ARIB STD-T66
Version 3.7-E1

ENGLISH TRANSLATION

SECOND GENERATION LOW POWER DATA COMMUNICATION SYSTEM/ WIRELESS LAN SYSTEM

ARIB STANDARD

ARIB STD-T66 Version 3.7

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Version 3.7 October 2nd 2014

Association of Radio Industries and Businesses

General Notes to the English Translation of ARIB Standards and Technical Reports

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Foreword

The Association of Radio Industries and Businesses (ARIB) investigates and summarizes the basic technical requirements for various radio systems in the form of "ARIB Standards". These standards are developed with the participation of and through discussions amongst radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

ARIB Standards include "government technical regulations" (mandatory standard) that are set for the purpose of encouraging effective use of frequency and preventing interference with other spectrum users, and "private technical standards" (voluntary standards) that are defined in order to ensure compatibility and adequate quality of radio equipment and broadcasting equipment as well as to offer greater convenience to radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

This ARIB Standard is developed for 【 Second Generation Low Power Data Communication System/Wireless LAN System 】. In order to ensure fairness and transparency in the defining stage, the standard was set by consensus at the ARIB Standard Assembly with the participation of both domestic and foreign interested parties from radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

ARIB sincerely hopes that this ARIB Standard will be widely used by radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

NOTE:

Although this ARIB Standard contains no specific reference to any Essential Industrial Property Rights relating thereto, the holders of such Essential Industrial Property Rights state to the effect that the rights listed in the Attachment 1 and 2, which are the Industrial Property Rights relating to this standard, are held by the parties also listed therein, and that to the users of this standard, in the case of Attachment 1, such holders shall not assert any rights and shall unconditionally grant a license to practice such Industrial Property Rights contained therein, and in the case of Attachment 2, the holders shall grant, under reasonable terms and conditions, a non-exclusive and non-discriminatory license to practice the Industrial Property Rights contained therein. However, this does not apply to anyone who uses this ARIB Standard and also owns and lays claim to any other Essential Industrial Property Rights of which is covered in whole or part in the contents of the provisions of this ARIB Standard.

Attachment 1 (selection of option 1)

PATENT HOLDER	NAME OF PATENT	REGISTRATION NO./ APPLICATION NO.	REMARKS
Nokia Mobile phones Ltd Nokia Telecommunications Osakeyhtiao *1	Method and apparatus for data transmission in wireless telephone system and wireless telephone network system	Application number 1995-170579	AT, CN, DE, EE, EP, ES, FI, FR, GB, IT, JP, NL, SE, US
Nokia Mobile phones Ltd *1	System for transmitting packet data in digital cellular time division multiple access (TDMA) air interface	Application number 1995-336774	AT, CH, CN, DE, EP, FI, FR, GB, IN, IT, JP, NL, SE, US
Nokia Mobile phones Ltd *1	Dynamic allocation of radio capacity in a TDMA system	Pending number 1998-512724 2001-JP3155010	GB, IT, JP, KR, NL, RU, SE, US, WO, AT, AU, CN, DE, FI, FR
Nokia Mobile phones Ltd *1	Method for encryption of data, and data communication	Application number 1998-66157	AU, CN, DE, ES, FI, FR, GB, IN, IT, JP, NL, SE, US, WO
Nokia Mobile phones Ltd *1	Method and device for handling data in certain layers according to certain protocols in a mobile communications system	Patent number 3445577	AT, AU, CN, DE, FI, FR, GB, HK, IT, JP, NL, RU, SE, US, WO
Nokia Japan Co, Ltd	The blanket confirming letter on ARIB STD-T66 Ver.3.1 is submitted.		

*1 Those patents are related with ARIB STD-T66 Ver.1

Attachment 2 (selection of option 2)

(Reference)

PATENT HOLDER	NAME OF PATENT	REGISTRATION NO./ APPLICATION NO.	REMARKS
Nokia Telecommunications Osakeyhtiao	Automatic retransmission with order of information changed	Pending number 2002-520904	No request for examination EP, US, WO
Nokia Mobile Phones Ltd	System for transmitting packet data in digital cellular time division multiple access (TDMA) air interface	US5,640,395	AT, AU, CN, DE, EP, FI, FR, GB, IN, IT, NL, SE, US
Nokia Mobile phones Ltd *	Method for transmitting packet switched data in a mobile communications system	Pending number 2001-522552	Examiner's decision of refusal(JP) DE, EP, FR, GB, US, WO
Nokia Telecommunications Osakeyhtiao	Improving for security of packet-mode transmission in a mobile communications system	Patent number 3472581	Right dissipation(JP) AU, BE, CA, CH, CN, DE, EP, ES, FR, GB, IN, IT, NL, SE, US, WO

Topics addressed in this standard

◆Regulations and the standard are described from Chapters 1 through 4.

◆Measurement methods appropriate for the standard are described in Chapter 5.

◆Annex 1 describes test items associated with specified radio equipment.

◆Annex 2 describes methods of preventing and troubleshooting co-frequency interference with RFID systems.

◆Annex 3 outlines Annex 2.

◆For technical and other requirements pertaining to radio equipment described in this ARIB Standard, relevant regulations are attached.

Law- and ordinance-related abbreviations in brackets represent the following:

RL:	Radio Law
OM:	Ordinance of the Ministry of Posts and Telecommunications if issued in 2000 or earlier, and Ordinance of the Ministry of Public Management, Home Affairs and Posts and Telecommunications if issued in 2001 or later.
AM:	Announcement of the Ministry of Posts and Telecommunications if issued in 2000 or earlier, and Notification of the Ministry of Public Management, Home Affairs and Posts and Telecommunications if issued in 2001 or later.
RLE:	Radio Law Enforcement Regulations
RE:	Radio Equipment Regulations
RTCSR:	Regulations Pertaining to Technical Regulations Conformity Certification for Specified Radio Equipment
TR:	Terminal and Other Equipment Regulations
RTADT:	Regulations Pertaining to Technical Regulations Conformity Approval and Design Authentication for Terminal Equipment

Contents

Chapter 1 General Descriptions

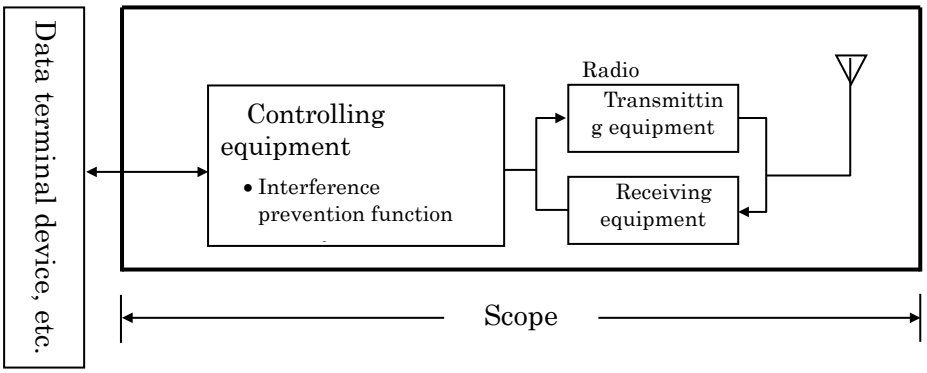
1.1 Outline

This ARIB Standard prescribes "Radio Equipment for Second-generation Low-power Data Communications Systems Radio Stations" and "Wireless LAN Systems' Equipment" performing radio communications primarily for data communication (including equipment connected to other facilities through telecommunications circuit) that use the frequency band of 2,400 - 2,483.5 MHz among radio stations for low-power data communications systems regulated in Article 6 paragraph 4 item 4 of the Radio Law Enforcement Regulations.

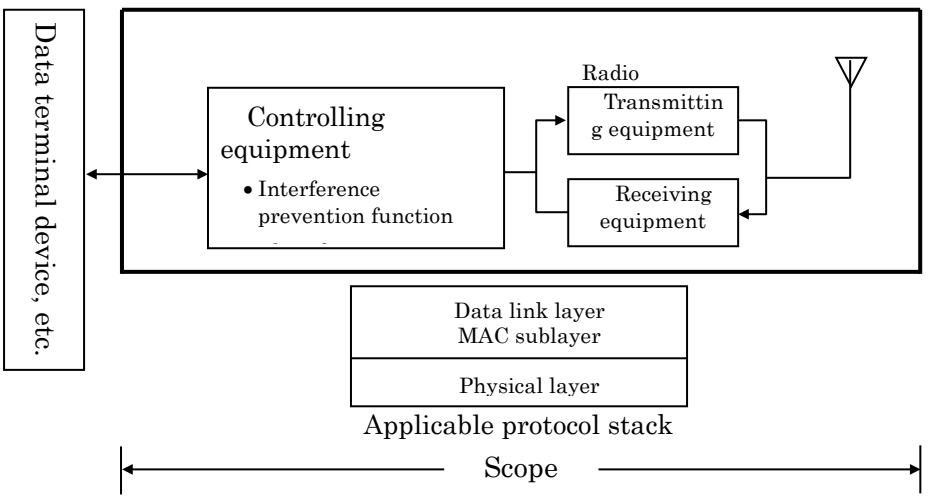
1.2 Scope of the Standard

Second-generation low-power data communications systems radio stations and wireless LAN systems are comprised of radio or infrared equipment, data terminal devices, and other devices (including equipment connected to other facilities through telecommunications circuit) as shown in Fig. 1.1.

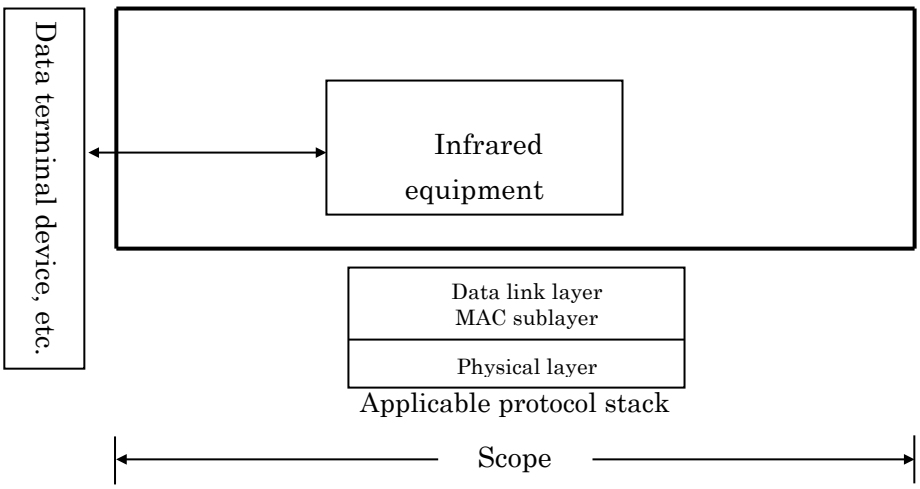
This ARIB Standard prescribes these particular radio and infrared equipment.



(1) Second-generation low-power data communications system radio station



(2) Wireless LAN system's radio equipment



(3) Wireless LAN system's infrared equipment

Fig. 1.1 Structure of second generation low-power data communication system radio station and wireless LAN system

1.3 Reference regulations

The following document is used as a normative document in this ARIB Standard:

(1) Information technology – Telecommunications and Information Exchange Between Systems – LAN/MAN Specific Requirements – Specific requirements – Part 11: Wireless Medium Access Control (MAC) and Physical Layer (PHY) specifications (ISO/IEC 8802-11)

Chapter 2　Standard System

2.1　System outline

Second-generation low-power data communications systems and wireless LAN systems are designed to perform radio or infrared transmission of digitized information signals.

Note that requirements of the protocol are not prescribed. However, requirements of the protocol prescribed in ISO/IEC 8802-11 shall be used for interconnected systems (hereinafter interconnected systems).

2.2　System configuration

Not particularly regulated.

Chapter 3 Technical Requirements of Radio Equipment

3.1 General conditions

(1) Communication method (RE: Article 49-20)

Communication method (including a spread spectrum system) that transmits digital signals and that is one-way communication, simplex operation, semi-duplex operation, or duplex operation shall be used.

(2) Contents of communication

Digitized data signals shall be mainly transmitted.

(3) Frequency band (RLE: Article 6)

Frequency band of 2,400 - 2,483.5 MHz shall be used.

(4) Environmental operating conditions

Not particularly regulated.

3.2 Transmitting equipment

(1) Modulation system (RE: Article 49-20)

a. Spread spectrum and orthogonal frequency division multiplexing systems

For spread spectrum systems, a Direct Sequence system (DS system), a Frequency Hopping system (FH system), a hybrid system combining these systems, or a hybrid system combining FH and orthogonal frequency division multiplexing systems (OFDM system) shall be used.

DS: A pseudo-random spreading code is combined with the information sequence to implement spreading function. The resulting signal modulates a carrier signal and consequently, the information signal is spread to a wide band signal.

FH: The transmitting signal is a sequence of pulses at different frequencies over a large bandwidth. This sequence is called as frequency hopping pattern.

b. Modulation type for information signal

Information modulation types for information transmission in spread spectrum systems are not particularly regulated.

c. Modulation techniques for systems other than spread spectrum and OFDM systems

Amplitude modulation, frequency modulation, phase modulation, or a digital modulation technique combining these modulation techniques shall be used.

(2) Antenna power (RE: Article 49-20)

a. The antenna power of a transmitting equipment (with a frequency band of 2,427 - 2,470.75 MHz, for spread spectrum systems using FH systems, hybrid systems of DS and FH, or hybrid systems of FH and OFDM) shall be such that the mean power within a bandwidth of 1 MHz is 3 mW or less in the case of modulation using a standard coding test signal with the same transmission rate as that of the modulation signal.

b. The antenna power of a transmitting equipment using a spread spectrum system other than any of those in "a" and the OFDM system shall be such that the mean power within a bandwidth of 1 MHz is 10 mW or less in the case of modulation using a standard coding test signal with the same transmission rate as that of the modulation signal.

c. The antenna power of a transmitting equipment using OFDM system shall be such that the mean power within a band width of 1MHz is either i) or ii) described below.
In the case of using a standard coding test signal with the same transmission rate as that of the modulation signal.

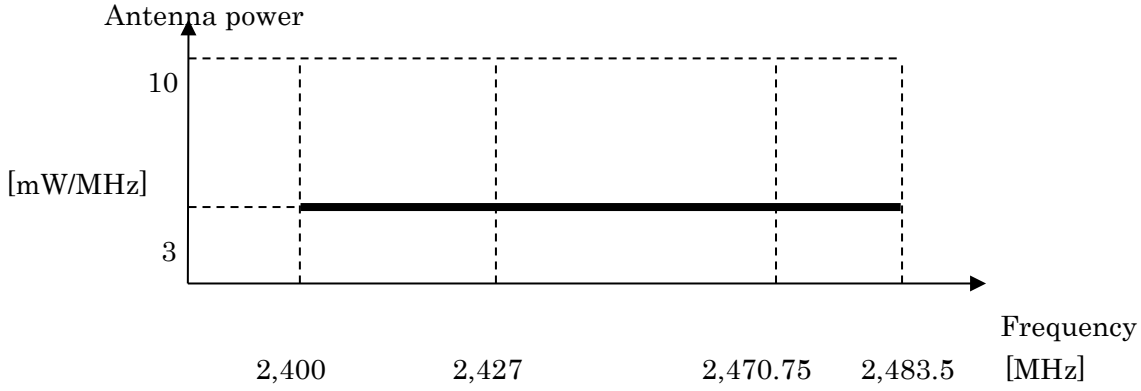
i) Transmitting equipment with occupied bandwidth with less than 26MHZ

→ 10mW or less

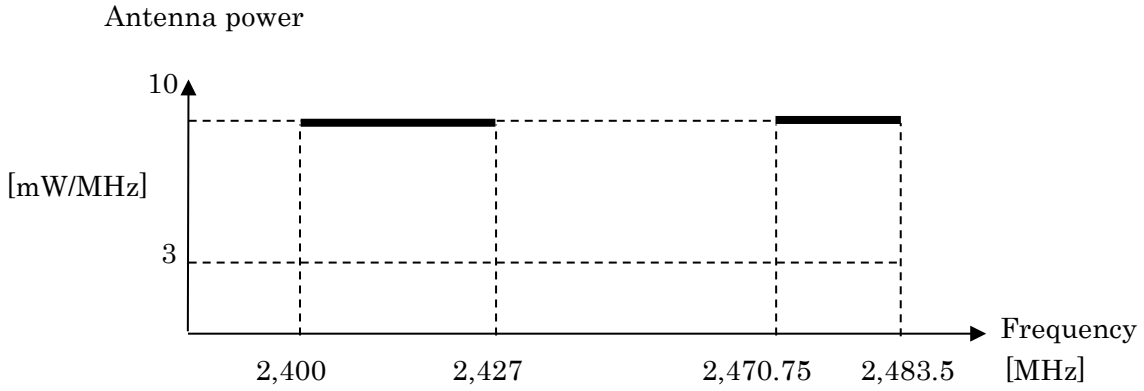
ii) Transmitting equipment with occupied bandwidth from 26MHz to 38MHz

→ 5mW or less

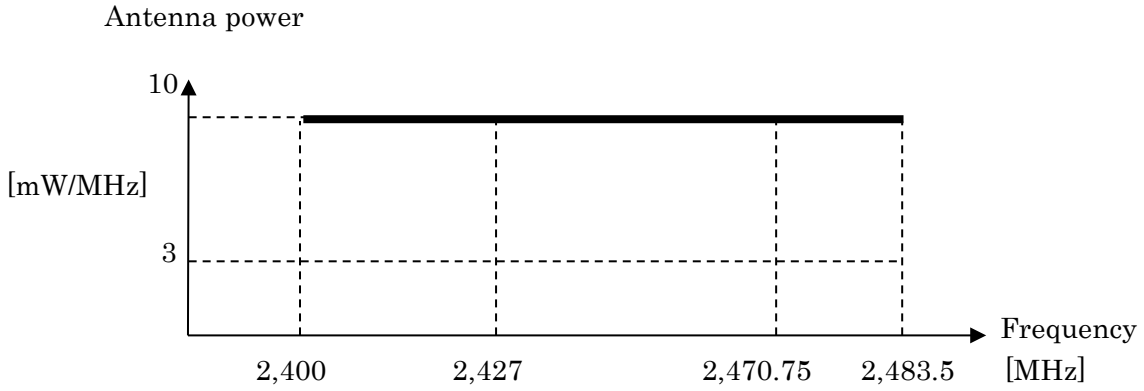
d. The antenna power of a transmitting equipment using systems other than any of those in "a" or "b" shall be 10 mW or less.



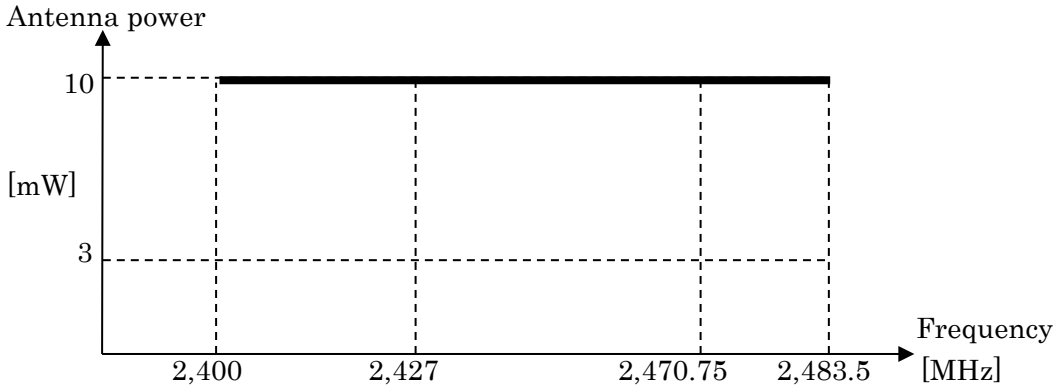
(1) An FH system, a hybrid system combining DS and FH systems, or a hybrid system combining FH and OFDM systems using the frequency band of 2,427 - 2,470.75 MHz or using 2,427 MHz or lower or 2,470.75 MHz or higher, including 2,427 - 2,470.75 MHz



(2) An FH system, a hybrid system combining DS and FH systems, or a hybrid system combining FH and OFDM systems using the frequency band of 2,400 to lower than 2,427 MHz or beyond 2,470.75 to 2,483.5 MHz



(3) DS or OFDM system



(4) System other than spread spectrum

Fig. 2.1　Antenna Power

(3) Tolerances for antenna power　(RE: Article 14)

Upper and lower limits of the tolerance for antenna power shall be 20% and 80%,

respectively. Note that they represent the tolerance for the maximum rated antenna power and that no upper and lower limits of the tolerance are regulated in the case of antenna power reduction for communications reasons.

(4) Frequency tolerance (RE: Article 5, Attached Table No. 1)

Tolerance of frequency shall be $\pm 50 \times 10^{-6}$.

(5) Transmission rate

No signal transmission rate is regulated.

(6) Spurious emission intensity

(a) Permissible value applied after December 1st 2005 (ORE: Article 7, attached Table No.3)

Permissible value of spurious emission (when carrier wave is modulated and supplied to a feeder, mean power of spurious emission at each frequency) is as follows:

Frequency band	Permissible value of spurious emission
2,387 MHz > f and 2,496.5 MHz < f	2.5 μW or less at 1MHz bandwidth
2,387 MHz ≤ f ≤ 2,400 MHz and 2,483.5 MHz < f ≤ 2,496.5 MHz	25 μW or less at 1MHz bandwidth

Noe: Interim measures are provided. (ORE: supplementary provisions Ministerial ordinance of MIC No. 119, Aug.9th,2005)

(b) Permissible value based on ORE before November 30th, 2005

(6) Permissible mean power of spurious emission of each frequency supplied to a feeder, that is, mean power of spurious emission in the 1 MHz bandwidth at frequency f other than frequency band used shall be as follows:

a.2,387 MHz ≤ f ≤ 2,400 MHz and 2,483.5 MHz < f ≤ 2,496.5 MHz 25 μW or less

b.2,387 MHz > f and 2,496.5 MHz < f 2.5 μW or less

(ARIB STD –T66 Ver.2.2)

(7) Permissible value for occupied bandwidth (RE: Article 6, Attached Table No. 2)

Permissible value for occupied bandwidth using the FH system, a hybrid system combining DS and FH systems, or a hybrid system combining FH and OFDM systems shall be 83.5 MHz or less, while necessary bandwidth (minimum occupied bandwidth sufficient to ensure information transmission of required quality at a required transmission rate for the system used under specified conditions for a given emission

type) using a system other than any of the above shall be 26 MHz or less.

(8) Spread bandwidth (RE: Article 49-20)

In spread spectrum systems, spread bandwidth (which refers to a frequency bandwidth with an upper limit and lower limit such that each of the mean powers radiated above the upper frequency limit and below the lower frequency limit is equal to 5 % of the total mean power radiated; this also applies hereafter) shall be 500 kHz or more.

(9) Process gain (RE: Article 49-20)

Process gain (value obtained by dividing the spread bandwidth by a frequency equal to the transmission rate of the modulation signal; this also applies hereafter) in the spread spectrum system shall be 5 or more.

(10) Number of carriers (RE: Article 49-20)

The OFDM system shall have one or more carriers per 1 MHz bandwidth.

(11) Hopping frequency occupancy time (RE: Article 49-20)

Frequency dwell time (time during which radio waves continue to be emitted at a specified frequency) of a transmitting equipment using the FH system shall be 0.4 seconds or less. When a simple FH system (except hybrid system) is used, total frequency dwell time at an arbitrary frequency within the time period obtained by multiplying 0.4 seconds by the process gain shall be 0.4 seconds or less.

3.3 Receiving equipment

(1) Limit on secondary radiated emissions (RE: Article 24)

The limit on secondary emissions radiated from the receiving equipment within which the function of other radio equipment will not be impaired shall be, in terms of the power of a dummy antenna circuit that has the same electrical constant as the receiving antenna, 4 nW or less at a frequency below 1 GHz and 20 nW or less at a frequency of 1 GHz or higher as measured using the circuit

(2) Other

Neither adjacent channel selectivity, intermodulation characteristic, nor spurious response are regulated.

3.4 Controlling equipment

Controlling equipment shall be equipped with the following devices and functionality and comply with the respective requirements:

3.4.1 Interference prevention function

(1) Identification code transmission/reception (RLE: Article 6-2)

(RE: Article 9-4)

Radio equipment used mainly on the same premises and automatically transmits or receives identification code

(2) Frequency switching and other functions

Users shall be able to choose operating frequencies and halt emission.

(3) Carrier sense

(a) Carrier sense function shall be supplied to the transmitter that uses OFDM system and its occupied bandwidth is more than 26MHz and less than 38MHz. (Hybrid system with FH system is excluded)

(b) Carrier sense function shall be supplied to the transmitter used for controlling a model plane in the open, and it shall function at the beginning of transmitting power.

3.4.2 Channel connection procedure

Not particularly regulated.

3.5 Telecommunications circuit connection

Radio equipment connected to telecommunications circuit facilities shall comply with the following requirements:

(1) Identification unit (TR: Article 9)

An identification unit shall have an identification code (code designed to identify the radio equipment used in terminal equipment and verify that the equipment at the time of communication channel establishment).

(2) Identification code (AM: No. 424 of 1994)

The identification code shall be 48 bits long.

(3) Judgment as to whether radio frequency to be used is available (TR: Article 9)
(AM: No. 424 of 1994)
(AM: No. 757 of 1999)

Judgment is performed by detecting radio waves emitted by other radio stations or calculating received signals and signals for spreading and detecting signal levels. Note, however, that if the radio equipment is capable of disconnecting the communication channel (its own communication link) in the event of deterioration of communication quality, such determination is carried out by verifying the communication channel (its own communication link) for proper operation.

(4) Requirements for interfacing with telecommunications circuit facilities

Requirements for interfacing with telecommunications circuit facilities shall comply

with technical regulations (including technical requirements prescribed by Type I telecommunications carriers) as specified in Terminal and Other Equipment Regulations.

3.6 Antenna

(1) Antenna structure

Not particularly regulated.

(2) Antenna gain (RE: Article 49-20)

a: The absolute gain of the transmitting antenna shall be 12.14 dB or less. However, when the equivalent isotropic radiated power (equivalent isotropic radiated power in the 1 MHz bandwidth in the case of spread spectrum and OFDM systems) is equal to or less than the value obtained by applying an antenna power with the mean power of 10 mW with its absolute gain being 12.14 dB, the shortage shall be compensated for by the gain of the transmitting antenna (Note that mean power is 10 mW in the 1 MHz bandwidth in the case of spread spectrum and OFDM systems; however, mean power of 3 mW in the 1 MHz bandwidth is applied if the FH system, a hybrid system combining DS and FH systems, or a hybrid system combining FH and OFDM systems is employed and the frequency band of 2,427 - 2,470.75 MHz is used.).

b: The half-power beam width (angle between two points at which radiated power becomes 1/2) of the transmitting antenna's horizontal and vertical planes shall not exceed the value as determined by the following formula:

$$360 / A \text{ [degrees]},$$

where constant A is equal to the value obtained by dividing the equivalent isotropic radiated power (equivalent isotropic radiated power in the 1 MHz bandwidth in the case of spread spectrum and OFDM systems) by the value obtained by applying an antenna power with the mean power of 10 mW with its absolute gain being 2.14 dB, and shall be assumed to be 1 if it is less than 1 (Note that mean power is 10 mW in the 1 MHz bandwidth in the case of spread spectrum and OFDM systems; however, mean power of 3 mW in the 1 MHz bandwidth is applied if the FH system, a hybrid system combining DS and FH systems, or a hybrid system combining the FH and OFDM systems is employed and the frequency band of 2,427 - 2,470.75 MHz is used.).

3.7 Others

(1) Cabinet (RE: Article 49-20)
(TR: Article 9)

(AM: No. 424 of 1994)

The radio equipment used shall be housed in a single cabinet that cannot be readily opened. Note, however, that radio equipment meeting the followings need not be housed in a single cabinet:

a. Radio equipment meeting the following requirements

i) Radio frequency and modulation sections other than antenna system are difficult to open.

ii) Identification unit resists removal.

b. Radio equipment devices listed below

i) Power supply unit, microphone, and earphone

ii) Receive-only antenna

iii) Control unit, indicators, volume controller, and their equivalents

(2) Indication of information associated with Technical Regulations Conformity Certification

(TR: Article 8)

Information associated with Technical Regulations Conformity Certification shall be indicated in the specified format at visible location on radio equipment.

(3) Indication of information associated with Technical Conditions Compliance Certification for Terminal Equipment (RTADT: Article 10)

For radio equipment connected to telecommunications circuit facilities, information associated with Technical Conditions Compliance Certification for Terminal Equipment shall be indicated in the specified format at a visible location on radio equipment.

Chapter 4 Requirements for Interconnected System

4.1 System outline, etc.

Pursuant to regulations in Chapters 1 through 5 in ISO/IEC 8802-11

4.2 Communication protocol, etc.

4.2.1 MAC service definition

Pursuant to regulations in Chapter 6 in ISO/IEC 8802-11

4.2.2 MAC frame format

Pursuant to regulations in Chapter 7 in ISO/IEC 8802-11

4.2.3 Authentication and privacy

Pursuant to regulations in Chapter 8 in ISO/IEC 8802-11

4.2.4 MAC sublayer functional description

Pursuant to regulations in Chapter 9 in ISO/IEC 8802-11

4.2.5 Layer management

Pursuant to regulations in Chapter 10 in ISO/IEC 8802-11

4.2.6 MAC sublayer management entity

Pursuant to regulations in Chapter 11 in ISO/IEC 8802-11

4.2.7 Physical service specification

Pursuant to regulations in Chapter 12 in ISO/IEC 8802-11

4.2.8 Physical layer management

Pursuant to regulations in Chapter 13 in ISO/IEC 8802-11

4.3 Radio equipment requirements

Radio equipment is required to comply with Chapter 3 technical requirements and the requirements given below. Note, however, that in the event of inconsistencies in the treatment and particulars of a standard described in both Chapter 3 and the following, the regulations set forth in Chapter 3 shall take precedence.

4.3.1 Frequency Hopping system

Pursuant to regulations in Chapter 14 in ISO/IEC 8802-11

4.3.2 Direct Sequence system

Pursuant to regulations in Chapter 15 in ISO/IEC 8802-11

4.4 Infrared equipment requirements

Pursuant to regulations in Chapter 16 in ISO/IEC 8802-11

4.5 Supplementary provision

Pursuant to regulations in Annexes A through E in ISO/IEC 8802-11

Chapter 5　Measurement Method

Measurement shall be conducted in accordance with MIC Ordinance with OTRCC Item (3) in Appendix 1 (Note 1).　Measurement method for test items that are not specified in the MIC Ordinance, however, shall be based on conventionally practiced methods.

(Note1): At the release date of ARIB STD-T66 Ver. 3.6 on December 18th 2012, it means "characteristic test method" of MIC Ordinance No.88 on January 26th 2004.　However, if the MIC Ordinance and the contents of the MIC ordinance are revised in near future, measurement methods shall be in accordance with latest version of The MIC Ordinance and the contents.

Furthermore, at the release date of ARIB STD-T66 Ver.3.6 on December 18th 2012, TELEC-T401, which is established according to Notification No.88 of MIC dated January 26th 2004 by Telecom Engineering Center, specifies " Characteristic test method for radio equipment used for 2.400MHz to 2.483MHz band low power data communication system(2.4GHz-band second generation low power data communication system) ".　This should be referenced.

Annex 1　Test Items Associated with Specified Radio Equipment

The test items associated with radio equipment for second-generation low-power data communications systems and wireless LAN systems radio stations are as follows:
In addition, Annex 5 should be referenced in detail.

(1) Transmitting equipment (RTCSR: Article 4, Attached Table No.3)

Frequency

Occupied bandwidth

Spurious emission intensity

Antenna power

Absolute antenna gain (in case of using antenna terminal and its measured isotropic radiated power is 12.14dBm or more)

Angle width of the main radiation of antenna (in case of its measured isotropic radiated power is 12.14dBm or more)

(2) Receiving equipment (RTCSR: Article 4, Attached Table No.3)

Limit on secondary radiated emissions

(3) Others

Function for preventing interference

Hopping frequency occupancy time

Annex 2 Operational Guidelines for Second-generation Low-power Data Communications Systems Radio Stations

1. Outline

1.1 Objective

The purpose of these guidelines is to prevent harmful interference with RFID systems (premises radio stations and specified low-power radio stations, both for RFID) operating in the frequency band of 2,427 - 2,470.75 MHz and amateur radio stations operating in the frequency band of 2,400 - 2,450 MHz, with the ultimate goals of ensuring effective use of frequencies and improving convenience for users in the operation of second-generation low-power data communications systems radio stations operating in the frequency band of 2,400 - 2,483.5 MHz. Note that "harmful interference" refers to successive and serious interference to the function of other radio equipment (RL: Article 82).

1.2 Abstract

These guidelines apply to users of second-generation low-power data communications systems and to those who manufacture, sell, install, operate, or maintain such systems (hereinafter experts).

1.3 Target systems

The following systems using the same frequency bands as second-generation low-power data communications systems radio stations are treated as target systems:

(1) RFID systems (premises radio stations): 2,427 - 2,470.75 MHz RCR STD – 1
(2) RFID equipment for specified low-power radio stations: 2,427 - 2,470.75 MHz RCR STD – 29
(3) RFID equipment using the frequency hopping system for specified low-power radio stations: 2,400 - 2,483.5 MHz ARIB STD – T81
(4) Second-generation low-power data communications systems radio stations: 2,400 - 2,483.5 MHz ARIB STD – T66
(5) Amateur radio stations: 2,400 - 2,450 MHz

1.4 Basic concepts

(1) Clarification of problems

Experts must act in good faith, taking appropriate measures to prevent interference. This can be done by providing notes in instruction manuals and other materials and through public relations efforts.

(2) Preliminary survey

When a user or an expert intends to introduce a radio equipment for a second-generation low-power data communications system, the user or expert must perform an interference survey prior to the introduction to ensure that the radio equipment does not cause harmful interference to other radio equipment.

(3) Coordinated response

The user and the expert must coordinate their efforts in good faith to resolve interference in the event that harmful interference to other radio equipment occurs for reasons attributable to the second-generation low-power data communications system. At this time, utmost consideration must be given to protection of the "premises radio station" already in operation.

2. Clarification of problems

2.1 Instruction manuals

Notes to the following effect and the meanings of equipment-indicated symbols described further below shall be provided in instruction manuals for second-generation low-power data communications systems:

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1　この機器を使用する前に、近くで移動体識別用の構内無線局及び特定小電力無線局並びにアマチュア無線局が運用されていないことを確認して下さい。

2　万一、この機器から移動体識別用の構内無線局に対して有害な電波干渉の事例が発生した場合には、速やかに使用周波数を変更するか又は電波の発射を停止した上、下記連絡先にご連絡頂き、混信回避のための処置等(例えば、パーティションの設置など)についてご相談して下さい。

3　その他、この機器から移動体識別用の特定小電力無線局あるいはアマチュア無線局に対して有害な電波干渉の事例が発生した場合など何かお困りのことが起きたときは、次の連絡先へお問い合わせ下さい。

連絡先：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

This equipment shares a frequency band with a wide range of equipment: e.g. industrial, scientific, and medical equipment such as microwave ovens, premises radio stations (radio stations requiring licenses), and specified low-power radio stations (radio stations not requiring licenses) for RFID used for factory production lines as well as amateur radio stations (radio stations requiring licenses).

1. Before use, confirm that no premises radio stations and specified low-power radio stations for RFID or amateur radio stations operate in your vicinity.

2. In the event that this equipment causes harmful interference to any premises radio station for RFID, immediately change frequencies or halt radio wave emission and contact us at the information indicated below for consultation on interference avoidance measures (e.g., partition installation).

3. Contact us at the information indicated below if this equipment causes harmful interference to any specified low-power radio stations for RFID or amateur radio stations or if other problems arise.

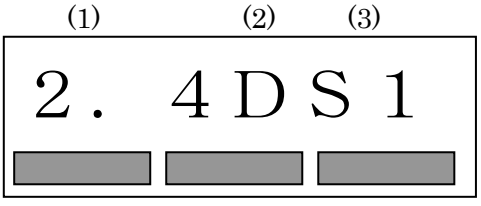
Contact us at :_____

2.2 Catalogs, pamphlets, and Web pages

The same information provided in instruction manuals, including definitions of equipment-indicated symbols (described further below), shall be provided in catalogs, pamphlets, Web pages, and other media related to second-generation low-power data communications systems.

2.3 Indication of symbols on equipment

Indication (representing “2.4 GHz band equipment, modulation system, estimated interference distance, and frequency-changing capability”) shall be provided on the main unit of the radio equipment for the second-generation low-power data communications system. Note, however, that a sticker bearing the same indication may be used instead if no indication can be provided on the main unit of radio equipment for reasons related to the radio equipment’s physical size, installation type, design restrictions, or other factors.



(1) "2.4": Represents radio equipment using the 2.4 GHz band.

(2) "DS": Represents modulation system (refer to Section 2.4.1 for details). Note that for radio equipment capable of emitting radio waves of multiple modulation systems, these modulation systems shall be stated by separating them with a slash as in "DS/OF."

(3) "1": Represents estimated interference-causing radius to premises radio stations for RFID (refer to Section 2.4.2 for details). Note that for radio equipment capable of emitting radio waves of multiple modulation systems, whose interference-causing radius varies depending on the modulation system, these modulation systems and interference-causing radiuses shall also be stated by separating the indications representing such modulation systems and interference-causing radiuses with a slash as in "DS2/OF1."

(4) " ▭ ▭ ▭ ": Indicates that the equipment can use the entire band and is capable of avoiding the band used by RFID systems (refer to Section 2.4.3 for details).

2.3.1 Modulation system

The modulation system shall be indicated by one of the symbols listed in Table 2.1.

Table 2.1 Modulation Systems

Symbol	Modulation system	Remarks
DS	DS – SS system	
FH	FH – SS system	
HY	DS – FH or FH – OFDM hybrid system	
OF	OFDM system	
XX	Other system	Narrow-band modulation, etc.

2.3.2 Indication of interference-causing radius

Table 2.2 shows the estimated interference-causing distances to a premises radio station for the RFID system, and antenna power values. Note that all values are obtained assuming that the antenna gain of second-generation low-power data communications system radio station is 2.14 dBi; the values are obtained by calculating radio wave propagation loss using the 3.5th power rule. On the other hand, as radio stations subject to interference, the specifications for a typical premises radio station for the RFID system (Model A in the RCR

TR-1 RFID System Research and Development Report) constitute the following parameters; antenna power of 300 mW, interrogator antenna gain of 11 dBi, interrogator feeder line loss of 0 dB, responder antenna gain of 2 dBi, responder total loss of 10 dB (including antenna gain and feeder line loss), communication distance of 5 m, receiving bandwidth of 32 kHz, receiving equipment noise power of -118 dBm, and propagation margin of 10 dB. Further, it is assumed that harmful interference does not occur if interference power level is at least 10 dB below that of the standard receiving input.

If the antenna gain is not 2.14 dBi or if the antenna power is different, estimated interference-causing radius may change with such differences in antenna gain or power, and this results in a change of symbols. Note that although four symbols – 1, 2, 4, 8 – are used in Table 2.2, other symbols may also be used. 1/10 of the estimated interference-causing radius shall be used as the symbol.

Table 2.2　Indication of Interference-causing Radius

Indicated symbol			1	2	4	8	
Estimated interference-causing radius			≦ 10m	≦ 20m	≦ 40m	≦ 80m	
Example of radio equipment	Narrow-band modulation		0.01 mW	0.1 mW	1 mW	10 mW	
	DS, OFDM		0.1 mW/MHz	1 mW/MHz	10 mW/MHz	–	
	FH	Antenna power	0.01mW/MHz	0.1mW/MHz	1 mW/MHz	10mW/MHz	3mW/MHz
		Spread bandwidth	83.5 MHz	26 MHz	26 MHz	26 MHz	83.5 MHz

Note:
The interference-causing radiuses given here are estimated distances from second-generation low-power data communications systems to RFID systems (premises radio stations). This table may have different values for distances between second-generation low-power data communications systems or for distances between second-generation low-power data communications systems and amateur radio stations.

2.3.3 Indication of frequency-changing capability

(1) 

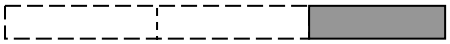
2,400 2,427 2,470.75 2,483.5 MHz

The above graph indicates that the equipment can use the entire band and is capable of avoiding the band used by RFID systems. Although the above indicates three parts, this does not mean that the equipment uses three channels, i.e., the graph has three parts regardless of the number of channels that the equipment uses.

(2) 

2,400 2,483.5 MHz

The above graph indicates that the equipment uses the entire band and is unable to avoid the band used by RFID systems.

(3) 

2,400 2,470.75 2,483.5 MHz

The above graph indicates that the equipment uses only the higher region (e.g., 2,471 - 2,483.5 MHz) of the band. According to this standard, no graphs are required for radio equipment using frequencies 2,470.75 MHz or higher or 2,427 MHz or lower. Nevertheless, it is recommended that graphs be provided for clarification.

(4) 

2,400 2,427 2,470.75 2,483.5 MHz

The above graph indicates that the equipment uses only the middle region of the band and is unable to avoid the band used by RFID systems.

(5) 

2,400 2,427 2,470.75 2,483.5 MHz

The above graph indicates that the equipment uses only the middle region of the band and is capable of changing frequencies within that region. Although the above indicates three parts, the graph indicates that the equipment can change frequencies within the band used by RFID systems. The graph has three parts regardless of the number of channels that the equipment uses.

2.3.4 Indication method and others

(1) Indication method

Not particularly regulated. Stickers, printing on equipment's nameplate, embossing on cabinet, or other methods may be used.

(2) Size, aspect ratio, background color, and presence/absence of border

Not particularly regulated.

(3) Material

Although not particularly regulated, the material shall resist peeling, removal, and discoloration.

(4) Font, character, and symbol color

Although not particularly regulated, the font and its color shall be easily visible and clear.

(5) Used frequency display graph

Although size, aspect ratio, division ratio, and others are not particularly regulated, the graph shape and color shall allow easy verification of the frequency used.

2.4 Indication of information on fixed, outdoor-installed equipment

A second-generation low-power data communications system radio station operating as a fixed outdoor station shall indicate the name of its owner or operator and contact information in addition to indications on the equipment, as described in the previous section. An example is given below:

2.4GHz 帯小電力データ通信システムの無線局	(1)
運用者　〇〇通信株式会社	(2)
ＩＰ事業部お客様相談室 連絡先　TEL 03-〇〇〇-〇〇〇 URL http://www.〇〇.co.jp	(3)

2.4 GHz band low-power data communications system radio station	(1)
Operator　XX Communication Co., Ltd.	(2)
IP Division Customer Service Center To contact : TEL : 03- XXXX - XXXX : URL: http://www.XX.co.jp	(3)

2.4.1 Indicated information

(1) Indication of radio station

The equipment shall be clearly labeled as “2.4 GHz band low-power data communications system radio station.”

(2) Name of owner or operator

The name of the individual shall be indicated if the radio station is owned or operated by that individual. The names of the relevant entity and section or person in charge shall be

indicated if the radio station is owned or operated by that entity.

(3) Contact information

Telephone number, e-mail address, or URL shall be indicated.

(4) Others

Useful information on interference avoidance may be indicated, as necessary.

2.4.2 Indication method and others

(1) Indication method

Not particularly regulated. Stickers, printing on equipment's nameplate, embossing on cabinet, or other methods may be used.

(2) Size, aspect ratio, background color, and presence/absence of border

Not particularly regulated.

(3) Material

Although not particularly regulated, the material shall resist peeling, removal, and discoloration even when left outside for an extended period.

(4) Font, character and symbol color

Although not particularly regulated, the font and its color shall be easily visible and clear.

(5) Location of indication

Information shall be indicated in prominent, easily visible locations that do not require additional steps to view the information. Such locations include the radio equipment's main unit, antenna, or casing.

2.5 Package

"2.4 GHz band equipment, modulation system, estimated interference distance, and frequency-changing capability" shall be indicated in a prominent position on the package of the radio equipment in the same format as the symbols indicated on equipment. This does not apply if the package is designed solely for transport purposes.

3. Preliminary survey

3.1 Preliminary survey method

(1) Those intending to operate a second-generation low-power data communications system radio station shall conduct a preliminary survey to determine whether any RFID system or amateur radio station operate, or have finalized preparations for operating within the estimated interference-causing radius shown in Table 2.2.

(2) If any premises radio station for RFID system is found to exist or is expected to begin

operating within this area, the second-generation low-power data communications system may not operate within the same frequency band. However, through consultation with the user of the station, if it is confirmed that no interference occurs by test operations and / or by measurement using a spectrum analyzer for example or dedicated testing instruments, this does not apply.

3.2 Expert's response

(1) Consulting

Before delivering a second-generation low-power data communications system, experts shall conduct the preliminary survey if requested to do so by its users. Ideally, preliminary surveys should be undertaken voluntarily, even if not specifically requested by users.

(2) Testing functions

Ideally, experts should ensure that the radio equipment has a function of, for example, continuous wave transmission, bit error rate measurement, and other testing functions required for preliminary surveys. If the radio equipment does not have such functions, testing equipment, measuring instruments, or other equipment should ideally be made available to enable such tests.

4. Coordinated response

4.1 Cooperation to avoid interference

Experts shall cooperate with users in good faith to resolve interference occurrence if an RFID system or an amateur radio station suffers harmful interference attributable to a second-generation low-power data communications system manufactured, sold, installed or maintained by the expert; and if the user of the system concerned and the user of the RFID system or the licensee of the amateur radio station need to consider interference avoidance measures.

4.2 Higher priority to pre-existing radio station

Those intending to operate a second-generation low-power data communications system radio station in an area in which a premises radio station for RFID systems already operates, using the same frequency band, or introduction of such system has been finalized, are responsible for conducting preliminary surveys and for taking interference avoidance measures.

In the event that a second-generation low-power data communications system causes harmful interference to a pre-existing premises radio station for RFID systems, the operator

shall immediately change frequencies or halt radio wave emissions in order to resolve interference issues. Users of both systems have to cooperate and work together to resolve the interference if the station-to-station distance is greater than the estimated interference-causing radius shown in Table 2.2.

4.3 Limitations of sector directive antenna

The half-power beam width of antennas is limited so that interference-causing area will not increase with increasing EIRP. However, the area in which interference occurs will eventually increase if multiple radio stations are installed at a single location and their antenna beams are pointed in multiple directions. For this reason, only one radio station may operate at any one location (within the estimated interference-causing radius shown in Table 2.2) if antennas with gain in excess of 2.14 dBi are used and if EIRP exceeds the corresponding value under “Omnidirectional” in Table 4.1.

Table 4.1 Upper Limit of EIRP for Modulation Systems

Modulation system	Frequency band used	Antenna power (max.)	EIRP (max.)	
			Omnidirectional case	Directional case
DS, OFDM1	2,400 - 2,483.5 MHz	10 mW/MHz	12.14 dBm/MHz	22.14 dBm/MHz
DS, OFDM2	2,400 - 2,483.5 MHz	10 mW/MHz	12.14 dBm/MHz	22.14 dBm/MHz
FH, DS-FH FH-OFDM	2,400 - 2,483.5 MHz	3 mW/MHz	6.91 dBm/MHz	16.91 dBm/MHz
	Excluding 2,427 - 2,470.75 MHz	10 mW/MHz	12.14 dBm/MHz	22.14 dBm/MHz
Other than the above	2,400 - 2,483.5 MHz	10 mW	12.14 dBm	22.14 dBm

Note1:
The half-power beam width for directional antenna shall be 360/A degrees or less, where A is a ratio which causes the EIRP concerned to exceed the omnidirectional EIRP upper limit.
Note2:
Among OFDM modulation system, systems with occupied bandwidth less than 26MHz belong to OFDM1 and systems with occupied bandwidth from 26MHz to 38MHz belong to OFDM2.

4.4 Matters that require attention in case of applying radio control system for airplane models in the open.

(1) Attention matters

In case of using this radio system for radio control system of airplane models in the open,

Special attentions to be paid in designing the radio equipment and operating it.

(2) Differences from common product (ORE: article49, 2)

(a) Hopping frequency occupancy time shall be 0.05second or less in FH system.

(b) Carrier sense which operates at the beginning of transmission shall be provided.

(3) Definition of airplane model

Airplane models here mean those that are operated by a radio control equipment with fixed wings (i.e. airplane), rotating wings (helicopter), and a glider.

(4) Exclusion

Video transmission equipment and data transmission equipment are not included in this category.

(5) Liaison office

It is recommended to contact the following office for detailed information when the radio equipment is used for a radio control airplane models operated in the open.

Japan Radio Control Safety Association (a foundation)

Tel: +81 3 3864 9175 Fax: +81 3 3864 9176

http://www.rck.or.jp

T.F.A Bld. 10th floor, 4-10-8 Asakusabashi, Daito-ku, Tokyo, 111-0053, Japan

Annex 3　Summary of Operational Guidelines for Second-generation Low-power Data Communications Systems Radio Stations

Introduction

Second-generation low-power data communications systems radio stations use the frequency band of 2,400 - 2,483.5 MHz, which overlaps both the frequency band of 2,427 - 2,470.75 MHz used by RFID systems (premises radio stations for RFID and specified low-power radio stations for RFID), and the frequency band of 2,400 - 2,450 MHz used by amateur radio stations. The Operational Guidelines have been prepared to prevent harmful interference within these overlapping frequency bands in order to ensure effective use of frequencies, and to improve convenience for all users.

Those who manufacture, sell, install, operate, or maintain second-generation low-power data communications systems (hereinafter experts) are requested to clarify any potential interference to users, to guide them in taking interference avoidance measures, and to work with them to implement such measures in the event that interference occurs.

1.　Clarification of problems

(1)　Instruction manuals

Notes to the following effect and the meanings of equipment-indicated symbols shall be described in instruction manuals. Note that a sticker bearing the same information shall be supplied with the product.

この機器の使用周波数帯では、電子レンジ等の産業・科学・医療用機器のほか工場の製造ライン等で使用されている移動体識別用の構内無線局（免許を要する無線局）及び特定小電力無線局（免許を要しない無線局）並びにアマチュア無線局（免許を要する無線局）が運用されています。

1　この機器を使用する前に、近くで移動体識別用の構内無線局及び特定小電力無線局並びにアマチュア無線局が運用されていないことを確認して下さい。

2　万一、この機器から移動体識別用の構内無線局に対して有害な電波干渉の事例が発生した場合には、速やかに使用周波数を変更するか又は電波の発射を停止した上、下記連絡先にご連絡頂き、混信回避のための処置等（例えば、パーティションの設置など）についてご相談して下さい。

3　その他、この機器から移動体識別用の特定小電力無線局あるいはアマチュア無線局に対して有害な電波干渉の事例が発生した場合など何かお困りのことが起きたときは、次の連絡先へお問い合わせ下さい。

連絡先：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

This equipment shares a frequency band with a wide range of equipment: e.g. industrial, scientific, and medical equipment such as microwave ovens, premises radio stations (radio stations requiring licenses) and specified low-power radio stations (radio stations not requiring licenses) for RFID used for factory production lines as well as amateur radio stations (radio stations requiring licenses).

1. Before use, confirm that no premises radio stations and specified low-power radio stations for RFID or amateur radio stations operate in your vicinity.
2. In the event that this equipment causes harmful interference to any premises radio station for RFID, immediately change frequencies or halt radio wave emission and contact us at the information indicated below for consultation on interference avoidance measures (e.g., partition installation).
3. Contact us at the information indicated below if this equipment causes harmful interference to any specified low-power radio stations for RFID or amateur radio stations or if other problems arise.

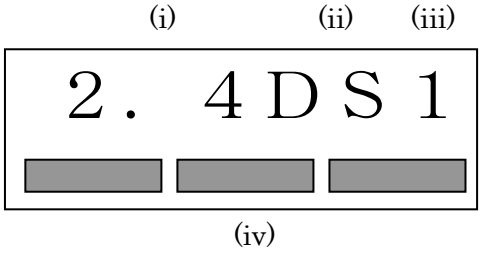
Contact us at : _____

(2) Catalogs, pamphlets, and Web pages

The same information provided in instruction manuals, including definitions of equipment-indicated symbols, shall be provided in catalogs, pamphlets, Web pages, and other media.

(3) Indication of symbols on equipment

The symbols listed below (representing “2.4 GHz band equipment, modulation system, estimated interference distance, and frequency-changing capability”) shall be indicated on the main unit of the radio equipment. The symbols in the same format shall be indicated also on the package. The following figure is intended to serve as an example. Refer to ARIB STD-T66 for details.



(i) "2.4": Represents radio equipment using the 2.4 GHz band.

(ii) "DS": Represents modulation system. Note that for radio equipment capable of emitting radio waves of multiple modulation systems, these modulation systems shall be stated by separating them with a slash as in "DS/OF."
DSSS system: DS, FHSS system: FH, OFDM system: OF, hybrid system: HY, others: XX

(iii) "1": Represents estimated interference-causing radius. This example represents estimated interference distance (1 x 10) m or less. Note that for radio equipment capable of emitting radio waves of multiple modulation systems, whose interference-causing radius varies depending on the modulation system, these modulation systems and interference-causing radiuses shall also be stated by separating the indications representing such modulation systems and interference-causing radiuses with a slash as in "DS2/OF1."

(iv) " ▭ ▭ ▭ ": Indicates that the equipment can use the entire band and is capable of avoiding the band used by RFID systems.

(4) Indication of information on fixed, outdoor-installed equipment

A second-generation low-power data communications system radio station operating as a fixed outdoor station shall indicate the following information at a prominent location on the radio equipment's main unit, antenna, or casing.

2.4GHz 帯小電力データ通信システムの無線局	(i)
運用者　〇〇通信株式会社	(ii)
ＩＰ事業部お客様相談室 連絡先　TEL 03-〇〇〇-〇〇〇 URL http://www.〇〇.co.jp	(iii)

2.4 GHz band low-power data communications system radio station	(i)
Operator　XX Communication Co., Ltd.	(ii)
IP Division Customer Service Center To contact : TEL : 03- XXXX - XXXX : URL: http://www.XX.co.jp	(iii)

(i) Indicate that the equipment is a 2.4 GHz band low-power data communications system radio station.

(ii) Indicate the owner's or operator's name.

(iii) Indicate the owner's or operator's telephone number, e-mail address, or URL.

2. Preliminary survey

(1) Those intending to operate a second-generation low-power data communications system radio station shall conduct a preliminary survey to determine whether any RFID system or amateur radio station operate within the estimated interference-causing radius.

(2) If any premises radio station for RFID system is found, the second-generation low-power data communications system may not operate within the same frequency band. However, through consultation with the user of the station, if it is confirmed that no interference occurs by test operations and / or by measurement using a spectrum analyzer for example or dedicated testing instruments, this does not apply.

(3) Experts shall conduct a preliminary survey if requested to do so by their users. It is recommended that experts conduct preliminary surveys on a voluntary basis, even if not specifically requested by their users.

3. Coordinated response

(1) Cooperation to avoid interference

Experts shall cooperate with users in good faith to resolve interference occurrence if an RFID system or amateur radio station suffers harmful interference attributable to a second-generation low-power data communications system; and if the user of the system concerned and the user of the RFID system or the licensee of the amateur radio station need to consider interference avoidance measures.

(2) Higher priority to pre-existing radio station

Those intending to operate a second-generation low-power data communications system radio station in an area in which a premises radio station for RFID systems already operates, using the same frequency band, or introduction of such system has been finalized, are responsible for conducting a preliminary survey and for taking interference avoidance measures.

In the event that a second-generation low-power data communications system causes harmful interference to a pre-existing premises radio station for RFID systems, the operator shall immediately change frequencies or halt radio wave emissions in order to resolve interference issues.

Notes:

1. This Summary of Operational Guidelines constitutes voluntary standards. For the details, consult the

Operational Guidelines attached to “ARIB STD-T66.”

2. For more information, contact
Secretariat of Wireless LAN Working Group, Standard Assembly Meeting of the Association of Radio Industries and Businesses
Tel: +81 3 5510 8590, Fax: +81 3 3592 1103, E-mail: info@arib.or.jp
Nittochi Bld. 14th floor, 1-4-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-0013, Japan

When the radio equipment is used for a radio control airplane models operated in the open.

Japan Radio Control Safety Association (a foundation)

Tel: +81 3 3864 9175 Fax: +81 3 3864 9176

http://www.rck.or.jp

T.F.A Bld. 10th floor, 4-10-8 Asakusabashi, Daito-ku, Tokyo, 111-0053, Japan

Annex 4 Instruction manual for the regulation of sector directive antenna (Operational manual attached to ARIB STD-T66)

1. Introduction

In the “Operational guidelines for Second-generation Low-power Data Communication Systems Radio Station” attached to ARIB STD-T66, restrictions of using sector directive antennas has been a voluntary regulation. It is prohibited from placing plural number of radio stations in a certain area. However, it is explained only in writing and operators of this system may be irresolute in case of actual application. Then, this annex is drawn up for contributing smooth operation of the voluntary regulation to the users and manufactures of Wireless LAN.

2. Point of the relaxation of EIRP regulation

On February 28th 2002, the Ordinance Regulation Radio Equipment was revised and the upper limit of equivalent isotropic radiated power (EIRP) of Low-power Data Communication Systems Radio Stations (hereinafter ” Wireless LAN”) was relaxed.(+10dB). Simple relaxation of power level may increase the area of interference to the neighboring radio stations that use the same frequency band (such as RFID radio stations or amateur radio stations), and it may cause a trouble for sharing the same frequency band. Avoiding that situation, it is regulated that the half-value angle of antenna beam will be reduced to keep interference area less than the previous interference area * (refer to Fig.1)

*: Interference area in case of using isotropic antenna of 2.14dB gain fed with maximum rated power (10mW/MHz in case of DSSS)

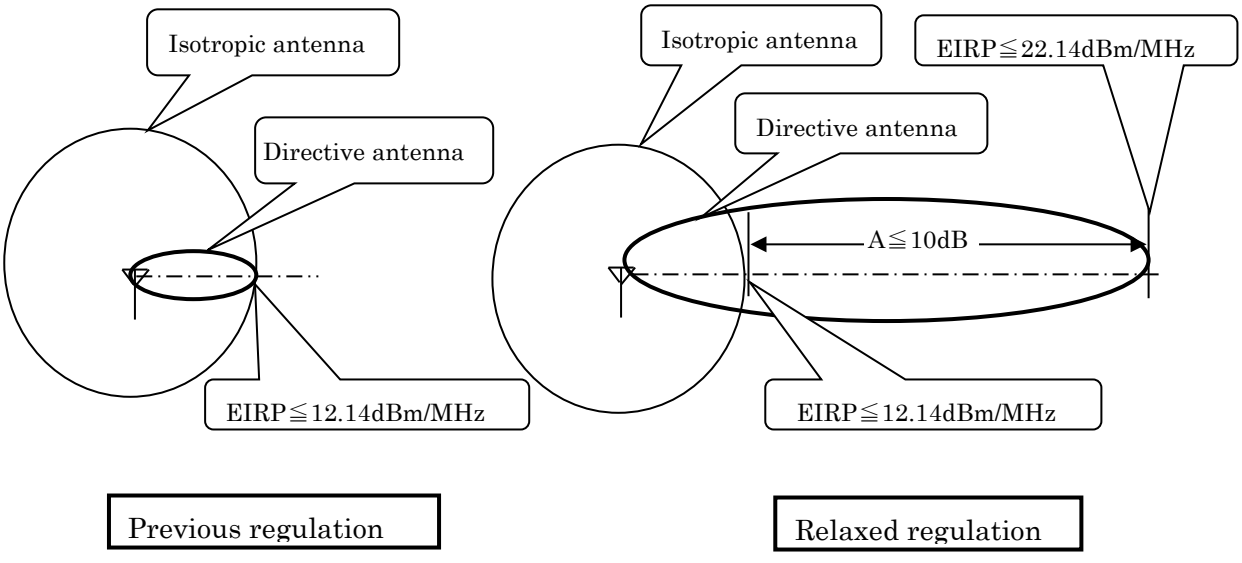


Fig1. Concept of EIRP regulation

As it is difficult to regulate the interference area by its surface, regulating the half-value angle of antenna is performed in actual cases.

$$\text{Half–value angle} \leq 360^\circ \div \text{A (number)}$$

Where; A should be the rate of concerned EIRP versus maximum value of isotropic antenna
For example, in the case of obtaining the maximum EIRP after relaxation of regulation, the half-value angle of the antenna shall be 36 degrees or less (=360° ÷10 times).
In contrary, in the case of using antenna with 60 degrees of half-value angle, the gain of the antenna could be up to 6 times (=360° ÷60°). It is 9.9dBi (=2.14dBi+7.78dBi).

3. Point of the sector directive antenna regulation

It is predictable that if plural radio stations are cited in the same area, the interference area will increase. As the extreme example, when 10 pieces of sector antenna, each of them has EIRP=22.14dBm/MHz and its half-value angle is 36degrees, are replaced with an Omni-directional antenna, the size of interference area will be 10times of its original interference area. This situation could not be accepted by the neighboring radio stations form the view point of frequency band co-sharing.

Then, it is voluntarily restricted that increasing the number of radio stations with high EIRP in the same area. The same area mentioned here means the radius surface in which a Wireless LAN radio station does not give a harmful interference to its neighboring RFID radio equipment (Premises radio station). Accordingly, the radius will vary along with the level of EIRP of Wireless LAN radio station, (refer to Table .1)

Table.1 Indication of Interference-causing Radius

Estimated interference-causing radius			≦ 10m	≦ 20m	≦ 40m	≦ 80m	
Example of radio equipment	Narrow-band modulation		0.01 mW	0.1 mW	1 mW	10 mW	
	DS, OFDM		0.1 mW/MHz	1 mW/MHz	10 mW/MHz	–	
	FH	Antenna power	0.01 mW/MHz	0.1mW/MHz	1 mW/MHz	10mW/MHz	3mW/MHz
		Spread bandwidth	83.5 MHz	26 MHz	26 MHz	26 MHz	83.5 MHz

4. Problems and solutions of operating Wires LAN

Regarding to the definition of sector directive antenna, if the clause " plural radio stations in the same area" is applied as it stands, radio relay stations could not be constructed. Also, it is not possible to cover a linear communication area (along a road or a railway) with utilizing beam of antenna's directivity on both up-link and down-link. This condition is impediment to the convenience of the user. The point of the restriction on sector directive antenna is shrinking the interference-causing area to a smaller surface than its maximum surface before the relaxation of regulation. In contrary, as long as there is no increase of the interference -causing area, it is not infringing the voluntary regulation that setting up plural Wireless LAN radio stations in the same area.

5. Example of decisions on applying the voluntary regulation

Some examples that indicate the basis of the decision making of infringement/acceptance are shown below.

(1) The case of using radio equipment defined by the previous regulation (EIRP≤ 12.14dBm/MHz)

Radio equipment defined by the previous regulation is excluded from the voluntary regulation. When a Wireless LAN system is composed with the radio equipment that comply with the previous regulation, the number of radio stations in the same area is not limited. However, it is predicted that the through-put of the system will be dropped in accordance with the number of Wireless LAN radio stations.

(2) The case of using both radio equipment defined by the previous regulation and a high EIRP radio equipment in the same area

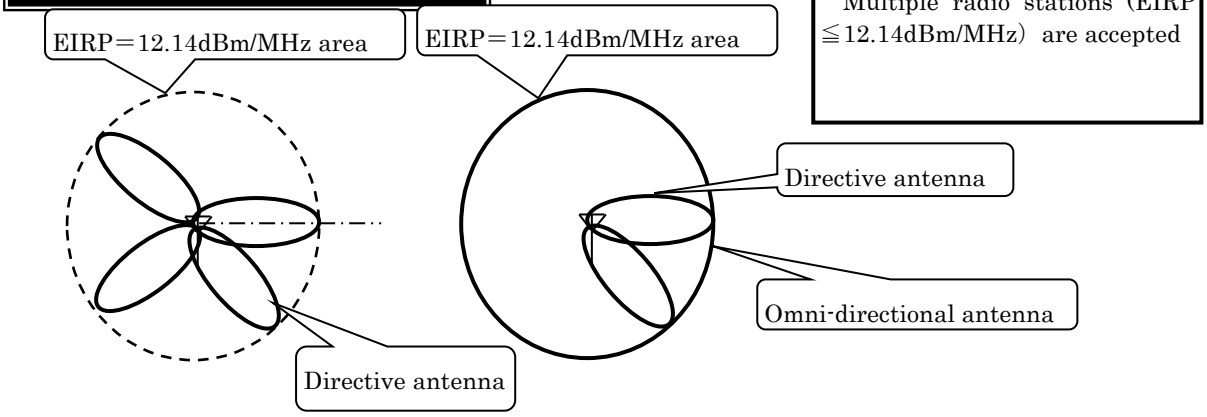
There will not be any problem as long as the high EIRP radio station is operated under the relaxed regulation (i.e. EIRP ≤22.14dBm/MHz and its half-value angle ≤ 360° ÷A). Regarding the number of radio stations defined by the previous regulation, there is no restriction.

(3) The case of the location of radio stations are not considered in the same area

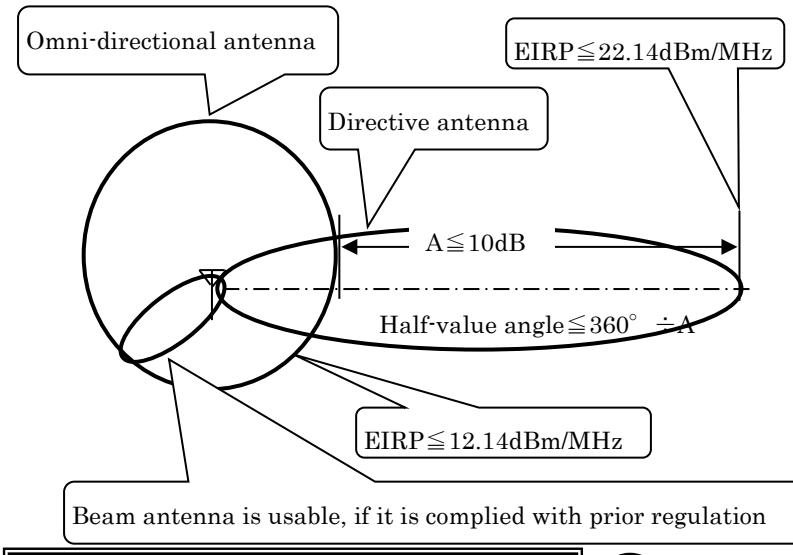
" in the same area" means the area covered by the assumed radius that Wireless LAN radio equipment does not cause a harmful interference to RFID radio station(Premises radio station). The assumed radius is dependent on its antenna power. However, Wireless LAN radio equipment is installed by different user, " in the same area" will not be applied to it.

【Examples 】 Legend: ◎ Pass ○ Conditionally pass × fail

Sector antenna complied with the Prior regulation ◎

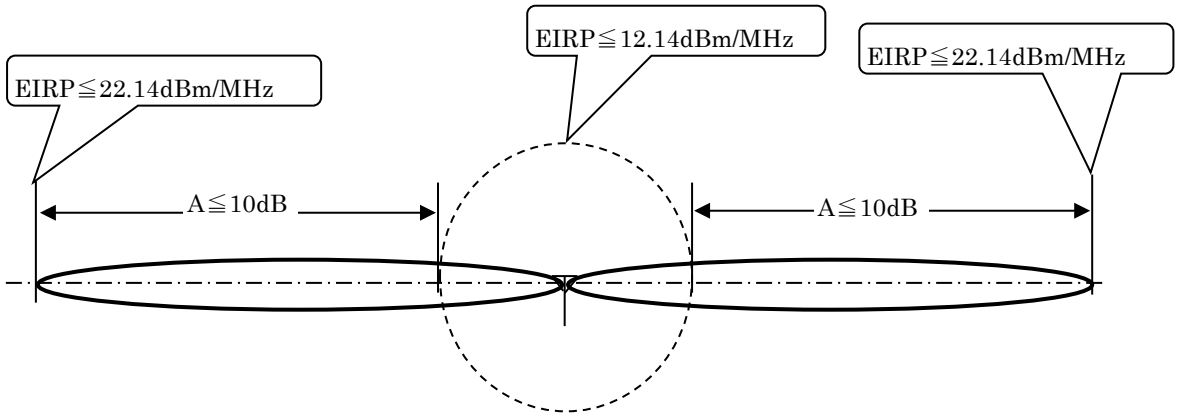


High EIRP antenna & Omni-directional antenna ◎



Omni-directional antenna complied with the prior regulation is excluded. As long as the high EIRP radio station comply with the voluntary regulation, there is no restriction on the number of radio station complied the prior regulation.

Plural high EIRP antennas ○ : Depends on condition



The case of using plural antennas with high EIRP, as long as the following formula is satisfied, it is permissible. Total of half-value angles ≤ 360° ÷A.

For example, when EIRP of these antennas is 22.14dBm/MHz, the half-value angle of these antennas shall be 36° or less. If 10degrees half–value angle antenna is adopted, up to 3 pieces of this antenna could be installed.

(36 degrees ≥ 10 degrees x 3)

The case of using different antennas which have different antenna gain, following formula shall be satisfied

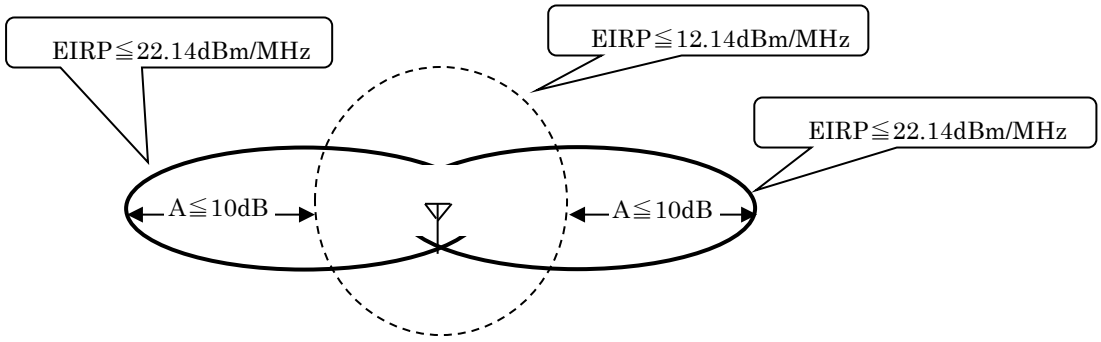
$\theta 1 \times A1 + \theta 2 \times A2 + \cdots + \theta n \times An \leqq 360$degrees

θn : Half-value angle of each antenna

An : Rate(number) of EIRP ratio of each antenna against 12.14dBm/MHz

$An \leqq 10$

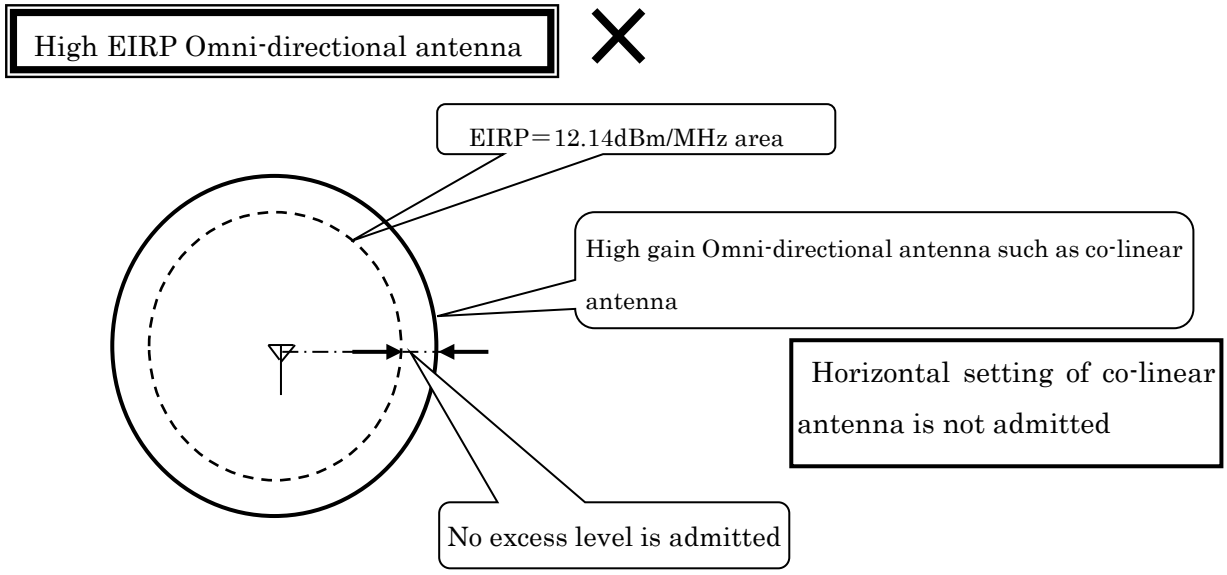
Dual directional beam antenna ○ : Depends on conditions



The case of using a dual directional beam antenna, as long as the following formula is satisfied, it is permissible.

Sum of all half –value angle ≤ 360 degrees ÷A

For example, when EIRP of antenna is 22.14dBm/MHz, the half-value angle of antenna shall be less than 36degrees. Then iti is possible to use a dual directional beam antenna with half-value angle is up to18 degrees.



6. Closing comment

The purpose of settling the voluntary regulation on sector antenna is to ensure common use of frequency bandwidth, but not to spoil the convenience of users, manufactures of Wireless LAN.

For example, an estimated area, where a Wireless LAN radio station does not cause any harmful interference to RFID radio station (Premises radio station), is controlled by the same user concerned, the user is not restricted from using sector antennas. Also, in a mountainous district, where RFID Low power radio stations (Premises radio station) or amateur radio stations are rarely scattered, using sector antenna is not always restricted. (Of course, preliminary survey shall be conducted.)

It is desirable to operate Wireless LAN radio station in conjunction with understanding of the voluntary regulation.

For more information, contact;

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Annex 5　Instruction manual for Leaky coaxial cable

Ver.1 July 6th 2005
Ver.2 October 4th 2005
Ver.3 December 16th 2009

1 Introduction

When ARIB STD-T66 and RCR STD-T33 were established, it was not considered that the application of Leaky coaxial cable as an antenna of this radio system. For the purpose of implementing the application of Leaky coaxial cable and avoiding the confusion in an actual operation, this instruction manual has been established through the meeting of Wireless LAN working Group. This instruction manual is applied to ARIB STD T-66(Second Generation Low power Data Communication System/Wireless LAN System) and RCR STD-T33 (Low power Data Communication System/Wireless LAN System).

2 Purpose of this manual

A leaky coaxial cable consists of coaxial cable with multiple slots on its outer conductor.
The combination of these slots constructs an antenna function and it has a radiation angle and gain as assembled antenna. As the nature of coaxial cable, it is flexible and is able to be installed in various shapes. However, its performance as an antenna will vary by its length or setting shape, even if it has the same number of slots.
Then, it is necessary to define a formula for calculating the maximum gain estimated by its length.

3. Idea of Leaky coaxial cable

(1) Definition of structure of Leaky coaxial cables

Leaky coaxial cables consist of center conductor, insulator, outer conductor which is assembled concentrically, and outer conductor has many small openings (i.e. slot) that are made and placed regularly. The shape and number of those slots shall be evenly placed in a certain span of coaxial cables. Also, structure of leaky coaxial cables shall have sufficient strength against the mechanical force from outside and shall not be distorted easily.

(2) Concept of Leaky coaxial cables as an antenna

Leaky coaxial cables are not a feeder but an antenna. There are three types of feeding power to coaxial cables shown in Figure.1. They are the single type, the grading type and the junction type. In these cases, leaky coaxial cables shall be defined as an antenna. The case of combination of the grading type and the junction type is also defined as antenna. The case of

different length of Leaky coaxial cables, they are defined as different antenna, even if the same layout and the same shape of slot are provided on them. Moreover, the case of different electrical performance of Leaky coaxial cables, they are defined as different antenna, even if they have the same cable length.

(3) Antenna gain

Antenna gain of a Leaky coaxial cable shall be 2.14 dBi or less. Provided that measured equivalent isotropic radiated power is less than the radiated power described below.

A higher gain transmission can be used to compensate its propagation loss. In the case of using customized feeder, the loss of the feeder may be included in the antenna gain.

- Frequency Spread system and OFDM system with occupied band width of 26MHz or less
  →10mW/MHz
- Frequency Spread system and OFDM system with occupied band width from 26MHz to 38MHz → 5mW/MHz
- Hybrid system with Frequency Hopping, Direct Sequence plus Frequency Hopping system , and Frequency hopping system plus OFDM(All of them are used in the frequency band between 2.4724MHz and 2.47075MHz).
  →3mW/MHz
- Frequency Spread system or OFDM system except above conditions → 10mW/MHz

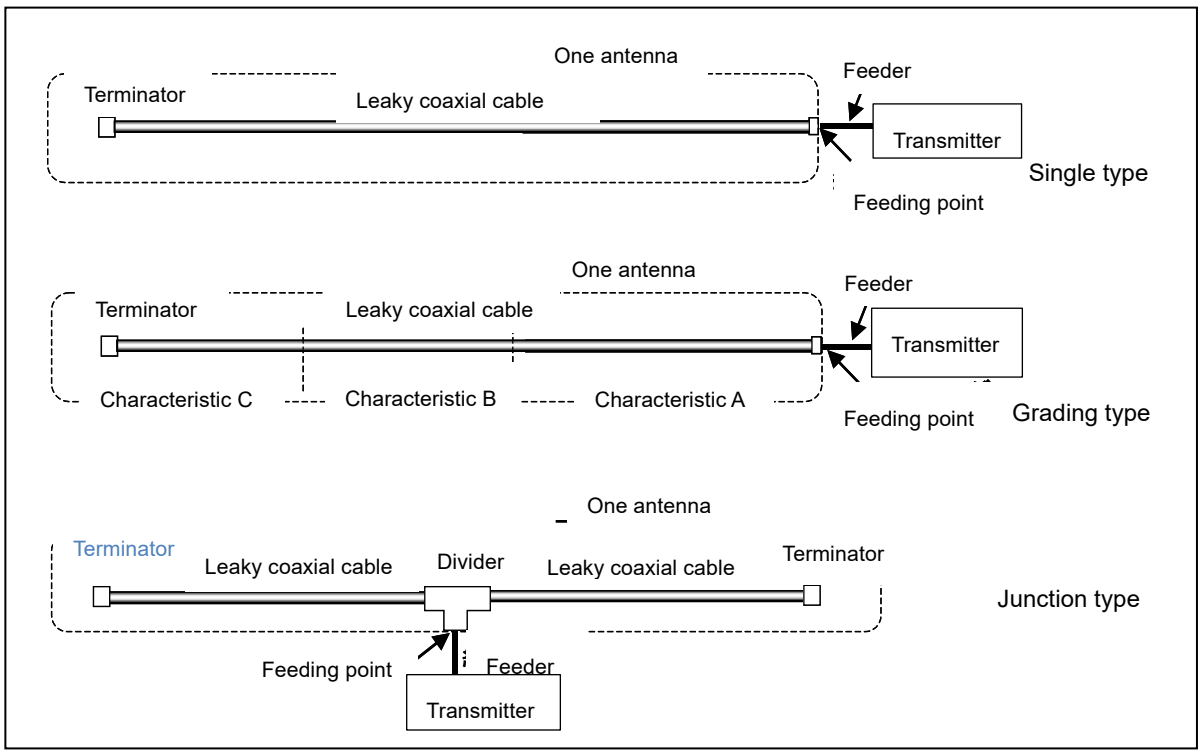


Figure .1 Example s for feeding power to Leaky coaxial cables

(4) Structure of terminal, junction, and divider of Leaky coaxial cables

At the terminal end of a leaky coaxial cable shall be terminated with a terminal device that has the same characteristic impedance as that the coaxial cable, and shall be structured not to be open easily. Regarding the grading type, if connecting port between Leaky coaxial cables that has different characteristic is provided connectors shall not be removed easily. Regarding the junction type, its junction portion (the connecting port of divider and Leaky coaxial cable) shall not be removed easily.

4. Method of measurement and calculation for antenna again

As described above, the antenna gain of a leaky coaxial cable varies in accordance with the way of its setting, so the way of estimating the maximum gain at a certain length of Leaky coaxial cable is needed. Then, supposing the most strict conditions that each transmitted power from all slots are summed at the receiving point of the same distance from each slots and that the phase of those transmitted power are the same, the maximum gain is estimated by measuring the transmitted power and by calculating it. I calculating maximum gain, different formulas are adopted for each connection type of Leaky coaxial cable (Single type, Grading type, and Junction type). The gain for a unit length (1m) and the transmission loss is commonly used.

(1) Measurement of the gain (Gu) for a unit length (1m)

Due to the length of Leaky coaxial cable, in many cases, it is difficult to measure the characteristic of the cable as it is in a radio wave darkroom. For the sake of inconvenience, the substituted method is adopted by measuring the gain Gu of a unit length (1m) as a sample, which is the appropriate length to handle on the rotating stand in a radio wave darkroom. (Figure.2)

(a) Site of measurement

A radio wave darkroom shall be used.

(b) Leaky coaxial cable under measurement

Unit length of the leaky coaxial cable is defined as follows.

The length between the first slot of feeding side and the last slot of the terminal end shall be about 1m. The terminal end shall be terminated with a non-reflective terminator.

(c) Set up for measurement

The leaky coaxial cable of unit length shall be placed horizontally on a rotating stand made of insulating materials. The stand shall be 1.5m high.

(d) Requirement for measuring equipment

(1) Spectrum analyzer shall be set to MAX HOLD

(2) The output of the standard signal generator shall be adjusted for measured maximum signal level to be exceeded by 20dB or more than the noise level of the spectrum analyzer. The signal power level at feeding terminal is the transmitting power Pin (dBm).

(3) Frequencies for measurement

- The case of using radio equipment complied to ARIB STD-T66
  2400MHz, 2441.75MHz, 2483.5MHz
- The case of using radio equipment complied to RCR STD-33
  2471MHz, 2484MHz, 2497MHz

(e) Requirement for receiving antenna

A horn antenna or a standard dipole antenna shall be used.

(f) Procedures of measurement

(1) The leaky coaxial cable and the measuring antenna are placed facing each other. The side of slots of leaky coaxial cable shall be faced toward the direction of the receiving antenna side. The receiving antenna shall be set in vertical polarity.

(2) The rotating stand is rotated to the position where the spectrum analyzer indicates the maximum receiving signal level, and is fixed at the position.

(3) The leaky coaxial cable is adjusted by turn around itself on its axis to obtain the maximum receiving signal level on the spectrum analyzer. Record the received signal level.

(4) Receiving antenna is set in horizontal polarity, and procedure (2) and (3) are repeated.

(5) Compare the received signal levels of above procedure (3) and (4), and the bigger one becomes the maximum received power Plcx (dBm).

(6) Then, replace the leaky coaxial cable with a standard dipole antenna (2.14dBi gain) in vertical polarity.

(7) Feeding transmitting power Pin that is obtained at procedure (1) to the replaced antenna, and measure the maximum received power Pdp (dBm).

(8) Calculation of gain (Gu) of unit length (1m)

The maximum gain (Gu) of unit length of leaky coaxial cable is given by the formula (1).

$$Gu = Plcx - Pdp + 2.14 \quad dBi \quad \text{----------} \quad (1)$$

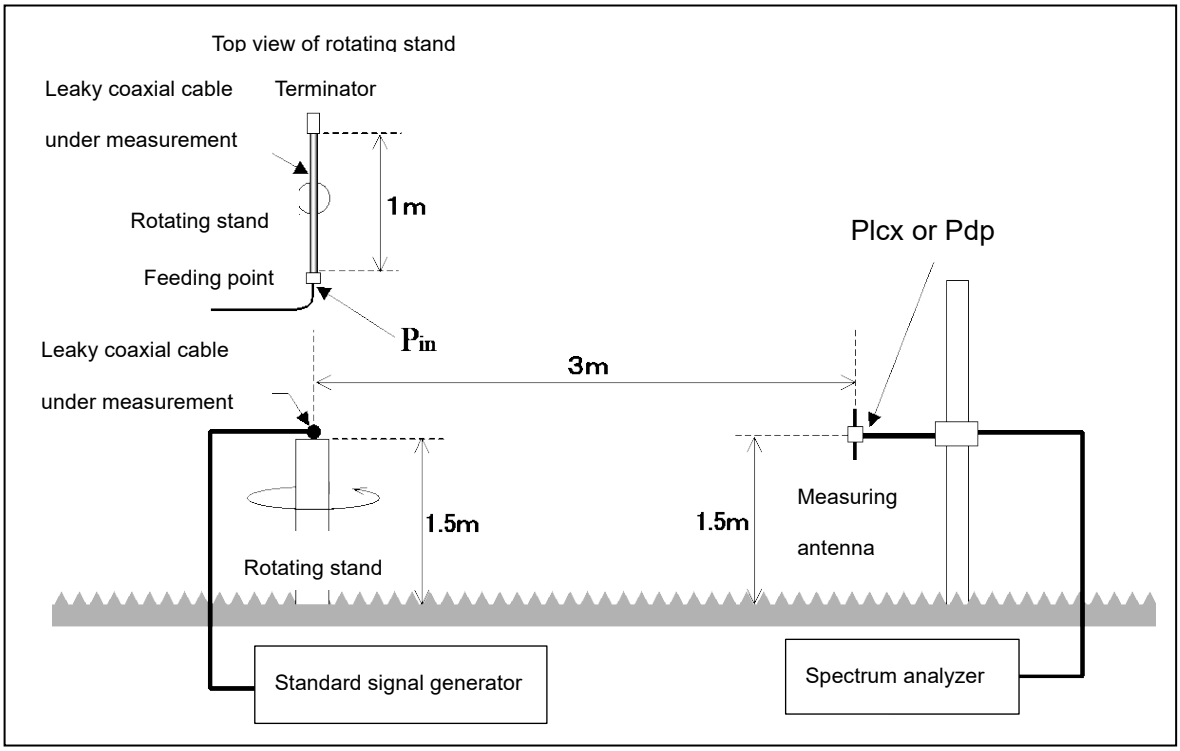


Figure.2 Measurement of the gain (Gu) for a unit length (1m)

(2) Measurement of transmission loss of the leaky coaxial cable

αc(dBm) represents the transmission loss per unit length (1m) of a leaky coaxial cable. αc consists of two losses, one is the transmission loss in the cable itself (ohmic loss, dielectric loss etc.), the other is the radiation loss which means the radiated power loss from slots. αc is adopted the minimum value within the operating frequency band.

Figure .3 shows the layout to measure the transmission loss of a leaky coaxial cable. to minimize the error of measurement, samples under measurement shall be more than 50m, and placed straightly on non-metal support of 10 cm high. The opening side of slot shall be faced to upper side. The case using samples shorter than 50m, connector loss (0.1dB) shall be counted on the calculation. The case of using a loss data provided by the manufacture of leaky coaxial cable, it is requested to confirm that the method of measurement is the same as described above or the equivalent method and the data is the minimum value.

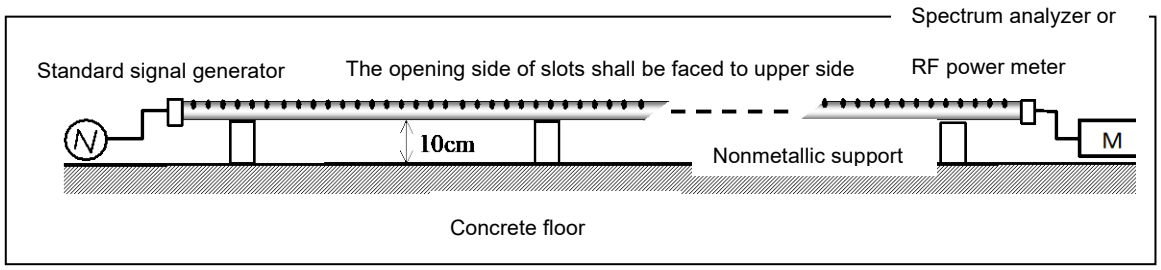


Figure.3 Layout to measure the transmission loss of a leaky coaxial cable

(3) Calculation of antenna gain of Single type

The antenna gain Gn (dBi) of n (m) leaky coaxial cable is obtained by the equation (2) under the pre-conditions described below.

[Preconditions]

1) A leaky coaxial cable with the length of n (m) consists of n pieces of unit length of cable.

2) Radio waves from each element are assumed that they have the same space propagation loss to the evaluation point and that they are added in the same phase.

3) The power reached to the kth antenna from feeding terminal takes the transmission loss of k x αc (dB).

However, the exciting power from each slot per unit length (1m) are the same.

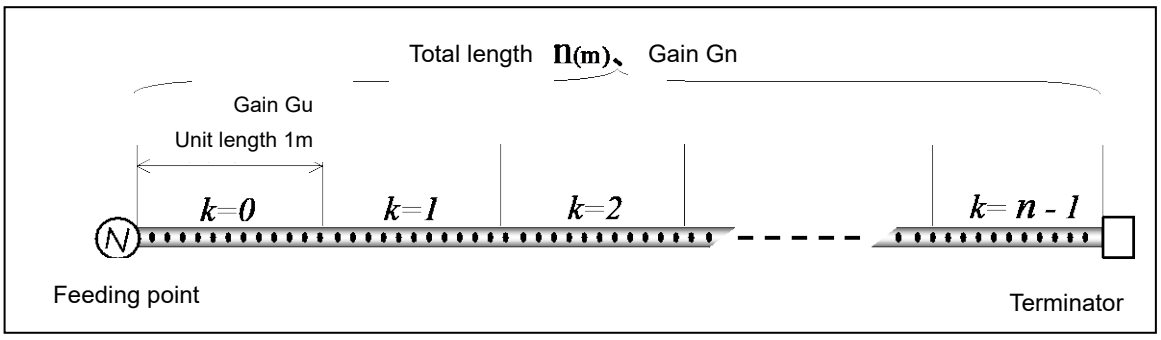


Figure.4

[Equation]

$$G_n[dBi] = 10Log_{10}\sum_{k=0}^{n-1} 10^{\frac{G_u - k\times\alpha_c}{10}} \qquad (\text{n : integer}) \quad \text{---------- (2)}$$

[Example of the use of equation]

In the case of total length n=100m,Gn=-18dBi, and αc=0.13 dB/m, G100=-2.92dBi is obtained from equation (2). Plotting the data of Gn vs n (n=1~500m), Figyre.5 is obtained.

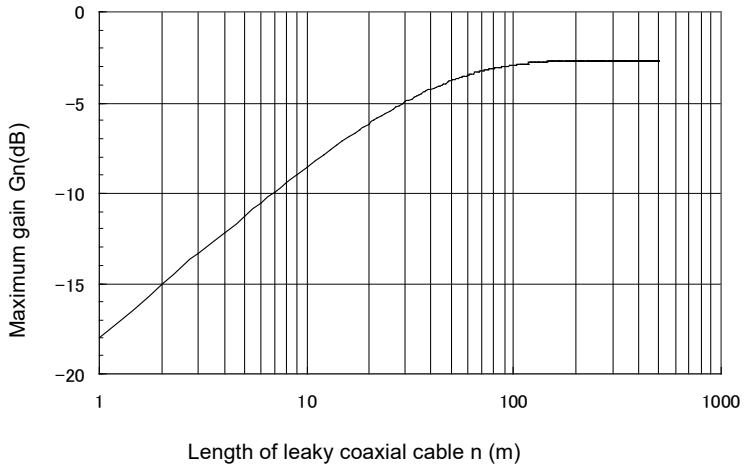


Figure.5

(4) Calculation of antenna gain of grading type

In the case of using a serial connection of different leaky coaxial cables shown as Figure .6, antenna gain Gn is obtained by adding each antenna gain that are calculated independently by each characteristic span of cables.

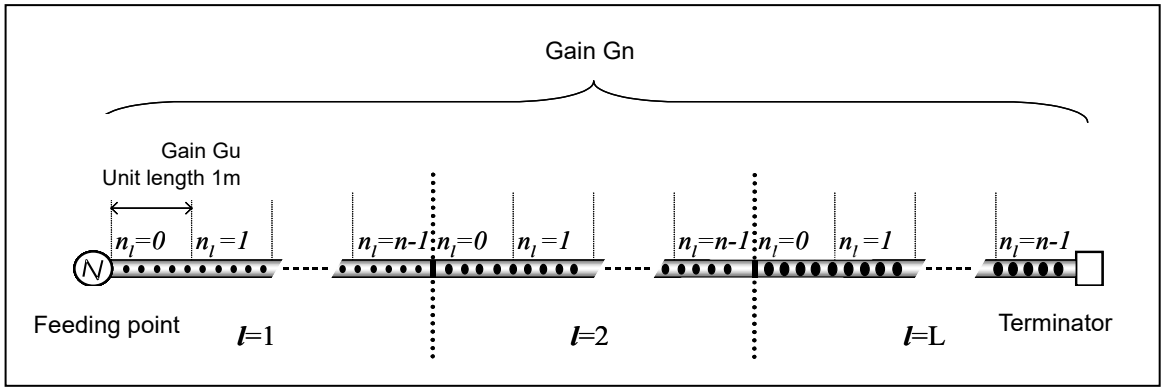


Figure.6

[Equation]

$$G_n[dBi] = 10Log_{10}\sum_{l=1}^{L}\left(\sum_{n_l=0}^{n-1}10^{\frac{G_{ul}-n_l\times\alpha_{cl}-\sum_{q=1}^{l}\left[n_{(q-1)}\times\alpha_{c(q-1)}\right]}{10}}\right) \quad \text{---------- (3)}$$

G_n : Antenna gain
L : Number of grading
l : Span number
n : Length of LCX in the span (integer)
G_u : Antenna gain of unit length
α_c : Transmission loss of unit length
where、 $n_0 = \alpha_{c0} = 0$

[Example of calculation]

In Figure .6, from the feeding point,

First span (l=1) total length n_1=20m、G_{u1}=－15 dBi、α_{c1}= 0.157 dB/m、
Second span (l=2) total length n_2=20m、G_{u2}=－10 dBi、α_{c2}= 0.231 dB/m
Third span (l=3) total length n_3=20m、G_{u3}=－5.8dBi、α_{c3}= 0.405 dB/m
are given、from equation (3)
G_n= 1.73 dBi

(5) Calculation of antenna gain of junction type

In the case of using a parallel connection of m pieces of leaky coaxial cables shown in Figure 7, total antenna gain Gn is obtained by adding antenna gains of each leaky coaxial cable. The basis for the calculation equation is explained in detail after describing example. In the case of Figure 7, antenna gain of the top cable (m=1) is firstly calculated including both gain element and loss element from feeding point to terminator. Regarding the divider portion, theoretical dividing loss is not considered in calculation, but only resistive loss L dBm is counted. Antenna gains from G2 to Gm are also calculated in the same manner as G1. The total of these antenna gains becomes the maximum hybrid gain. This total gain is expressed in the equation (4).

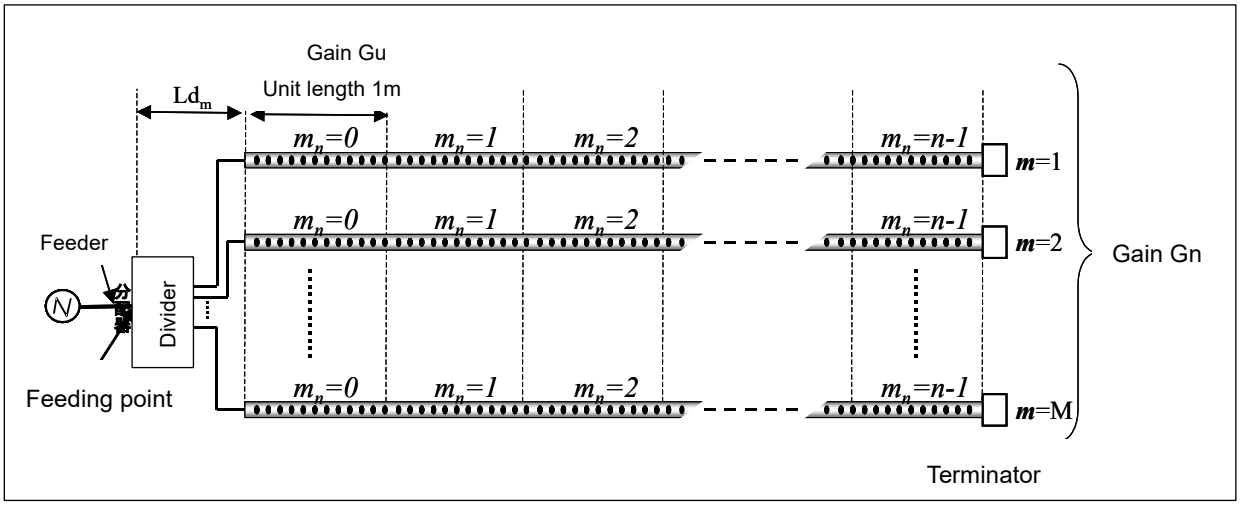


Figure.7

[Equation]

$$G_n[dBi] = 10Log_{10}\sum_{m=1}^{M}\left(\sum_{m_n=0}^{n-1}10^{\frac{G_{um}-m_n\times\alpha_{cm}-Ld_m}{10}}\right) \quad \text{---------- (4)}$$

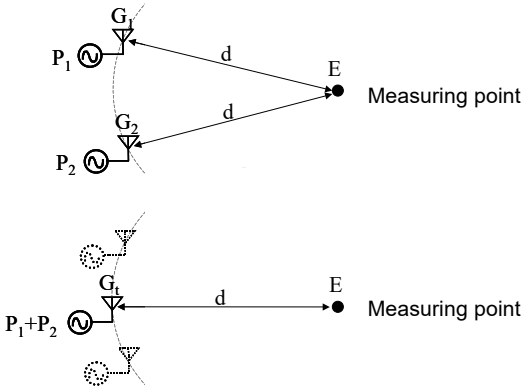
G_n : Antenna gain
M : Number of junctions
n : Length of LCX（integer）
G_u : Antenna gain of unit length
α_c : transmission loss of unit length
Ld_m : Loss of divider
(Theoretical dividing loss is excluded, only Ohmic loss and dielectric loss are counted)

[Example]
Number of junctions m=2
Total length $n_1=n_2=50$m、$G_u=-20.86$ dBi、$\alpha_c=0.13$ dB/m、$Ld_1=Ld_2=0.2$dB
are given, from equation (4),
$G_n=-3.85$dBi is obtained

In this junction type, the theoretical basis that the maximum hybrid gain comes from the sum

of gains of each antenna is explained as follows. The case of using two branches of leaky coaxial cable is taken as shown below. Branches of LCX have gain G1 and G2 respectively and the fed power P1 and P2 are given in the same phase. The electric field strength E at a distance d from both antennas is combined and calculated in equation (a).

$$E = K(\sqrt{G_1 P_1} + \sqrt{G_2 P_2})/d \quad \text{---------- (a)}$$



It is supposed that an imaginary antenna with fed power of P1+P2 is set in between above antennas and that the electric field strength E at a distance d. The electric field strength E is calculated in equation (b).

$$E = K\sqrt{G_t(P_1 + P_2)}/d \quad \text{---------- (b)}$$

From equations (a) and (b), gain of the imaginary antenna Gt is expressed with G1, G2, and r in equation (c). Here, r means the power ratio of P2/P1, and P1+P2 are always constant.

$$G_t = (\sqrt{G_1} + \sqrt{G_2 r})^2/(1+r) \quad \text{---------- (c)}$$

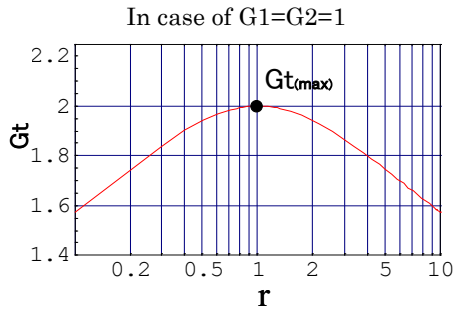
Combined gain Gt is varied by the power of the ratio r, and the condition of r for the maximum gain Gt is found from equation (d).

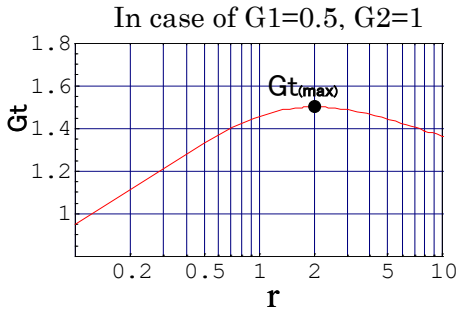
$$dGt/dr = 0 \quad \text{---------- (d)}$$

Then the condition is given by equation (e).

$$r = G_2/G_1 \quad \text{---------- (e)}$$

Taking equation (e) into (c), the maximum value of gain Gt is always hold as G1+G2 and is independent to the power ratio r. Also, it becomes clear that the combined antenna gain is obtained as the sum of each antenna gain, and that is not affected by any number of split or any power ratio.





(6) Calculation of coupling loss between antennas

At a measurement of gain for a unit length (1m) of leaky coaxial cables, the propagation path loss, which is called coupling loss Lc (dB) between leaky coaxial cable and receiving antenna, is calculated by formula (5)

$$L_c = P_{in} - P_{LCX} \quad \text{dB} \quad \text{---------- (5)}$$

(Pin means the fed power to the leaky coaxial cable under measurement)

However, in case of measuring Lc itself directly, there is no need to measure Pin and Plcx.

This coupling loss is not directly used for calculating antenna gain, but is checked as a reference item. Furthermore, this coupling loss does not have the same definition as that of leaky coaxial cable characteristics described in a catalog etc. .

5. How to state a leaky coaxial cable as an antenna on the construction design document (For reference only)

While a construction design document is stated properly on the leaky coaxial cable used as an antenna as shown below, it will be convenient to take the condition between technical standard and inspection standard.

Item 4 Antenna

(1) Type and structure

"A leaky coaxial cable antenna (Structure is shown as attached drawings)" is noted.

(2) Gain

"Maximum gain value "is noted. The gain shall be that of the actual leaky coaxial cable measured in accordance with the procedures described in "4.Method of measurement and calculation for antenna gain".

Item8. Referential matters

The coupling loss shall be noted, which is found in the procedures described in "4.Method of measurement and calculation for antenna gain".

3 製造者名等	製造者名	型式又は名称	製造番号
4 空中線	(1) 型式及び構成	(2) 利得	
5 附属装置の種類及び型式又は名称			
6 その他の工事設計			
7 添付図面	無線設備系統図		
8 参考事項			

6. Closing

This instruction manual on leaky coaxial cables is objected and created for the contribution of following the Radio Law, preventing interference to other radio communication systems and enabling use of leaky coaxial cables as one of antennas for Wireless LAN radio communication system. Also, this instruction manual is objected to contribute for benefit of users or manufactures of Wireless LAN radio communication systems. Proper use of this manual will be welcome.

For more information, contact

Secretariat of Wireless LAN Working Group, Standard assembly Meeting of the Association of Radio Industries and Businesses.

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Annex 6 Design standard and Operational Guidelines for Radio Equipment usable to the Second –generation Low-power Data Communication System in 40MHz bandwidth

Ver.1 July 5th 2007

Ver.2 December 21st 2007

1. Introduction

On June 28th 2007, Radio Regulations on the Radio Equipment for Low-power Data Communications Systems were revised. Radio equipment with OFDM modulation in the frequency band from 2,400MHz to 2,483.5MHz may be operated extending its occupied band width by more than 26MHz up to 38MHz under the condition of carrier sense capability.

However, some radio equipment operated in the same frequency band and in the same area does not have any countermeasure against interference such as carrier sense function. In such a situation, the probability of causing interference becomes higher and the common use of RF band might be hindered. So, this annex 6 is settled for ensuring effective use of frequencies and for improving convenience for users in the operation of Second–generation Low-power Data communications systems radio station as 40MHz systems, which uses transmitting power with occupied bandwidth more than 26MHz up to 38MHz.

2. Probability of interference caused by 40MHz systems

In accordance with the deployment of Wireless LAN, there becomes a demand for high speed data rate. To respond this demand, radio equipment of 40MHz systems is defined.

40MHz systems (its occupied bandwidth is more than 26MHz up to 38MHz) is the radio equipment that has data transmission speed as more than twice as that of current Wireless LAN radio equipment by extending its occupied bandwidth form 26MHz. Also, the Second-generation Low-power Data Communications Systems radio equipment for 40MHz systems shall have both OFDM (Orthogonal frequency division multiplex) modulation and carrier sense function.

Radio station of 40MHz systems transmit its power after detecting that there is no other radio station operated in its occupied bandwidth. However, in the case of other radio station which does not have carrier sense function, avoiding interference is not sufficient. Also, in the case of other radio station using frequency hopping modulation, carrier sense could not detect the radio wave from it because of non-capability of synchronization and interference could be caused.

Accordingly, it is desirable that 40MHz systems radio equipment is operated only when the user needs the feature for reducing the probability of causing interference, and that the user should

be informed or awaken on this point.

3. Design standard of 40MHz systems radio equipment

In designing Radio equipment of 40MHz Second–generation Low-power Data Communications Systems, a switch function of enabling and /or disabling the 40MHz operational mode shall be equipped. The 40MHz operational mode shall be set in disable position as its initial state (when radio equipment is shipped form a production factory). However, radio equipment whose occupied bandwidth is controlled by other radio station is excluded.

※ When the switch of 40MHz mode is ON, radio equipment is able to send transmitting power within the occupied bandwidth from 26MHz to 38MHz.
When the switch of 40MHz mode is OFF, radio equipment is able to send transmitting power only within the occupied bandwidth less than 26MHz.

4. Operational guidelines of radio equipment usable for 40MHz systems.

It is recommended to put cautions or notices described below on operational manual, catalogue, pamphlet etc. issued by designer, marketer or constructor of the Second-generation Low-power Data Communications Systems usable for 40MHz systems.

①Before setting 40MHz mode ON, checking frequencies and/or field strength of other radio in the area, and confirming no interference are necessary.

②When any interference caused by 40MHz system is found, the switch shall be set OFF.

Annex 7 Recommended Channel Assignment and Operational Guidelines of Wireless LAN/Second-Generation Low-power Data Communication System Radio station

1. Introduction

In Wireless LAN/Second-Generation Low-power Data Communications Systems that utilizes 2,400MHz to 2,483.5MHz (hereinafter Wireless LAN), the throughput and the effective use of frequencies are degraded by interference and frame collision and so on when multiple radio stations use overlapped frequencies(overlap cannel) simultaneously. A countermeasure against this problem, "Recommended channel plan and operational guidelines" is settled in order to minimize the data rate drop and ensuring effective use of frequencies in actual operation of radio equipment.

2. Purpose

Channel plan of Wireless LAN using 2,400MHz to 2,483.5MHz is laid on 5MHz interval fromCH1(center frequency is 2,412MHz) to CH13(center frequency is 2,472MHz). Each channel uses about 11MHz on both side of its center frequency as occupied bandwidth (total is about 22MHz). Accordingly, multiple Wireless LAN radio station is used in the same area, their channel should be separated by 5CH (5MHz x 5 = 25MHz) for avoiding interference.
This is an investigation of channel plan for Wireless LAN in order to minimize data rate drop and to improve effective usage of frequencies.

3. Target system

Wireless LAN that use frequencies from 2,400MHz to 2,483.5MHz.

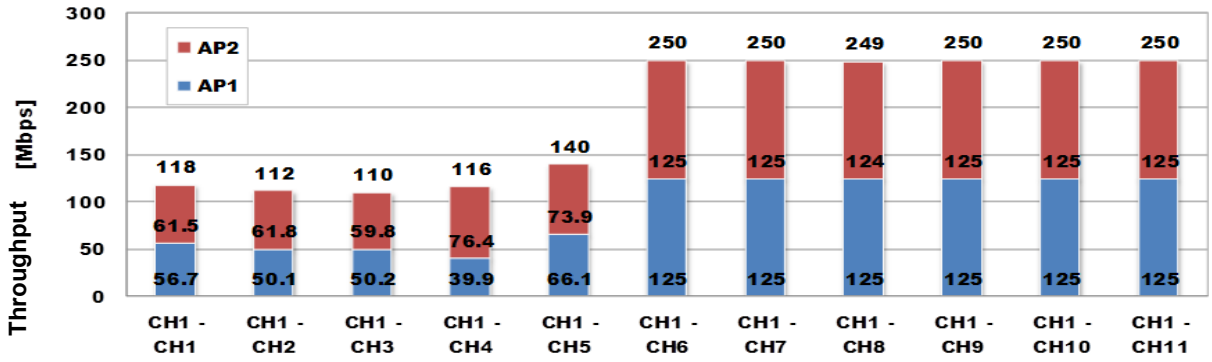
4. Process of investigation

The occupied bandwidth of Wireless LAN radio equipment is about 22MHz, separation of 5 channels seems to be effective for avoiding interference. Then, an experimental examination has been made in a radio wave dark room on the degradation of throughput versus interference caused by overlapping channel.

(1) Method of measurement

Wireless LAN radio equipment base on IEEE802.11n is set in a radio wave dark room. While changing its communication channels, the throughput data is measured.

(2) Result of measurement



(3) Consideration of result

There seems to be no interference when communication channels are separated by 5 channels as depicted above. Channel separation more than 5 channels is necessary to avoid degradation of the throughput.

5. Summary and recommendation

The following channels are recommended for actual operation.

< Recommended channels>

CH1 (center frequency is 2.412MHz)

CH6 (center frequency is 2,437MHz)

CH11 (center frequency is 2,462MHz)

However, in the case of preventing interference with other radio systems except Wireless LAN, these three channels are insignificant.

6. Operational guidelines of recommended channels

(1) Channel plan of recommended channels

For the Wireless LAN operated in the frequency band from 2,400MHz to 2,483.5MHz, CH1(center frequency is 2,412MHz), CH6(center frequency is 2,437MHz),and CH11(center frequency is 2,462MHz) is recommended in order to reduce interference with other radio systems.

(2) Description on operational manuals

In the case of Wireless LAN radio equipment that has a manual selective function on channels, procedures of channel set is requested to put in the operational manual. Also, a note

similar to the following description is requested to add in the operational manual.
[In the case of 2,400MHz operation, CH1, CH6, and CH11 are recommended as operational channels for reducing interference and for improving effective frequency usage]

Amendment History

Second Generation Low Power Data communication system /

Wireless LAN system

ARIB STANDARD

(ARIB STD-T66)

The 3.7th edition amendment history

Date established: October 2nd, 2014

<Note>

Related ministerial ordinances, announcements, etc.:

Year 1999 ministerial ordinance No. 75 of MPT (Ministry of Posts and Telecommunications) (Partial revision of Radio Law Enforcement Regulations)

Year 1999 ministerial ordinance No. 76 of MPT (Partial revision of Radio Equipment Regulations)

Year 1999 announcement No. 757 of MPT

Revision Number	Date of Revision	Contents of Revision	Remarks
2.0	March 28, 2002		Determined at the 42nd Standard Assembly Meeting
		The phrase “and amateur radio stations” was added to the introduction.	To broaden coverage to interference affecting amateur radio stations
		In 3.2 (1) a), the phrase “and orthogonal frequency division multiplexing systems” was added; the phrase “or a hybrid system combining FH and orthogonal frequency division multiplexing systems (OFDM system)” was added to a).	In line with the revision of Radio Equipment Regulations (RE) (Year 2002 ministerial ordinance [MO] No. 21 of Ministry of Public Management, Home Affairs, Posts and Telecommunications [MPHPT])
		In 3.2 (1) c), the phrase “and OFDM systems” was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		In 3.2 (2) a), the phrase “or hybrid systems of FH and OFDM” was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)

		In 3.2 (2) b), the phrase “and OFDM system” was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		In Fig. 2.1 (1), the phrase “or a hybrid system combining FH and OFDM systems” was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		In Fig. 2.1 (2), part of the previous description was revised to “An FH system, a hybrid system combining DS and FH systems, or a hybrid system combining FH and OFDM systems using the frequency band of 2,400 to lower than 2,427 MHz or beyond 2,470.75 to 2,483.5 MHz.”	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT) and for clarification
		In Fig. 2.1 (3), the phrase “or OFDM system” was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		In 3.2 (3), “Note that they represent the tolerance for the maximum rated antenna power and that no upper and lower limits of the tolerance are regulated in the case of antenna power reduction for communications reasons.” was added.	For clarification
		3.2 (6) was revised to “Permissible mean power of spurious emission of each frequency supplied to a feeder, that is, mean power of spurious emission in the 1 MHz bandwidth at frequency f other than frequency band used shall be as follows.”	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		In 3.2 (7), the phrase “or a hybrid system combining FH and OFDM systems” was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		After 3.2 (9), (10) was added and subsequent paragraphs were renumbered accordingly.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)

		3.2 (11) was revised to "When a simple FH system (except hybrid system) is used, total frequency dwell time at an arbitrary frequency within the time period obtained by multiplying 0.4 seconds by the process gain shall be 0.4 seconds or less."	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		From 3.4.1 (2), the phrase "When the frequency band of 2,427 - 2,470.75 MHz is used," was deleted.	Because there is no need to limit the frequency
		In 3.6 (2) a), "2.14dB" was revised to "12.14dB."	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		3.6 (2) was revised to "The absolute gain of the transmitting antenna shall be 12.14 dB or less. However, when the equivalent isotropic radiated power (equivalent isotropic radiated power in the 1 MHz bandwidth in the case of spread spectrum and OFDM systems) is equal to or less than the value obtained by applying an antenna power with the mean power of 10 mW with its absolute gain being 12.14 dB, the shortage shall be compensated for by the gain of the transmitting antenna (Note that mean power is 10 mW in the 1 MHz bandwidth in the case of spread spectrum and OFDM systems; however, mean power of 3 mW in the 1 MHz bandwidth is applied if the FH system, a hybrid system combining DS and FH systems, or a hybrid system combining FH and OFDM systems is employed and the frequency band of 2,427 - 2,470.75 MHz is used.)," all of 3.6 (2) is now designated as a).	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)

		In 3.6 (2), b) was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)
		1.1 in Annex 2 was revised to "The purpose of these guidelines is to prevent harmful interference with RFID systems (premises radio stations and specified low-power radio stations, both for RFID) operating in the frequency band of 2,427 - 2,470.75 MHz and amateur radio stations operating in the frequency band of 2,400 - 2,450 MHz, with the ultimate goals of ensuring effective use of frequencies and improving convenience for users in the operation of second-generation low-power data communications systems radio stations operating in the frequency band of 2,400 - 2,483.5 MHz. Note that "harmful interference" refers to successive and serious interference to the function of other radio equipment (RL: Article 82)."	The frequency band was expanded to 2,400 - 2,483.5 MHz. Interference affecting amateur radio stations was also considered and harmful interference was defined.
		In 1.2 in Annex 2, "those (called "experts" in this document) who design, manufacture, import, sell, set, or maintain the system" was revised to "those who manufacture, sell, install, operate, or maintain such systems (hereinafter experts)."	To allow broader application

		After 1.3 (2) in Annex 2, the phrases “RFID equipment using the frequency hopping system for specified low-power radio stations ARIB STD-T81,” and “(5) Amateur radio stations” were added, and (3) became item (4); the frequency bands for the radio stations were added.	In consideration of RFID systems using specified low-power radio stations frequency hopping systems, and amateur radio stations, and for clarification
		The frequency band of each radio equipment was appended to each item of 1.3 in Annex 2.	For clarification
		In 1.4 (2) in Annex 2, “continuously interfere with other radio equipment to a great extent.” was revised to “harmful interference to other radio equipment.”	For consistent terminology
		In 1.4 (3) in Annex 2, “interference to other radio equipment” was revised to “harmful interference to other radio equipment.”	For consistent terminology
		In 1.4 (3) in Annex 2, “premises station” was revised to “premises radio station.”	For consistent terminology
		In the notes for 2.1 in Annex 2, the phrases “as well as amateur radio stations (radio stations requiring licenses),” “or amateur radio stations,” and “or amateur radio stations” were added.	To broaden coverage to interference affecting amateur radio stations
		In the notes for 2.1 in Annex 2, “In case that RF interference occurs” was revised to “In the event that this equipment causes harmful interference.”	For consistent terminology

		In 2.4 (2) in Annex 2, the phrases "(refer to Section 2.4.1 for details)" was added.	For clarification
		In 2.4 (3) in Annex 2, the phrases "(refer to Section 2.4.2 for details)" was added.	For clarification
		In 2.4 (4) in Annex 2, "(refer to Section 2.4.3 for details)" was added.	For clarification
		In Table 2.1 in Annex 2, "FH – OFDM hybrid system" was added, and "In the future" was deleted.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)

		In 2.4.2 in Annex 2, “Note that all values are obtained assuming that the antenna gain of the second-generation low-power data communications system radio station is 2.14 dBi; the values are obtained by calculating radio wave propagation loss using the 3.5th power rule. On the other hand, as radio stations subject to interference, the specifications for a typical premises radio station for the RFID system (Model A in the RCR TR-1 RFID System Research and Development Report) constitute the following parameters; antenna power of 300 mW, interrogator antenna gain of 11 dBi, interrogator feeder line loss of 0 dB, responder antenna gain of 2 dBi, responder total loss of 10 dB (including antenna gain and feeder line loss), communication distance of 5 m, receiving bandwidth of 32 kHz, receiving equipment noise power of -118 dBm, and propagation margin of 10 dB. Further, it is assumed that harmful interference does not occur if interference power level is at least 10 dB below that of the standard receiving input.” was added.	To specify calculation conditions

		In Table 2.2 in Annex 2, "OFDM" was added and under the table "Note: The interference-causing radiuses given here are estimated distances from second-generation low-power data communications systems to RFID systems (premises radio stations). This table may have different values for distances between second-generation low-power data communications systems or for distances between second-generation low-power data communications systems and amateur radio stations." was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT); notes are added for clarification.
		After 2.4.4 in Annex 2, 2.5 was added and the paragraphs renumbered.	Information related to indications for outdoor fixed installations
		In 3.1 (1) in Annex 2, "or amateur radio station" was added.	To broaden coverage to interference affecting amateur radio stations
		In 4.1 in Annex 2, the phrases "or amateur radio station" and "or the licensee of the amateur radio station" were added, and "when interference happens" was revised to "if... suffers harmful interference."	To broaden coverage to interference affecting amateur radio stations and for consistent terminology
		In 4.2 in Annex 2, "premises station/specified station is in operation" was revised to "a premises radio station for RFID systems already operates," and "In case the second one's system damages the radio stations in operation with interference" was revised to "In the event that a second-generation low-power data communications system causes harmful interference	For clarification of licensed premises radio stations, and for consistent terminology

		to a pre-existing premises radio station for RFID systems."	
		In Annex 2, 4.3 was added.	To explain restrictions placed on sector directional antennas
		In the Introduction in Annex 3, the phrase "the frequency band of 2,400 - 2,450 MHz used by amateur radio stations" was added.	To broaden coverage to interference affecting amateur radio stations
		In the operating manual for 1 (1) in Annex 3, "as well as amateur radio stations" and "or amateur radio stations" were added, and "In case that RF interference occurs" was revised to "In the event that this equipment causes harmful interference."	To broaden coverage to interference affecting amateur radio stations and for consistent terminology
		In 1 (3) in Annex 3, the table of ii) was deleted, and the phrases "DSSS system: DS; FHSS system: FH; OFDM system: OF; Hybrid system: HY; Other: XX" was added.	In line with the revision of RE (Year 2002 MO No. 21 of MPHPT)

		In 1 in Annex 3, (4) was added.	Information related to indications for outdoor fixed installations
		In 2 (1) in Annex 3, “or amateur radio station” was added.	To broaden coverage to interference affecting amateur radio stations
		In 3 (1) in Annex 3, the phrases “or amateur radio station” and “or the licensee of amateur radio station” were added, and “when interference happens” was revised to “if... suffers harmful interference.”	To broaden coverage to interference affecting amateur radio stations and for consistent terminology
		In 3 (2) in Annex 3, “mobile object identification system is already in operation” was revised to “a premises radio station for RFID systems already operates,” and “In case the second one’s system damages the radio station in operation with interference” was revised to “In the event that a second-generation low-power data communications system causes harmful interference to a pre-existing premises radio station for RFID systems.”	For clarification of licensed premises station, and for consistent terminology
		Corrections of other items, such as clerical, grammatical, or idiomatic errors	
2.1	March 26, 2003		Determined at the 48th Standard Assembly Meeting
		In 2.4 (2) in Annex 2, “Note that for radio equipment capable of emitting radio waves of multiple modulation systems, these modulation systems shall be stated by separating them with a slash as in “DS/OF.”” was added.	For indication of symbols on radio equipment using multiple modulation systems
		In 2.4 (3) in Annex 2, “Note that for radio equipment capable	For indication of symbols on radio equipment using

		of emitting radio waves of multiple modulation systems, whose interference-causing radius varies depending on the modulation system, these modulation systems and interference-causing radiuses shall also be stated by separating the indications representing such modulation systems and interference-causing radiuses with a slash as in "DS2/OF1."" was added.	multiple modulation systems
		In 1 (3) (ii) in Annex 3, "Note that for radio equipment capable of emitting radio waves of multiple modulation systems, these modulation systems shall be stated by separating them with a slash as in "DS/OF."" was added.	For indication of symbols on radio equipment using multiple modulation systems
		In 1 (3) (iii) in Annex 3, "Note that for radio equipment capable of emitting radio waves of multiple modulation systems, whose interference-causing radius varies depending on the modulation system, these modulation systems and interference-causing radiuses shall also be stated by separating the indications representing such modulation systems and interference-causing radiuses with a slash as in "DS2/OF1."" was added.	For indication of symbols on radio equipment using multiple modulation systems
2.2	September 29th, 2005		Determined at the 59th Standard Assembly Meeting
		Annex4 and Annex5 were added To [Topics addressed in this standard]. "Terminal and other equipment regulations " and "regulations pertaining to technical conformity	In line with the revision of related regulations and its name, and the addition of instruction manual

		approval and design authentication for technical equipment" of related regulations were revised in naming	
		In 3.7 (2), the related regulation was revised to "TR Article 8".	In line with the revision of RTCSR
		In 3.7 (3), the related regulation was revised to "RTADT Article 10".	In line with the revision of RTADT
		Chapter 5 Method of measurement was revised to "Measurement shall be conducted in accordance with MIC Ordinance with OTRCC Item (3) in Appendix 1".	To refer to AM as method of measurement
		In title of Annex1, "technical Regulations Conformity Certification of" was added.	To cope with the description of RCR STD-T33
		In Annex 1, "Test items --- are as follows" was revised to "Test items --- are such as follows".	To cover test items that are not listed in the list
		In Annex 1, the related regulations were deleted to refer that of Chapter 5 for details.	To avoid duplicative description with that of Chapter 5.
		Annex 5 Instruction manual for Leaky coaxial cable was added to Annex 4 "Instruction manual for the regulation of sector directive antenna".	To add the article described in the news of ARIB home page to ARIB standard.
		Correction of other items, such as clerical, grammatical, or idiomatic errors	
2.3	November 30th 2005		Determined at the 60th Standard Assembly Meeting
		In3.2 (6) was revised to "Permissible mean power of spurious emission"; "(a)	In line with the revision of Radio Equipment

		Permissible value applied after December 1st 2005 (ORE Article 7)" was added.; "(b) Permissible value based on ORE before November 30th 2005" was remained as interim measures.	Regulations (RE) (Year 2005 Ministerial Ordinance (MO) No.119)
		In Chapter 5 " Regulations Pertaining to Technical Regulations Conformity Certification for Specified Radio Equipment and Appendix " was revised to "RTCSR and Appendix"。	To use regulatory abbreviation
		In Chapter 5, "Ver.2.2 September 29th, 2005" was revised to "Ver.2.3 November 30th, 2005".	In line with the revision of this Standard.
		In Annex 1, "Test items associated with Technical Regulations Conformity Certification of Specified Radio equipment" was revised to correspond with those of MO.	For coordination with the test items of MO
		In "4.(1) Measurement of gain (Gu) for a unit length (1m)" of Annex 5, "(3) Frequencies for measurement in (d) Requirement for measuring equipment" was revised to apply two cases. One is "the case of using radio equipment complied to ARIB STD-T66" and the other is "the case of using radio equipment complied to RCR STD-T33".	For the necessity of different result between ARIB STD T-66 and RCR STD-T33 in actual operation due to their classical difference.
		In Annex5 Fig.6, the order number of span "l=l" was revised to "l=L"; in equation (3) the upper limit number of Σ was revised to "L" from "l" and the proviso was added.	For clarification

		Example of the use of equation (3) in Annex 5, values of αc2, αc3, and Gu were revised.	For the correction of initial conditions of transmission loss. Decreasing transmission loss from span1 to span3 is not realistic.
		In Annex 5 Fig.7, the number of branches was revised to "m=M" from "m=m" and the upper limit number of Σ in equation (4) was revised to "M" from "m".	For clarification
		In Annex 5 equation (4), "LdBm" was moved to the area of exponent.	For the convenience of calculation because LdBm was expressed in dB.
		Example of the use of equation (4) in Annex 5, the result was corrected.	For the correction of equation (4)
2.4	March 14th 2005		Determined at the 61st Standard Assembly Meeting
		In Foreword, "Radio frequency identification systems (Premises radio stations and Specified Low-power radio station)" was revised to "2.4 GHz-band radio frequency identification systems (Premises radio station and Specified Low-power radio station)".	To be classified form 950MHz Radio frequency identification systems
		In Chapter 5 (Note.1), "This standard Ver.2.3 November 30th, 2005" was revised to "This standard Ver.2.4 March 14th, 2006".	In line with the revision of the standard
		In Annex 2, "1.3 (1) Radio frequency identification systems (Premises radio station)"was revised to "1.3 (1) Premises radio station and 2.4GHz radio frequency identification systems radio equipment"	In line with the revision of the title of STD-1

		In Annex 2, "1.3 (2) RFID equipment for Specified Low-power radio stations" was revised to "2.4GHz-band RFID equipment for Low-power radio station".	In line with the revision of the title of STD-29
		In Annex2, "1.3 (3) RFID equipment using FH system for Specified Low-power radio stations" was revised to "1.3 (3) 2.4GHx-band RFID equipment using FH system for Specified Low-power radio stations"	In line with the revision of the title of STD-T81
		Correction of other items such as clerical, grammatical, and idiomatic errors	
3.0	September 26th 2007		Determined at the 67th Standard Assembly Meeting
		In 3.2 (2) Antenna power, regulations on OFDM system were added.	In line with the revision of RE (Year 2007 MO No.74 of MPHPT)
		In 3.2 Fig. 2.1 ②, Antenna power limit was revised to show two kind of levels in corresponding with "DS system or OFDM system with 26MHz occupied bandwidth" and " OFDM system with occupied bandwidth from 26MHz to 38MHz"	In response to the addition of regulation on OFDM system
		In 3.2 (7), "Permissible value of occupied bandwidth using OFDM system shall be less than 38MHz" was added.	In response the addition of regulations on OFDM system with occupied bandwidth from 26MHz to 38MHz.
		In 3.4.1, "(3) Carrier sense" was added.	In response to the addition of regulation on transmitter with occupied bandwidth from 26MHz to 38MHz

		In 3.6 (2), the regulation on OFDM system with occupied bandwidth from26MHz to38MHz was added.	In response to the addition of regulation on OFDM system with occupied bandwidth from 26MHZ to 38MHz
		In Chapter 5, “Measurement shall be conducted in accordance with MIC Ordinance with OTRCC Item (3) in Appendix 1 (Note1). Measurement method for test items that are not specified in the MIC Ordinance, however, shall be based on conventionally practiced method” was revised to “ Measurement shall be conducted in accordance with MIC Ordinance with OTRCC Item(3) in Appendix 1(Note.1) or a equivalent method. Measurement method for test items that are not specified in the MIC Ordinance, however, shall be based on conventionally practiced method”.	To amend description in accordance with OTRCC Item(3) in Appendix 1
		In Chapter 5 (Note1), “At the release date of this standard Ver.2.4 on March 14th, 2006 was revised to “At the release date of this standard Ver.3.0 on September 26th, 2007”.	In line with the revision of this standard
		In Chapter 5, the description that enables user to cite TELEC T-401 as a reference was added.	To add the article as a reference information for the convenience of user
		In Annex 2, Table 4.1 was revised.	In response to the addition of regulation on OFDM system with occupied bandwidth from 26MHz to 38MHz
		Annex 6 Design standard and Operational guidelines for the Radio equipment usable to the Second-generation Low-power Data	To add the article described in the news of ARIB home page to ARIB standard

		Communication systems in 40MHz Correction of other items such as clerical, grammatical, or idiomatic errors.	
3.1	March 19th 2008	In Chapter 5, "At the release date of Ver.3.0 on September 26th, 2007" was revised to "At the release date of Ver.3.1 on March 19th, 2008". In Annex 6, Ver. 1 July 5th, 2007" and "Ver.2 December 21st, 2007" were added. In Annex 6 3. Design standard of 40MHz system radio equipment, "on user's option" was deleted and "However, radio equipment whose occupied bandwidth is controlled by other radio station is excluded" was added.	Determined at the 69th Standard Assembly Meeting In line with the revision of this standard To add the revision history To add the article described in the news of ARIB home page to ARIB standard.
3.2	September 25th 2008	In Chapter 3 3.2 (11), "Hopping frequency occupancy time (time duration in which radio wave continue to be emitted at a specified frequency) of a transmitting equipment using FH system shall be 0.4 seconds or less. Also, a simple FH system (except hybrid system such as DS+ FH or FH+OFDM) is used, total Hopping frequency occupancy time at an arbitrary frequency within the time period obtained by multiplying 0.4 seconds by spread rate shall be 0.4 seconds or less" was revised to " Frequency occupancy time (in which radio wave	Determined at the 69th Standard Assembly Meeting In line with the revision of RE(Year 2008 MO No.96 of MPHPT)

		continue to be emitted at a specified frequency) shall be 0.4 seconds or less (In the case of a transmitting equipment applied for the use of radio control of model airplanes, it shall be 0.05seconds or less). Also, a simple FH system (except hybrid system such as DS+FH or FH+OFDM) is used, total Hopping frequency occupancy time at an arbitrary frequency within the time period obtained by multiplying 0.4seconds by spread rate shall be 0.4seconds or less".	
		In Chapter 3 3.4.1(3), item(b)"Carrier sense function shall be supplied to the transmitter used for controlling a model airplane in the open, and it shall function at the start of transmitting power" was added.	In line with the revision of MO(Year 2008 No.96 of MPHPT)
		In Chapter 5, "Ver.3.1 March 19th, 2008" was revised to "Ver. 3.2 September 25th, 2008".	n line with the revision of this standard
		In Annex 2, "4.4 Attention items in case of applying it to the radio control system of model airplane in the open" was added and the liaison office of Japan Radio Control Safety Association was added for more information.	For clarification of attention items and the liaison office in order to use controlling equipment of model airplane in the open.
		In Annex 3 note2, "the liaison office of Japan Radio Control Safety Association" was added.	For clarification of the liaison office
		Correction of other items such as clerical, grammatical, or idiomatic errors.	

3.3	December 12th 2008	In Attachment of Foreword, Patent holders, Registration/Application numbers were corrected, and some of patents were classified as reference.	Determined at the 69th Standard Assembly Meeting In line of the revision of the document related with the patents.
3.4	December 16th 2009	In 3.4.1 (3) Carrier sense (a) of Chapter3, "transmitter with occupied bandwidth more than 26MHz and less than 38MHz" was revised to "transmitter that uses OFDM system and its occupied bandwidth is more than 26MHz and less than 38MHz(Hybrid system with FH system is excluded)".	Determined at the 69th Standard Assembly Meeting To cope with the description of RE
		In Chapter 5, "Ver. 3.2 September 29th, 2008" was revised to "Ver.3.4 December 16th, 2009".	In line with the revision of this standard
		In Annex 2 Table 2.2 Indication of interference causing radius, values of the 4th and 5th raw in the column of simbol1 were revised form "1mW" to "o.1mW/MHz" and "0.01mW/MHz" respectively.	For the correction of values based on power density
		In Annex 4 Table 1 Indication of interference causing radius, values of 4th and 5th raw in the column of "≤10m" were revised from "1mW" to "0.1mW/MHz" and "0.01mW/MHz" respectively.	For the correction of values based on power density
		In Annex 5, "December 16th, 2009" was added at the revision date when the75th ARIB Standard Assembly Meeting was held.	In line with the revision of this standard

		In Annex 5 1 Introduction, the latter part of the clause "This is applied to the ARIB TD-T66 (Second-generation Low power Data Communication System/ Wireless LAN) and RCR STD-T33 (Low-power Data Communication System/Wireless LAN), and is examined under the condition of antenna gain2.14dBi or less. For the application to other systems, another investigation is necessary" was revised to "This s applied to the ARIB STD-T66 (Second-generation Low-power Data Communication system/Wireless LAN) and RCR STD-T33 (Low-power Data Communication System/Wireless LAN)".	For clarification of antenna gain set which is equivalent to EIRP based on standard condition
		In Annex 5 2.Puepose of this manual, the latter part of the clause "in the past, this was mainly used for railways" and the rest of the description was deleted, and "then, it is necessary to define a formula for calculating the maximum gain estimated by its length" was added.	For clarification of antenna gain set which is equivalent to EIRP based on standard condition
		In Annex 5 3. Idea of Leaky Coaxial Cable item (3) antenna gain, the description "Antenna gain of a leaky coaxial cable shall be 2.4dBi or less" was revised to "Antenna gain of a leaky coaxial cable shall be 2.14dBi or less. Provided that measured EIRP is less than the radiated power listed below, and that a higher gain transmission antenna can be used to	For clarification of antenna gain set which is equivalent to EIRP based on standard condition

		compensate its propagation loss". . DS system or OFDM system:10mW/MHZ .DS system and OFDM system with occupied bandwidth 26MHz or less: 10mW . OFDM system with occupied bandwidth from26MHz to38MHz: 5mW .FH, FH+DS, or FH+OFDM system with frequency band from 2,427MHz to2,470.5MHz: 3mW	
		In Annex 5 4.Method of measurement and calculation for antenna gain, the description of the first clause "It is necessary to keep antenna gain 2.14dBi or less in any kind of layout of" was revised to "estimating the maximum gain at a certain length is needed"	For clarification of antenna gain set which is equivalent to EIRP based on standard condition
		In Annex 5 4. Method of measurement and calculation for antenna gain," Plotting the data of Gn VS n (n=1~500m), Fig.5 is obtained" was added.	For clarification of antenna gain set which is equivalent to EIRP based on standard condition
3.5	April 26th 2010		Determined at the 76th Standard Assembly Meeting
		In Annex 5, "At the release date of this standard Ver.3.4 on December 16th, 2009" was revised to "At the release date of Ver.3.5 on April 26th, 2010"	In line with the revision of this standard
		In Annex 5 3.(3)Antenna gain, "Provided that measured EIRP is less than that of 2.14dBi antenna with 10mW fed power, a higher gain can be used to compensate its propagation loss" was revised to " Provided that measured EIRP is less than that of	For correction of clerical error

		2.14dBi antenna with 10mW fed power, a higher gain **antenna** can be used to compensate its propagation loss".	
3.6	December 18th 2012	In Chapter 5, "At the release date of this standard Ver.3.5 on April 26th 2010" was revised to "At the release date of this standard Ver. 3.6 on December 18th, 2012".	Determined at the 86th Standard Assembly Meeting In line with the revision of this standard
		In Annex 2 2.Clarification of Problems, the clause "2.2 Sticker" was deleted, and the clause numbers of the latter description were moved up.	To delete the redundant description related with sticker after achievement of the initial purpose
		In Annex 3 1. Clarification of Problems, the clause related with sticker was deleted.	To delete the redundant description related with sticker after achievement of the initial purpose
3.7	October 2nd 2014	The description regarding to Annex 7 was added to " Topics addressed in this standard"	Determined at the 86th Standard Assembly Meeting
		Annex 7 Recommended Channel Assignment and Operational Guidelines of Wireless LAN/ Second – generation Low-power data Communication System Radio Station was added to this standard.	To propose the recommended channel assignment for the effective use of frequencies and for minimizing the drop of throughput in the case of using Wireless LAN using radio frequency band from 2,400MHz to 2,483.5MHz.

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SECOND GENERATION LOW POWER DATA
COMMUNICATION SYSTEM/WIRELESS LAN SYSTEM

ARIB STANDARD

ARIB STD-T66 Version 3.7
(October 2, 2014)

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