel occupancy and move times of ITU-R M.1652.

5) If the UUT does not properly detect the simulated radar pulses in [to be determined] minutes the device will not pass the test.

Note that both types of Fixed frequency radars from Table 5 will be tested.

Frequency Hopping Radar Simulator

1) The power level (-64, -62, -55 dBm) of the radar signal will be calibrated for the frequency hopping radar signal type in Table 5 at the antenna of the unlicensed U-NII

device. The higher power level (-55 dBm) will be used to test the DFS functionality of the unlicensed device before the ITU detection thresholds are tested.

2) The unlicensed U-NII devices will be turned on and be instructed to operate on the appropriate U-NII channel that must incorporate DFS functions. Attenuators or some type of power control will be used to set the power of the unlicensed link [to be determined] db above the radar simulator power.

3) The radar simulator will be turned on and emulate the frequency hopping radar in Table 5 with the appropriate parameters (pulsewidth, burst length, burst period, and hopping rate).

4) Spectrum analyzer #1 and a diagnostic computer/monitor will be used to monitor the output of the unit under test (UUT) to observe that its behavior is consistent with the channel occupancy and move times of ITU-R M.1652.

5) The UUT will be monitored for [to be determined] minutes to determine if it can detect the frequency hopping radar.

APPENDIX C

SCHEDULE OF PROJECTED MILESTONES FOR 5 GHZ PROJECT TEAM

Task_Name	Duration	Start_Date	Finish_Date	Status
Bench Test Procedures	116 days	9-Jun-03	14-Nov-03	Incomplete
Draft Bench Test Procedures	39 days	9-Jun-03	31-Jul-03	Yes
Draft Deadline	1 day	31-Jul-03	31-Jul-03	Yes
DFS Project Team Meeting	1 day	15-Aug-03	15-Aug-03	Yes
Finalize Bench Test Procedures	11 days	18-Aug-03	31-Aug-03	Yes
Bench Test Procedure Deadline	1 day	31-Aug-03	31-Aug-03	Yes
FCC NPRM Comment Reply Deadline	1 day	3-Sep-03	3-Sep-03	Yes
Bench Testing	10 days	3-Nov-03	14-Nov-03	Confirmed
Bench Test Report	76 days	17-Nov-03	1-Mar-04	Incomplete
Draft Report	66 days	17-Nov-03	16-Feb-04	Pending
DFS Project Team Meeting	1 day	15-Jan-04	15-Jan-04	Pending
DFS Project Team Meeting	1 day	2-Feb-04	2-Feb-04	Pending
Submit to FCC	1 day	1-Mar-04	1-Mar-04	Pending
Field Test Procedures	100 days	1-Mar-04	15-Jul-04	Incomplete
Outline Field Test Procedures	34 days	1-Mar-04	15-Apr-04	Pending
Draft Field Test Procedures	22 days	16-Apr-04	16-May-04	Pending
Draft Deadline	1 day	16-May-04	16-May-04	Pending
DFS Project Team Meeting	1 day	5-May-04	5-May-04	Pending
Radar Asset Confirmation Deadline	1 day	31-May-04	31-May-04	Pending
DFS Project Team Meeting	1 day	1-Jun-04	1-Jun-04	Pending
Finalize Field Test Procedures	11 days	1-Jun-04	15-Jun-04	Pending
Field Test Procedures Deadline	1 day	15-Jun-04	15-Jun-04	Pending
Field Testing	11 days	1-Jul-04	15-Jul-04	Pending
Field Test Report	66 days	16-Jul-04	15-Oct-04	Incomplete
Draft Report	13 days	16-Jul-04	3-Aug-04	Pending
DFS Project Team Meeting	1 day	31-Jul-04	31-Jul-04	Pending
DFS Project Team Meeting	1 day	3-Aug-04	3-Aug-04	Pending
Submit to FCC	1 day	15-Oct-04	15-Oct-04	Pending
Comprehensive NTIA Report	65 days	19-Oct-04	17-Jan-05	Incomplete
Draft Report	57 days	19-Oct-04	5-Jan-05	Pending
Report Deadline	1 day	3-Jan-05	3-Jan-05	Pending
Submit to FCC	1 day	17-Jan-05	17-Jan-05	Pending
ITU Methodology	296 days	15-Mar-04	29-Apr-05	Incomplete
Draft DFS Testing Question	192 days	15-Mar-04	6-Dec-04	Pending
Drafting of DFS Test Question	106 days	15-Mar-04	6-Aug-04	Pending
Submit to U.S. Preparatory Process	1 day	11-Aug-04	11-Aug-04	Pending

Submit to ITU-R WP 8A	1 day	1-Sep-04	1-Sep-04	Pending
Draft New Question Deadline	1 day	6-Dec-04	6-Dec-04	Pending
Draft Methodology Recommendation	207 days	15-Jul-04	29-Apr-05	Pending
Drafting of DFS Recommendation	45 days	15-Jul-04	15-Sep-04	Pending
Submit to U.S. Preparatory Process	1 day	17-Sep-04	17-Sep-04	Pending
Submit to ITU-R WP 8A	1 day	1-Oct-04	1-Oct-04	Pending
Draft New Recommendation Deadline	1 day	29-Apr-05	29-Apr-05	Pending