



Functional Requirements for the U.S. 6 GHz Band under the Control of an AFC System

Document WINNF-TS-1014

Version V1.0.0

16 December 2021



TERMS, CONDITIONS & NOTICES

This document has been prepared by the 6 GHz Committee Functional Specification WG to assist The Software Defined Radio Forum Inc. (or its successors or assigns, hereafter “the Forum”). It may be amended or withdrawn at a later time and it is not binding on any member of the Forum or of the 6 GHz Committee Functional Specification WG.

Contributors to this document that have submitted copyrighted materials (the Submission) to the Forum for use in this document retain copyright ownership of their original work, while at the same time granting the Forum a non-exclusive, irrevocable, worldwide, perpetual, royalty-free license under the Submitter’s copyrights in the Submission to reproduce, distribute, publish, display, perform, and create derivative works of the Submission based on that original work for the purpose of developing this document under the Forum's own copyright.

Permission is granted to the Forum’s participants to copy any portion of this document for legitimate purposes of the Forum. Copying for monetary gain or for other non-Forum related purposes is prohibited.

The Forum draws attention to the fact that it is claimed that compliance with this specification may involve the use of a patent (“IPR”) concerning [section of Specification]. The Forum takes no position concerning the evidence, validity or scope of this IPR.

The holder of this IPR has assured the Forum that it is willing to license all IPR it owns and any third party IPR it has the right to sublicense which might be infringed by any implementation of this specification to the Forum and those licensees (members and non-members alike) desiring to implement this specification. Information may be obtained from:

Qualcomm Incorporated
5775 Morehouse Drive
San Diego, CA 92121

Attention is also drawn to the possibility that the Forum shall not be responsible for identifying any or all such IPR.

THIS DOCUMENT IS BEING OFFERED WITHOUT ANY WARRANTY WHATSOEVER, AND IN PARTICULAR, ANY WARRANTY OF NON-INFRINGEMENT IS EXPRESSLY DISCLAIMED. ANY USE OF THIS SPECIFICATION SHALL BE MADE ENTIRELY AT THE IMPLEMENTER'S OWN RISK, AND NEITHER THE FORUM, NOR ANY OF ITS MEMBERS OR SUBMITTERS, SHALL HAVE ANY LIABILITY WHATSOEVER TO ANY IMPLEMENTER OR THIRD PARTY FOR ANY DAMAGES OF ANY NATURE WHATSOEVER, DIRECTLY OR INDIRECTLY, ARISING FROM THE USE OF THIS DOCUMENT.

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the specification set forth in this document, and to provide supporting documentation.

This document was developed following the Forum's policy on restricted or controlled information (Policy 009) to ensure that that the document can be shared openly with other member organizations around the world. Additional Information on this policy can be found here: http://www.wirelessinnovation.org/page/Policies_and_Procedures

Although this document contains no restricted or controlled information, the specific implementation of concepts contain herein may be controlled under the laws of the country of origin for that implementation. Readers are encouraged, therefore, to consult with a cognizant authority prior to any further development.

Wireless Innovation Forum TM and SDR Forum TM are trademarks of the Software Defined Radio Forum Inc.

Table of Contents

TERMS, CONDITIONS & NOTICES	i
Table of Contents	iii
Contributors	v
1 Scope	6
2 References	6
2.1 Normative References	6
2.2 Informative References	8
3 Definitions, Abbreviations and Symbols	8
3.1 Definitions	8
3.1.1 FCC Definitions	8
3.1.2 WinnForum Definitions	9
3.2 Abbreviations	10
3.3 Symbols	10
4 Requirement Organization	11
5 Standard Power Device General Requirements (DGR)	12
5.1 Device Registration and Spectrum Inquiry	12
5.2 Geolocation Capability	13
5.3 Use of Proxy	14
6 Standard Power Device Security Requirements (DSQ)	14
6.1 Communication Security	14
7 AFC System General Requirements (AGR)	14
7.1 Device Registration	14
7.2 Determination of Available Frequencies and the Maximum Permissible Power	15
7.3 Storage of Information	15
7.4 Enforcement Instructions from the Commission	16
8 AFC System Security Requirements (ASQ)	16
8.1 Communication Security	16
9 AFC System Incumbent Protection (AIP)	16
9.1 Fixed Service Receiver Protection	16
9.2 Radio Astronomy Service Protection	19
9.3 International Border Protection	20
Annex A (Normative): 3GPP Specific Features (Optional)	21
A.1 Description	21
A.1.1 NRU1: 3GPP-defined 6 GHz Channel	21
A.2 Use for Operations not impacting Part 15 Subpart E Regulatory Compliance	21
A.2.1 AFC System General Requirements (AGR)	21
A.2.2 Device General Requirements (DGR)	21
A.3 Use for Operations that could impact Part 15 Subpart E Regulatory Compliance	21
Annex B (Normative): IEEE 802.11ax Specific Features (Optional)	22
B.1 Feature Description	22
Annex C (Informative): AFC System Operator Certification Procedure Information	23
Annex D (Informative): Revision History	24

List of Tables

Table 1: Requirements Categorization.....	12
Table 2: Reference coordinates and receiver heights above ground level (AGL).....	20

Contributors

The following individuals made significant contributions to this document:

Group Chair: Navin Hathiramani (Nokia)

Editor: Sho Furuichi (Sony)

Other Member Representatives:

- Aruba: Chuck Lukaszewski, Stuart Strickland
- AT&T: Tom Willis
- Cisco: Peter Ecclesine
- CommScope: Mark Gibson, Peter Young
- Ericsson: Virgil Cimpu, Christopher Richards
- Google: Andrew Clegg, Kate Harrison, Yi Hsuan
- NCTA: Andy Scott
- Qualcomm: Tevfik Yucek
- RED Technologies: Thomas Hervier, Meryem Messaoudi, Christophe Le Thierry
- Sony: Naotaka Sato, Yusuke Tanaka
- WISPA: Fred Goldstein

Functional Requirements for the U.S. 6 GHz Band under the Control of an AFC System

1 Scope

The scope of this technical specification is to define the functional requirements for the AFC System, AFC System Operator, Standard Power Access Points, Fixed Client Devices and Proxies and to specify the necessary standards to enable test and certification procedures for a properly functioning environment in the 6 GHz band. The functional requirements specified in this specification are based on Federal Communications Commission (FCC) rules governing the use of 6 GHz band subject to the control of an AFC System, which are codified in Part 15 Subpart E of Title 47 the U.S. Code of Federal Regulations [n.1] adopted in the 2021.

The requirements captured in this specification, outside of the normative annexes, are described in a technology neutral manner and applicable for any unlicensed wireless communication technology operating in the 6 GHz band under the Part 15 Subpart E rules in the 6 GHz band. This specification will be further extended to include the following topics in different normative annexes.

- Technology-neutral optional features and the requirements for those features that are not required to be tested for FCC certification;
- Technology-specific optional features and the requirements for those features that are required to be tested for FCC certification if implemented by an AFC System, a Standard Power Access Point or a Fixed Client Device; and,
- Technology-specific optional features and the requirements for those features that are not required to be tested for the FCC certification.

The FCC's Part 15 Subpart E rules will hereafter be referred to as "the FCC Rules", "the Rules" or "Part 15" and reference to specific items in the rules will be given in the form of, for example, 15.407(k)(16) if from Part 15.

NOTE 1: Not all the 6 GHz-specific rules are captured in this specification as this document is not a comprehensive list of requirements for the implementation or operation of an AFC System, Standard Power Access Point or Fixed Client Device. AFC System operation, components and/or devices, as applicable, are expected to comply with the rules that are not considered in this specification.

NOTE 2: Unless otherwise specified, "Standard Power Access Point" and "Fixed Client Device" are collectively referred to as "Standard Power Device" in this document.

2 References

2.1 Normative References

The following referenced documents are necessary for the application of the present document.

- [n.1] Title 47, Code of Federal Regulations, Part 15 Subpart E - Unlicensed National Information Infrastructure Devices, available at:
<https://ecfr.federalregister.gov/current/title-47/chapter-I/subchapter-A/part-15/subpart-E>
- [n.2] RFC-2119, “Key words for use in RFCs to Indicate Requirement Levels”, March 1997. Available at: <https://tools.ietf.org/html/rfc2119>
- [n.3] Federal Communications Commission, Unlicensed Use of the 6 GHz Band Report and Order and Further Notice of Proposed Rulemaking ET Docket No. 18-295; GN Docket No. 17-183, available at: https://docs.fcc.gov/public/attachments/FCC-20-51A1_Rcd.pdf
- [n.4] P. Kyösti et al., “WINNER II channel models”, IST-4-027756 WINNER II Deliverable D1.1.2, 2008, available at: <https://www.cept.org/files/8339/winner2%20-%20final%20report.pdf>
- [n.5] NTIA – ITS Irregular Terrain Model (ITM) (Longley-Rice) (20MHz-20 GHz), available at: <http://www.its.bldrdoc.gov/resources/radio-propagation-software/itm/itm.aspx>
- [n.6] ITU-R P.2108: Prediction of clutter loss (P.2108-0 (06/2017)), available at <https://www.itu.int/rec/R-REC-P.2108/en>
- [n.7] ITU-R P.452: Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz (P.452-16 (07/2015)), available at <https://www.itu.int/rec/R-REC-P.452-16-201507-I/en>
- [n.8] Federal Communications Commission, “Unlicensed Use of the 6 GHz Band; Review of the Commission’s Rules Governing the 896-901/935-940 MHz Band”, Federal Register / Vol. 86, No. 32, available at:
<https://www.federalregister.gov/documents/2021/02/19/2021-00782/unlicensed-use-of-the-6-ghz-band-review-of-the-commissions-rules-governing-the-896-901935-940-mhz>
- [n.9] RFC-2616, “Hypertext Transfer Protocol -- HTTP/1.1”, Fielding, Gettys, Mogul, Frystyk, Masinter, Leach and Berners-Lee, June 1999.
- [n.10] RFC-5246, “The Transport Layer Security (TLS) Protocol Version 1.2”, Dierks and Rescorla, August 2008.
- [n.11] RFC-8446, “The Transport Layer Security (TLS) Protocol Version 1.3”, E. Rescorla and Mozilla, August 2018
- [n.12] 3GPP TS 38.101-1, “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”, available at:
<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3283>
- [n.13] 3GPP TS 38.104, “NR; Base Station (BS) radio transmission and reception”, available at:
<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3202>
- [n.14] Wi-Fi Alliance AFC System to AFC Device Interface Specification, available at:
<https://www.wi-fi.org/file/afc-system-to-afc-device-interface-specification>

2.2 Informative References

The following referenced documents are not necessary for the application of the present document, but they assist the reader with regard to a particular subject area.

- [i.1] RFC-8996, “Deprecating TLS 1.0 and TLS 1.1”, K. Moriarty, CIS, S. Farrell, Trinity College Dublin, March 2021
- [i.2] NIST Special Publication 800-52 Revision 2, “Guidelines for the Selection, Configuration, and Use of Transport Layer Security (TLS) Implementations”, August 2019, available at: <https://doi.org/10.6028/NIST.SP.800-52r2>
- [i.3] RFC-7525, “Recommendations for Secure Use of Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS)”, Y. Sheffer, Intuit, R. Holz, NICTA, P. Saint-Andre, &yet, May 2015
- [i.4] IEEE Std 802.11ax™-2021, “IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks--Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Enhancements for High-Efficiency WLAN”, May 2021.
- [i.5] TIA-10 (2019 Edition), “Interference Criteria for Microwave Systems”, The Telecommunications Industry Association
- [i.6] ITU Recommendation ITU-R F.758-7, “System parameters and considerations in the development of criteria for sharing or compatibility between digital fixed wireless systems in the fixed service and systems in other services and other sources of interference”.
- [i.7] Federal Communications Commission, “The Commission Begins The Process For Authorizing 6 GHz Band Automated Frequency Coordination Systems”, FCC 21-100, available at: <https://ecfsapi.fcc.gov/file/09281454120568/FCC-21-100A1.pdf>

3 Definitions, Abbreviations and Symbols

3.1 Definitions

3.1.1 FCC Definitions

The Wireless Innovation Forum 6 GHz Committee leverages the definitions provided by the FCC from 47 CFR 15.403. These definitions and others are also available at reference [n.1].

Access Point (AP): A U-NII transceiver that operates either as a bridge in a peer-to-peer connection or as a connector between the wired and wireless segments of the network or as a relay between wireless network segments.

Automated Frequency Coordination (AFC) System: A system that automatically determines and provides lists of which frequencies are available for use by Standard Power Access Points operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands.

NOTE: Although not explicitly stated in the definition, the AFC System provides lists of which frequencies are available for use by Fixed Client Devices in the same way as to Standard Power Access Points operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands. (See the definition of Fixed Client Device)

Client Device: A U-NII device whose transmissions are generally under the control of an Access Point and is not capable of initiating a network.

Fixed Client Device: A Client Device intended as customer premise equipment that is permanently attached to a structure, operates only on channels provided by an AFC System, has a geolocation capability, and complies with antenna pointing angle requirements.

NOTE: WinnForum believes that the FCC allows a Fixed Client Device to operate as a Client Device in accordance with 15.407(a)(7), 15.407(d)(5) and 15.407(d)(7), and, while doing so, to communicate with an AFC System.

Maximum Power Spectral Density: The Maximum Power Spectral Density is the maximum Power Spectral Density, within the specified measurement bandwidth, within the U-NII device operating band.

Power Spectral Density: The Power Spectral Density is the total energy output per unit bandwidth from a Pulse or sequence of Pulses for which the transmit power is at its maximum level, divided by the total duration of the Pulses. This total time does not include the time between Pulses during which the transmit power is off or below its maximum level.

Pulse: A Pulse is a continuous transmission of a sequence of modulation symbols, during which the average symbol envelope power is constant.

Standard Power Access Point: An Access Point that operates in the 5.925-6.425 GHz and 6.525-6.875 GHz bands pursuant to direction from an Automated Frequency Coordination System.

U-NII devices: Intentional radiators operating in the frequency bands 5.15-5.35 GHz, 5.470-5.85 GHz, 5.925-7.125 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.

3.1.2 WinnForum Definitions

AFC System Operator: An entity designated by the Commission to operate an AFC System in accordance with the rules and procedures set forth in the Part 15 Subpart E.

Available Channel: A Channel, determined by an AFC System, on which a Standard Power Access Device is allowed to operate at its geographic coordinates.

NOTE: For the purpose of this document, the WinnForum definition of *Available Channel* takes precedence over the definition in the 47 CFR Part 15 Subpart E [n.1] since the FCC-defined *Available Channel* applies only in the context of its DFS rules.

Channel: A contiguous frequency range between lower and upper frequency limits.

Proxy: An entity engaging in communications with an AFC System on behalf of one or more Standard Power Devices, or networks of such devices.

Standard Power Device: A terminology collectively referring to Standard Power Access Point and Fixed Client Device.

NOTE: In this document, this terminology is used for R1, R2 and R3 requirements.

3.2 Abbreviations

3GPP	3rd Generation Partnership Project
AFC	Automated Frequency Coordination
AGL	Above Ground Level
BER	Bit Error Rate
DFS	Dynamic Frequency Selection
e.i.r.p.	Equivalent Isotropically Radiated Power
FCC	Federal Communications Commission
FS	Fixed Service
IEEE	Institute of Electrical and Electronic Engineers
ITM	Irregular Terrain Model
ITU	International Telecommunication Union
NAD	North American Datum
NIST	National Institute of Standards and Technology
OET	Office of Engineering and Technology
TIA	Telecommunications Industry Association
U-NII	Unlicensed National Information Infrastructure
WINNER II	Wireless World Initiative New Radio phase II

3.3 Symbols

BW_{FS}	Channel bandwidth of the fixed microwave service receiver
dkm_{los}	size of the exclusion zone to protect the radio astronomy antenna
$F_{c, FS}$	Center frequency of the fixed microwave service receiver

Hrx	height of the radio astronomy antenna above ground level
Htx	height of the unlicensed Standard Power Device
<i>I</i>	interference from the Standard Power Device at the fixed microwave service receiver
k_B	Boltzmann's constant
L	combined path loss
L _{LOS}	line-of-sight path loss
<i>N</i>	background noise level at the fixed microwave service receiver
<i>NF</i>	noise figure
P _{LOS}	probability of line-of-sight
P _{NLOS}	probability of non-line-of-sight
<i>T</i>	threshold level
<i>T/I</i>	threshold-to-interference
T_0	standard temperature

4 Requirement Organization

Requirements shall be uniquely identified by: R#-<FEATURE>-<CATEGORY>-<XX>-<Y>, where R<#> is defined by:

- R0-: Requirements directly from FCC rules
- R1-: Requirements derived from FCC rules or from the text of an applicable FCC order
- R2-: Requirements imposed by WinnForum to meet FCC rules
- R3-: Requirements imposed by WinnForum to meet industry needs.

NOTE: Support of R3 requirements for some optional features specified in normative annexes will need to be considered in the protection of fixed service receivers and radio astronomy service facilities in accordance with the technology neutral requirements specified in the main body of this technical specification. See details in each normative annex.

- <FEATURE>: Unique feature identifier for which the requirements are applicable.

NOTE: If this tag is not present, the requirement is not feature specific.

- <CATEGORY>: Categorization of the requirement by using a code from the table below:

Table 1: Requirements Categorization

Code	Category
DGR	Standard Power Device General Requirements
DSQ	Standard Power Device Security Requirements
AGR	AFC System General Requirements
ASQ	AFC System Security Requirements
AIP	AFC System Incumbent Protection

- <XX>: Unique number to identify the requirement
- <Y>: Optional and used to identify subordinate requirements, typically captured in an alphabetical list following the main requirement number <XX> (e.g., R0-DTR-06-a).

Requirements taken from the FCC Rules are included as “R0” and we attempted to use the FCC Rules without change. In some instances, the FCC uses “must”, “should” or “will” for the rules, which we have included below as “R0” requirements; however, [shall] is inserted to indicate this is considered as a mandatory requirement. In addition, the FCC uses the term “network element” or “network element device” in some of the rules which have been adopted for “R0” requirements in this specification; for these cases the term [Proxy] is inserted for clarification purposes. Furthermore, citations used in the FCC rule are converted into the corresponding requirement numbers in this specification.

The following terms are used within this document and should be interpreted as described in RFC-2119 [n.2]:

- SHALL is a mandatory requirement (negative is SHALL NOT)
- SHOULD is recommended requirement/best practice (negative is SHOULD NOT)
- MAY is an optional requirement, i.e. something that is allowed (negative is NEED NOT)

5 Standard Power Device General Requirements (DGR)

5.1 Device Registration and Spectrum Inquiry

R0-DGR-01 Device registration requirements:

- Standard Power Access Points and Fixed Client Devices must [shall] register with and be authorized by an AFC System prior to the Standard Power Access Point and Fixed Client Device’s initial service transmission, or after a Standard Power Access Point or Fixed Client Device changes location. (15.407(k)(8)(i))
- Standard Power Access Points and Fixed Client Devices must [shall] register with the AFC System by providing the following parameters: geographic coordinates (latitude and longitude referenced to North American Datum 1983 (NAD 83)), antenna height above ground level, FCC identification number, and unique manufacturer’s serial number. (15.407(k)(8)(ii))

- i. If any of these parameters change, the Standard Power Access Point or Fixed Client Device must [shall] provide updated parameters to the AFC System.
- c. Standard Power Access Points and Fixed Client Devices must [shall] provide the registration information to the AFC System either directly and individually or by a network element [Proxy] representing multiple Standard Power Access Points or Fixed Client Devices from the same operating network. (15.407(k)(8)(iii))

R0-DGR-02 Standard Power Access Points and Fixed Client Devices may transmit only on frequencies and at power levels that an AFC System indicates as available. (15.407(k)(1))

R0-DGR-03 Standard Power Access Points and Fixed Client Devices must [shall] contact an AFC System at least once per day to obtain the latest list of available frequencies and the maximum permissible power the Standard Power Access Point or Fixed Client Device may operate with on each frequency at the Standard Power Access Point and Fixed Client Device's location. (15.407(k)(8)(iv))

R0-DGR-04 If the Standard Power Access Point or Fixed Client Device fails to successfully contact the AFC System during any given day, the Standard Power Access Point or Fixed Client Device may continue to operate until 11:59 p.m. of the following day at which time it must [shall] cease operations until it re-establishes contact with the AFC System and re-verifies its list of available frequencies and associated power levels. (15.407(k)(8)(iv))

R3-DGR-01 When contacting an AFC System to obtain the latest list of available frequencies and the maximum permissible power in accordance with R0-DGR-03, Standard Power Devices may request the AFC System to provide a list of Channels that align with channelization defined for a specific air interface technology.

5.2 Geolocation Capability

R0-DGR-05 Geolocation capability:

- a. A Standard Power Access Point and a Fixed Client Device must [shall] report such coordinates [its geographic coordinates] and location uncertainty to an AFC System at the time of activation from a power-off condition. (15.407(k)(9)(i))
- b. An external geolocation source may be connected to a Standard Power Access Point or Fixed Client Device through either a wired or a wireless connection. A single geolocation source may provide location information to multiple Standard Power Access Points or Fixed Client Devices. (15.407(k)(9)(ii))
- c. The applicant for certification of a Standard Power Access Point or Fixed Client Device must [shall] demonstrate the accuracy of the geolocation method used and the location uncertainty. (15.407(k)(9)(iv))
- d. For Standard Power Access Points and Fixed Client Devices that may not use an internal geo-location capability, this uncertainty must [shall] account for the accuracy of the

geolocation source and the separation distance between such source and the Standard Power Access Point or Fixed Client Device. (15.407(k)(9)(iv))

R1-DGR-01 A Standard Power Device must [shall] include either an internal geolocation capability or an integrated capability to securely connect to an external geolocation devices or service, to automatically determine the Standard Power Device's geographic coordinates and location uncertainty (in meters), with a confidence level of 95%. (15.407(k)(9)(i))

5.3 Use of Proxy

R2-DGR-01 The obligations of one or more Standard Power Devices to communicate with the AFC System may be met in combination with a Proxy.

6 Standard Power Device Security Requirements (DSQ)

6.1 Communication Security

R2-DSQ-01 A Standard Power Device or Proxy if applicable shall use, for the purpose of communications with an AFC System, the following protocols: HTTP 1.1 [n.9] or higher and TLS 1.2 [n.10] or higher, or an alternative method of communication which provides a similar or higher level of security.

NOTE: Useful information related to this requirement is available in RFC-8996 [i.1], NIST Special Publication 800-52 Revision 2 [i.2], and RFC-7525 [i.3].

R2-DSQ-02 A Standard Power Device or Proxy shall support at least the following cipher suites when utilizing TLS 1.2 [n.10]:

- TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
- TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

R2-DSQ-03 Cipher suites that offer equivalent or higher levels of protection as those cited in R2-DSQ-02 may also be supported and used.

R2-DSQ-04 All cipher suites supported in TLS 1.3 [n.11] or higher may also be supported and used.

7 AFC System General Requirements (AGR)

7.1 Device Registration

R1-AGR-01 An AFC System must [shall] verify the validity of the FCC identifier (FCC ID) of any Standard Power Device seeking access to its services prior to authorizing the Standard Power Device to begin operation. (15.407(k)(6))

- a. A list of Standard Power Devices with valid FCC IDs and the FCC IDs of those devices must [shall] be obtained from the Commission's Equipment Authorization System.

R1-AGR-02 The AFC System shall register, authenticate and authorize Standard Power Device operations, individually or through a network element device [Proxy] representing multiple Standard Power Devices from the same operating network. (15.407(k)(7)(ii))

7.2 Determination of Available Frequencies and the Maximum Permissible Power

R0-AGR-01 An AFC System must [shall] be capable of determining the available frequencies in steps of no greater than 3 dB below the maximum permissible e.i.r.p of 36 dBm, and down to at least a minimum level of 21 dBm. (15.407(k)(2))

R1-AGR-03 An AFC System must [shall] use the information supplied by Standard Power Devices during registration to determine available frequencies and the maximum permissible power in each frequency range for a Standard Power Device at any given location using propagation models and interference protection criteria defined in 47 CFR 15.407(l). (15.407(k)(4), 15.407(k)(7)(iii), 15.407(l))

- a. All such determinations and assignments must [shall] be made in a non-discriminatory manner.

R2-AGR-01 An AFC System shall use location uncertainty reported by a Standard Power Device to determine maximum acceptable power levels to protect fixed service receivers. ([n.3], Paragraph 41)

R3-AGR-01 An AFC System operating under R3-AIP-01 shall use the information supplied by Standard Power Devices during registration to determine Available Channels and the maximum permissible power in each Channel for a Standard Power Device at any given location using propagation models and interference protection criteria defined in 47 CFR 15.407(l).

- a. All such determinations and assignments shall be made in a non-discriminatory manner.

R3-AGR-02 An AFC System shall provide a list of Available Channels and power levels to Standard Power Devices if requested by the Standard Power Devices.

7.3 Storage of Information

R0-AGR-02 An AFC System shall obtain updated protected sites information from Commission databases. (15.407(k)(7)(iv))

R0-AGR-03 Each AFC System Operator designated by the Commission must [shall] maintain a regularly updated AFC System database, including incumbent's information and Standard Power Access Points and Fixed Client Devices registration parameters. (15.407(k)(15)(i))

R1-AGR-04 Storage of registered information (15.407(k)(5)):

- a. An AFC System shall store Standard Power Device registration information in a secure database.
- b. The stored registration information shall be available for more than three months after the Standard Power Devices last contacted with the AFC System.

7.4 Enforcement Instructions from the Commission

R1-AGR-05 AFC Systems shall have the capability to deny spectrum access to a particular Standard Power Device upon requests by the Commission, in the event of harmful interference caused by a particular device or type of device. ([n.3], Paragraph 83)

R1-AGR-06 Each AFC System Operator designated by the Commission must [shall] comply with enforcement instructions from the Commission, including discontinuance of Standard Power Device operations in designated geographic areas. (15.407(k)(15)(vi))

8 AFC System Security Requirements (ASQ)

8.1 Communication Security

R2-ASQ-01 An AFC System shall use the following protocols for the purpose of communications between itself and a Standard Power Device or Proxy: HTTP 1.1 [n.9] or higher and TLS 1.2 [n.10] or higher, or an alternative method of communication which provides a similar or higher level of security.

NOTE: Useful information related to this requirement is available in RFC-8996 [i.1], NIST Special Publication 800-52 Revision 2 [i.2], and RFC-7525 [i.3].

R2-ASQ-02 An AFC System shall support at least the following cypher suites when utilizing TLS 1.2 [n.10]:

- TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
- TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

R2-ASQ-03 Cypher suites that offer equivalent or higher levels of protection as those cited in R2-ASQ-02 may also be supported and used.

R2-ASQ-04 All cipher suites supported in TLS 1.3 [n.11] or higher may also be supported and used.

9 AFC System Incumbent Protection (AIP)

9.1 Fixed Service Receiver Protection

R0-AIP-01 An AFC System must [shall] obtain information on protected services within the 5.925-6.425 GHz and 6.525-6.875 GHz bands from Commission databases and use that information to determine frequency availability for Standard Power Access Points and Fixed Client Devices based on protection criteria specified in R0-AIP-03 and R0-AIP-04. (15.407(k)(3))

R0-AIP-02 Propagation models to determine the appropriate separation distance between a Standard Power Access Point or a Fixed Client Device and an incumbent fixed microwave service receiver. For a separation distance:

- a. Up to 30 meters, the AFC System must [shall] use the free space path-loss model. (15.407(l)(1)(i))

- b. More than 30 meters and up to and including one kilometer, the AFC System must [shall] use the Wireless World Initiative New Radio phase II (WINNER II) model [n.4]. (15.407(l)(1)(ii))

- i. The AFC System must [shall] use site specific information, including buildings and terrain data, for determining the line-of-sight/non-line-of-sight path component in the WINNER II model [n.4], where such data is available.
- ii. For evaluating paths where such data is not available, the AFC System must [shall] use a probabilistic model combining the line-of-sight path and non-line-of-sight path into a single path-loss as follows:

$$\text{Path-loss (L)} = \sum_i P(i) * L_i = P_{\text{LOS}} * L_{\text{LOS}} + P_{\text{NLOS}} * L_{\text{NLOS}},$$

where P_{LOS} is the probability of line-of-sight, L_{LOS} is the line-of-sight path loss, P_{NLOS} is the probability of non-line-of sight, L_{NLOS} is the non-line-of-sight path loss, and L is the combined path loss. The WINNER II path loss models include a formula to determine P_{LOS} as a function of antenna heights and distance. P_{NLOS} is equal to $(1 - P_{\text{LOS}})$.

- iii. In all cases, the AFC System will [shall] use the correct WINNER II parameters to match the morphology of the path between a Standard Power Access Point and a fixed microwave receiver (i.e., Urban, Suburban, or Rural).
- c. More than one kilometer, the AFC System must [shall] use Irregular Terrain Model (ITM) [n.5] combined with the appropriate clutter model. (15.407(l)(1)(iii))
- i. To account for the effects of clutter, such as buildings and foliage, that the AFC System must [shall] combine the ITM [n.5] with the ITU-R P.2108-0 (06/2017) [n.6] clutter model for urban and suburban environments and the ITU-R P.452-16 (07/2015) [n.7] clutter model for rural environments.
 - ii. The AFC System should use the most appropriate clutter category for the local morphology when using ITU-R P.452-16 [n.7].
 - iii. If detailed local information is not available, the “Village Centre” clutter category should [shall] be used.
 - iv. The AFC System must [shall] use 1 arc-second digital elevation terrain data and, for locations where such data is not available, the most granular available digital elevation terrain data.

R0-AIP-03 The AFC System must [shall] use -6 dB I/N as the interference protection criteria in determining the size of the co-channel exclusion zone where I (interference) is the co-channel signal from the Standard Power Access Point or Fixed Client Device at the fixed microwave service receiver, and N (noise) is background noise level at the fixed microwave service receiver (15.407(l)(2)(i))

R0-AIP-04 The AFC System must [shall] use -6 dB I/N as the interference protection criteria in determining the size of the adjacent channel exclusion zone, where I (interference) is the signal from the Standard Power Access Point or Fixed Client Device’s out of channel emissions at the fixed microwave service receiver and N (noise) is background noise level at the fixed microwave service receiver. (15.407(l)(2)(ii))

- a. The adjacent channel exclusion zone must [shall] be calculated based on the emissions requirements specified in 47 CFR 15.407(b)(7).

R2-AIP-01 AFC Systems shall protect temporary fixed links from harmful interference during the term defined by “start date” and “end date” in the ULS database. ([n.3], Paragraph 32, and [n.8])

R2-AIP-02 Fixed Service Receiver Noise Level:

In determining the noise level N of a fixed service receiver for I/N calculations, if the AFC System has the needed radio manufacturer data, technique b, technique c or technique d shall be used. Otherwise, technique a shall be used.

- a. Use of the typical noise level N determined as follows:

$$N = \begin{cases} -110.0 \text{ dBm/MHz} & (\text{if } F_{c, \text{FS}} \leq 6425 \text{ MHz}) \\ -109.5 \text{ dBm/MHz} & (\text{if } F_{c, \text{FS}} > 6425 \text{ MHz}) \end{cases}$$

where:

- $F_{c, \text{FS}}$: Center frequency of the FS receiver

NOTE: These noise levels are computed by the formula in c below with a noise figure value of 4 dB below or equal to 6425 MHz and 4.5 dB above 6425 MHz. These values are provided as default FS parameters in ITU-R F.758-7 [i.6]. See Table 7 of ITU-R F.758-7 [i.6] for more information.

- b. Use of the noise level N (with proper consideration for the occupied bandwidth) specified by the manufacturer’s specification for the given receiver model identified by the corresponding data element in the ULS.

NOTE: For example, if the receiver model is listed as “ACME XYZ” in ULS, an AFC System can use N available in the specification for XYZ receiver model published by the Acme receiver company.

- c. Use of the noise level N determined by the following equation:

$$N = -114 \text{ dBm/MHz} + NF,$$

where:

- NF : Noise figure specified by the manufacturer’s specification for the receiver model identified by the corresponding data element in the ULS

NOTE: -114 dBm/MHz equals $10 \log_{10}(k_B T_0) + 10 \log_{10}(10^6 \text{ Hz/MHz}) + 10 \log_{10}(10^3 \text{ mW/W})$, where k_B is Boltzmann’s constant of $1.38064852 \times 10^{-23} \text{ m}^2 \cdot \text{kg} \cdot \text{s}^{-2} \cdot \text{K}^{-1}$ and T_0 is the standard reference temperature of 290 K.

- d. Use of the noise level N determined by the following equation:

$$N \text{ (dBm/MHz)} = T \text{ (dBm)} - T/I \text{ (dB)} - 10 \log_{10}[BW_{FS} \text{ (MHz)}] + 6 \text{ dB},$$

where:

- BW_{FS} : Channel bandwidth of the FS receiver
- T : Threshold for 10^{-6} bit error rate (BER) for the channel bandwidth BW_{FS}
- T/I : Threshold-to-Interference (T/I) specified by the manufacturer's specification for the given receiver model identified by the corresponding data element in the ULS.

NOTE: The T/I specification is defined to apply for 10^{-6} BER in TIA-10, 2019 Edition [i.5].

- R2-AIP-03 When calculating an adjacent channel exclusion zone in accordance with R0-AIP-04-a, the AFC system shall take into account out of channel emissions up to one and a half times the device's channel bandwidth away from its channel center.

NOTE: Out of channel emissions in this requirement refer to device's emission limits specified in 47 CFR 15.407(b)(7).

- R3-AIP-01 An AFC System shall use the information on protected services obtained pursuant to R0-AIP-01 to determine Available Channels for Standard Power Devices based on protection criteria specified in R0-AIP-03 and R0-AIP-04.

9.2 Radio Astronomy Service Protection

- R0-AIP-05 Protection of radio observatories:

- a. The AFC System must [shall] enforce an exclusion zones to the following radio observatories that observe between 6650-6675.2 MHz:
 - Arecibo Observatory,
 - the Green Bank Observatory,
 - the Very Large Array (VLA),
 - the 10 Stations of the Very Long Baseline Array (VLBA),
 - the Owens Valley Radio Observatory, and
 - the Allen Telescope Array.
- b. The exclusion zone sizes are [shall be] based on the radio line-of-sight and determined using 4/3 earth curvature and the following formula:

$$dkm_{los} = 4.12 * (\text{sqrt}(H_{tx}) + \text{sqrt}(H_{rx})),$$

where H_{tx} is the height of the unlicensed Standard Power Access Point or Fixed Client Device and H_{rx} is the height of the radio astronomy antenna in meters above ground level. (15.407(m))

R1-AIP-01 Radio Astronomy Service protection:

For protection of radio astronomy facilities listed in R0-AIP-05-a, the following reference coordinates and receiver antenna heights above ground level (AGL) shall be used.

Table 2: Reference coordinates and receiver heights above ground level (AGL)

Observatory	North latitude	West longitude	AGL (in meters)
Arecibo Observatory, PR	18° 20' 37"	66° 45' 11"	142.2
Green Bank Telescope (GBT), WV	38° 25' 59"	79° 50' 23"	139.6
Very Large Array (VLA), Socorro, NM	34° 04' 44"	107° 37' 06"	25
Very Long Baseline Array (VLBA) Stations:			
Brewster, WA	48° 07' 52"	119° 41' 00"	25
Fort Davis, TX	30° 38' 06"	103° 56' 41"	25
Hancock, NH	42° 56' 01"	71° 59' 12"	25
Kitt Peak, AZ	31° 57' 23"	111° 36' 45"	25
Los Alamos, NM	35° 46' 30"	106° 14' 44"	25
Mauna Kea, HI	19° 48' 05"	155° 27' 20"	25
North Liberty, IA	41° 46' 17"	91° 34' 27"	25
Owens Valley, CA	37° 13' 54"	118° 16' 37"	25
Pie Town, NM	34° 18' 04"	108° 07' 09"	25
St. Croix, VI	17° 45' 24"	64° 35' 01"	25
Allen Telescope Array	40° 49' 03"	121° 28' 24"	6.1
Owens Valley Radio Observatory	37° 14' 02"	118° 16' 56"	40

9.3 International Border Protection

R0-AIP-06 An AFC System must [shall] implement the terms of international agreements with Mexico and Canada. (15.407(k)(14))

Annex A (Normative): 3GPP Specific Features (Optional)

A.1 Description

This annex provides requirements for 3GPP specific features. In this section, unless otherwise specified, Standard Power Devices refer to those employing 3GPP based radio access technology for operations in the 6 GHz band.

A.1.1 *NRU1: 3GPP-defined 6 GHz Channel*

An NRU1 feature enables an AFC System and a Standard Power Devices to support 3GPP-defined 6 GHz channels (e.g., channels within the 3GPP-defined n96 band [n.12][n.13]).

The support of this feature is optional for AFC System and Standard Power Devices.

A.2 Use for Operations not impacting Part 15 Subpart E Regulatory Compliance

Requirements for the NRU1 feature in this section need to be considered in the protection of fixed service receivers and radio astronomy service facilities in accordance with the technology neutral requirements specified in the main body of this technical specification.

A.2.1 *AFC System General Requirements (AGR)*

R3-NRU1-AGR-01 Support of 3GPP-defined 6 GHz channelization [n.12][n.13]:

When an AFC System determines and provides a list of Available Channels and the associated maximum power levels pursuant to R2-AIP-02 and R3-AIP-01, for a Standard Power Device request based on R3-NRU1-DGR-01, each Channel in the list shall be aligned with 3GPP-defined 6 GHz channelization.

A.2.2 *Device General Requirements (DGR)*

R3-NRU1-DGR-01 Support of 3GPP-defined 6 GHz channelization [n.12][n.13]:

A Standard Power Device operating under R3-DGR-01 shall be able to request from an AFC System that each Channel in the list of Available Channels be aligned with 3GPP-defined 6 GHz channelization.

A.3 Use for Operations that could impact Part 15 Subpart E Regulatory Compliance

Not applicable for this version of this document.

Annex B (Normative): IEEE 802.11ax Specific Features (Optional)

B.1 Feature Description

This annex provides requirements for the support of IEEE 802.11ax specific features [i.4].

In this release of the specification, all mandatory and optional requirements for IEEE 802.11ax-specific features are found in the Wi-Fi Alliance AFC System to AFC Device Interface Specification [n.14].

Annex C (Informative): AFC System Operator Certification Procedure Information

The FCC has provided the information about the certification procedure for AFC System Operators in its Public Notice [i.7]. The descriptions below can be found in the Public Notice and are shown for informational purpose only.

- As specified in the 6 GHz Report and Order [n.3], OET will follow a multistep process to approve AFC Systems in which each prospective AFC System Operator must demonstrate its ability to perform the required functions pursuant to the Commission's 6 GHz unlicensed rules [n.1]. ([i.7], Paragraph 7)
- We request that parties interested in becoming an AFC System operator as part of the initial evaluation process submit their proposals no later than November 30, 2021. ([i.7], Paragraph 7)
 - The AFC System proposals must describe how the prospective AFC System Operator will comply with the requirements and core functions described in Section 15.407(k) of the Commission's rules [n.1] and the 6 GHz Report and Order [n.3]. ([i.7], Paragraph 9)
 - The public will then have an opportunity to review and comment on these proposals, including on each prospective operator's fitness to operate an AFC System as well as the technical and operational description of each proposed AFC System. Comments on these proposals must be submitted by December 21, 2021. ([i.7], Paragraph 7)
 - OET will review all proposals submitted by November 30, 2021 concurrently and with equal priority. Proposals submitted after this date will be considered by OET, but they may not be considered concurrently with proposals submitted by November 30, 2021. For any proposal received after November 30, 2021, OET will issue a public notice announcing receipt of the proposal and establishing a period for the public to review and comment on the proposal. ([i.7], Paragraph 7)
- Proposals will not be considered mutually exclusive and OET will conditionally approve as many proposals as are found to satisfy all AFC System requirements. ([i.7], Paragraph 7)
- Applicants who receive a conditional approval will then be required to allow access to their AFC System for a public trial period to provide interested parties an opportunity to check that it provides accurate results. ([i.7], Paragraph 8)
 - This trial period shall include thorough testing, both in a controlled environment (e.g., lab testing) and through demonstration projects (e.g., field testing). OET may also require prospective AFC System Operators to attend workshops and meetings as part of the assessment process. ([i.7], Paragraph 8)
- Prospective AFC system operators must comply with all instructions from OET and must provide any requested information in a timely manner. ([i.7], Paragraph 8)

Annex D (Informative): Revision History

Document History		
V1.0.0	15 December, 2021	Initial version.