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SERIES K: PROTECTION AGAINST INTERFERENCE

Techniques to mitigate interference between radio devices and cable or equipment connected to wired broadband networks and cable television networks

Recommendation ITU-T K.106

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Summary

Recommendation ITU-T K.106 describes techniques used to mitigate the effects of interference between radio devices used in the home and cable or equipment connected to wired broadband networks and cable television networks. With the advancement of household appliances, many widely used devices are now connected to home networks. This Recommendation introduces the relevant electromagnetic compatibility (EMC) requirements applicable to wired home network devices, and feasible solutions to resolve EMC problems caused by the use of radio devices in proximity to other wired network equipment.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.106	2015-03-01	5	11.1002/1000/12426

Keywords

Cables, home network, interference, wireless.

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FOREWORD

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Introduction

Along with advances in radio communication technologies, possible interference between home-use radio devices and telecommunication devices, such as cable or equipment connected to wired broadband networks and cable television networks are new phenomena. Interference to cabling or devices falls under the responsibility of ITU-T, whereas the interference between two (or more) radio devices falls under the responsibility of ITU-R. Such problems may occur in the field, especially in a home environment. This Recommendation provides guidance on how to solve problems arising from these kinds of phenomena by taking measures to reduce the interference and to ensure normal operating conditions of wired telecommunication equipment. Guidance on mitigation measures against radio devices is not provided in this Recommendation.

Recommendation ITU-T K.106

Techniques to mitigate interference between radio devices and cable or equipment connected to wired broadband networks and cable television networks

1 Scope

This Recommendation provides guidance to solve interference problems in home networking environments between radio devices and the cable or equipment connected to wired broadband networks and/or cable television networks. It also presents appropriate measures to be applied to the cable and the equipment connected to wired broadband networks and/or cable television networks for solving the interference and procedures to address these troubles in the field.

The scope of this Recommendation focuses on procedures to identify the cause of interference problems in the home, and mitigation measures for the equipment or cabling needed to solve these problems. Mitigation techniques for the radio devices and interference problems between multiple radio devices are outside the scope of this Recommendation.

Necessary electromagnetic compatibility (EMC) requirements for the equipment are given by relevant international standards, such as: [ITU-T K.74], [ITU-T K.93], [ITU-T K.37], [ITU-T K.43], [ITU-T K.48] and [IEC CISPR 22]. Moreover, interference related to power line communication (PLC) is outside the scope of this Recommendation, which is already covered by [ITU-T K.60].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T J.142] Recommendation ITU-T J.142 (2000), *Methods for the measurement of parameters in the transmission of digital cable television signals*.

[ITU-T K.34] Recommendation ITU-T K.34 (2003), *Classification of electromagnetic environmental conditions for telecommunication equipment – Basic EMC Recommendation*.

[ITU-T K.37] Recommendation ITU-T K.37 (1999), *Low and high frequency EMC mitigation techniques for telecommunication installations and systems – Basic EMC Recommendation*.

[ITU-T K.43] Recommendation ITU-T K.43 (2009), *Immunity requirements for telecommunication network equipment*.

[ITU-T K.48] Recommendation ITU-T K.48 (2006), *EMC requirements for telecommunication equipment – Product family Recommendation*.

[ITU-T K.60] Recommendation ITU-T K.60 (2008), *Emission levels and test methods for wireline telecommunication networks to minimize electromagnetic disturbance of radio services*.

[ITU-T K.74] Recommendation ITU-T K.74 (2008), *EMC, resistibility and safety requirements for home network devices*.

[ITU-T K.92] Recommendation ITU-T K.92 (2012), *Conducted and radiated electromagnetic environment in home networking*.

[ITU-T K.93] Recommendation ITU-T K.93 (2012), *Immunity of home network devices to electromagnetic disturbances*.

[ITU-T MTIM] ITU-T Handbook (2008), *Mitigation measures for telecommunication installation – Part 1*. ITU-T, Geneva.

[IEC 61000-2-5] IEC TR 61000-2-5 (2011), *Electromagnetic compatibility (EMC) – Part –2-5: Environment – Description and classification of electromagnetic environments*.

[IEC 60728-2] IEC 60728-2 (2010), *Cable networks for television signals, sound signals and interactive services – Part 2: Electromagnetic compatibility for equipment*.

[IEC 60728-12] IEC 60728-12 (2001), *Cabled distribution systems for television and sound signals – Part 12: Electromagnetic compatibility of systems*.

[IEC CISPR 22] IEC CISPR 22 (2008), *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*.

[IEC CISPR 24] IEC CISPR 24 (2010), *Information technology equipment – Immunity characteristics – Limits and methods of measurement*.

[IEC CISPR 32] IEC CISPR 32 (2015), *Electromagnetic compatibility of multimedia equipment –Emission requirements*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 cable television [ITU-T J.142]: Communication systems that distribute broadcast and non-broadcast signals, as well as a multiplicity of satellite signals originating programming and other signals by means of coaxial cable and/or optical fibre.

3.1.2 home network device [ITU-T K.74]: A home network device is an electronic/electric equipment whose primary function is the distribution of data within the home, between the network termination point and one or more terminal devices.

3.1.3 shielding effectiveness [ITU-T K.43]: For a given external source, the ratio of electric or magnetic field strength at a point before and after the placement of the shield in question.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 radio device: A device, whose primary function is the transmission or reception of data by using radio waves in order to communicate with other devices; it does not require any physical wires for transmitting data to, or receiving data from, other devices.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC Alternating Current

ADSL Asymmetric Digital Subscriber Line

BS Broadcasting satellite

CMC Common-Mode Choke

CS	Communication satellite
DC	Direct Current
DSL	Digital Subscriber Line
DVB	Digital Video Broadcasting
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
HD	High Definition
IF	Intermediate Frequency
IMT	International Mobile Telecommunication
NGN	Next Generation Network
PC	Personal Computer
PE	Protective Earth
PLC	Power Line Communication
PSTN	Public Switched Telephone Network
RF	Radio Frequency
RFI	Radio Frequency Interface
STB	Set Top Box
VoIP	Voice over Internet Protocol

5 Conventions

None.

6 Issues to be considered in this Recommendation

6.1 Background and problems

With the widespread use of home networks, radio devices, including both new and conventional systems, could be used in close proximity to network cable or devices in the home. Thus, there is a possibility that new EMC problems may occur in the field. One concern is possible interference between radio devices, such as international mobile telecommunication (IMT) user equipment and cable or equipment connected to wired broadband networks and cable television networks. This may occur due to the lack of appropriate installation, such as faulty connections, damaged cables, overly close proximity of devices, etc. Therefore, part of this issue falls under EMC problems and requires necessary mitigation techniques. Key issues are to provide methodologies for preventing possible interference between devices and for providing appropriate measures to be applied to the equipment or cable connected to wired broadband and cable television networks.

For example, if the connection between a coaxial cable and its connecter does not have sufficient electrical contact, then it may cause interference to wired broadcasting systems, radio devices or vice versa. Examples of these phenomena in the field are given in Appendices I and III. Therefore, an urgent issue is to take into consideration problems caused by wired broadband networks and cable television network installations.

The area covered in this Recommendation is given in Figure 6-1. Interference into radio devices falls under the responsibility in ITU-R.

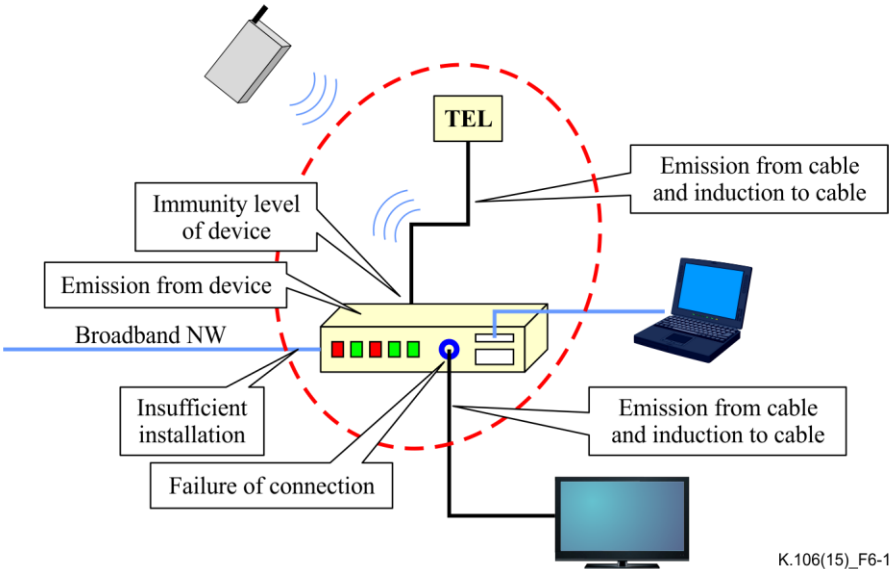


Figure 6-1 – Area covered in this Recommendation

7 Relevant requirements

7.1 Relevant EMC standards for devices

Devices considered in this Recommendation should comply with relevant international standards, such as: [ITU-T K.74], [IEC CISPR 22], [IEC CISPR 24], [IEC CISPR 32], [IEC 60728-2] and [IEC 60728-12]. If devices do not comply with these standards, the devices shall be tested and checked for their EMC performances.

7.2 Regional regulations

In some regions or countries, there are regulations related to interference due to the coexistence of wired telecommunication and radio communication systems. These regional or national regulations should be checked before surveying an interference case between wired telecommunications and radio communications. Examples of these regulations, especially for cable television networks, are given in Appendix II.

8 Guidance to identify and address interference

8.1 Procedure to identify interference sources

8.1.1 Flowchart

The procedure to reduce interference is shown in the flowchart in Figure 8-1. An interference case is dependent on the surrounding conditions, e.g., the number of devices, the electromagnetic (EM) environment and the distance from the antenna of the radio devices. Therefore, users of this Recommendation should take these conditions into account.

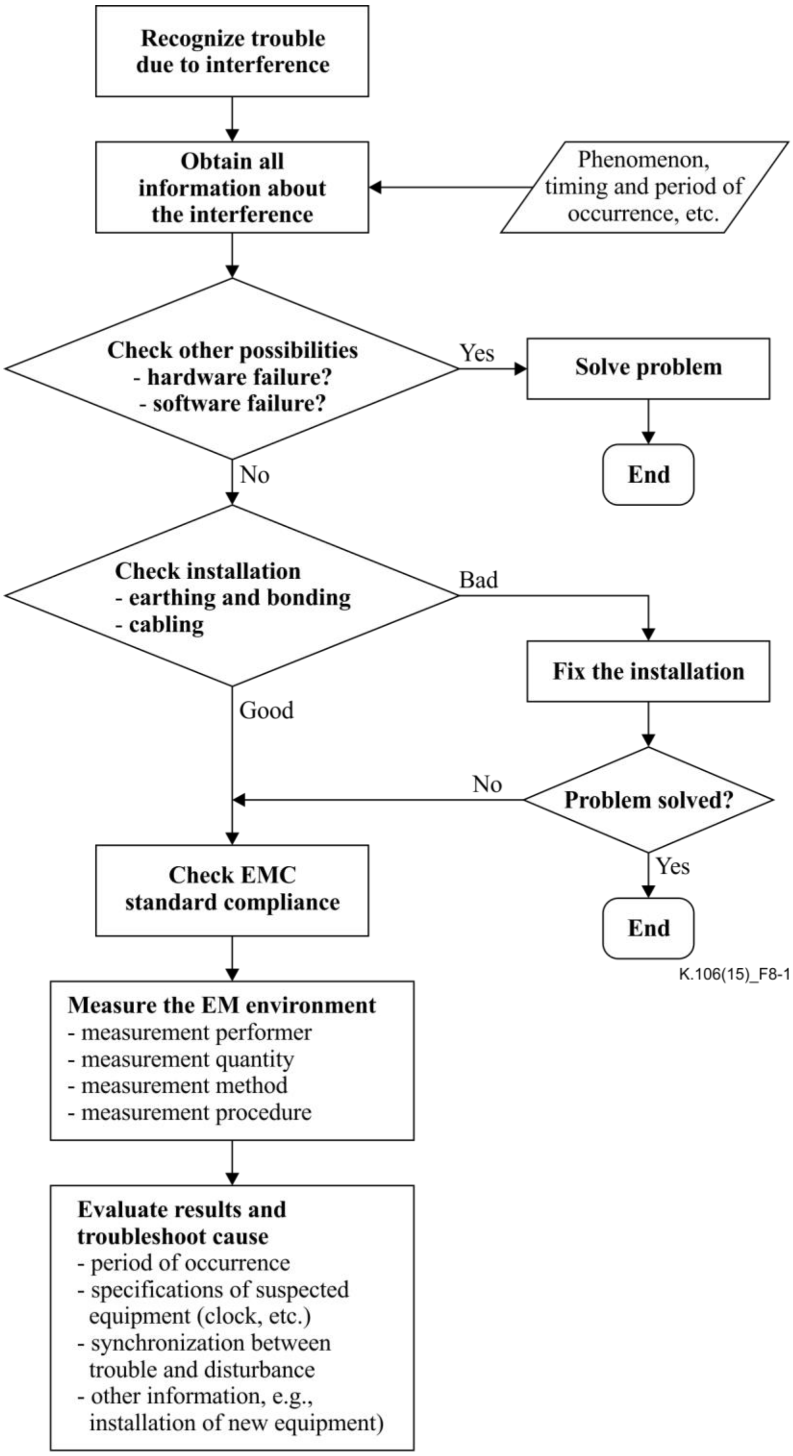


Figure 8-1 – Interference reduction and troubleshooting flowchart

8.1.2 Checking for hardware or software failure

In some cases, an interference problem may cause hardware or software failure. Therefore, the devices should be checked to ensure that they are in a normal operation condition. This can be accomplished by checking or reviewing: operations lamps (e.g., device on/off LED status), logging data, software settings, protocols, error correction (such as forward error correction (FEC)), and placement diversity techniques, etc.

8.1.3 Checking the installation

Before obtaining information on the EM environment of the surroundings, the installation shall be checked. The following conditions/questions should be checked:

- do the devices and cables comply with relevant international or national standards?
- is the installation of the cables and/or devices that are connected to the broadband networks appropriate? check the device's user manual for specifications of cables, connectors, etc.
- is the connection point unstable or faulty?
- has the cable or the shell of the device been damaged?
- is the cabling/cable distribution suitable for use in the home?

8.1.4 Checking relevant standards and regulations

All equipment connected to broadband networks should comply with relevant international or national EMC standards. Moreover, radio devices that could be related to interference should also comply with relevant standards and regulations. These compliance checks need to be completed before measurements are carried out. Furthermore, some regions and countries have their own regulations, especially for cable television networks. Any such compliance checks to these regional or country-specific regulations should also be checked before surveying an interference case.

8.1.5 Measurement methods

Fundamental measurement methods for measuring interference cases are given in [ITU-T MTIM]. For interference cases between radio devices and a cable or equipment connected to wired broadband telecommunication networks and/or cable television networks, the use of measurement equipment, such as a vector spectrum analyser, digital demodulation receiver, communication analyser, etc., are helpful to understand the phenomena correctly.

The EM environment should be measured by following these four steps:

1) Before measuring the EM environment, all devices that intentionally radiate electromagnetic waves should be turned off in order to reduce intentional electromagnetic radiation. Once this has been completed, the EM environment is measured using appropriate measurement instruments.
2) After step 1 has been completed, all devices that were turned off in step 1 should be turned back on. All devices that are connected to wired broadband networks should then be turned off in order to reduce unintentional emission from the devices.
3) After steps 1 and 2 have been completed, all devices that may be related to interference should be turned off, and the EM environment should be measured again.
4) After step 3 has been completed, the results obtained in the above three steps shall be compared to find out the differences among them.

A description of the EM environment in a home network is given in [ITU-T K.92]; the measurement procedures for the actual EM environment in the home are also presented in Appendix II of [ITU-T K.92]. The disturbance characteristics and levels of the environment in customer premises are described in both [ITU-T K.34] and in clauses 8.3 and A.1 of [IEC 61000-2-5].

8.1.6 Evaluation of measured data

Several quantities obtained by the measurements, such as frequency, signal levels, demodulation data (e.g., eye-pattern, constellation diagram), etc., shall be evaluated.

8.1.6.1 Frequency and signal levels

Intentional radio signals in measured frequency bands should first be checked using standards or information on frequency allocations. For example, Appendix IV gives protection levels for radio communication systems related to safety issues in aeronautical systems. By comparing measured results with frequencies according to the radio frequency (RF) allocation table or reference publications, intentional radio signals can be identified, and their levels, necessary to meet requirements, checked. According to the results from step 1 of clause 8.1.5, the radiation signal from radio devices should have disappeared. However, if a signal exists at the same frequency that is used by the radio devices in the spectrum, then that signal may be considered as an unintentional emission from a cable or from devices connected to the wired broadband networks, or an intentional radiation emission from the surroundings. Demodulation data of that signal could yield useful information.

Additional measurements should be performed to obtain more detailed information from the interference source.

8.1.6.2 Demodulation data

Current radio devices mainly use digital modulation techniques. Evaluating the demodulated data can provide additional information about the interference source. For example, if the signal originates from the radio device, the transmission property of the device can be obtained. However, if the signal is unintentionally emitted from the cable or device, then demodulation properties cannot be obtained if modulation is different between the radio device and wired networks. Therefore, it is important to check the modulation method being used in the radio device.

8.1.7 Finding interference sources and part of emission or entry

Evaluating the information obtained from measurement data and interference phenomena can be used to identify interference sources, and an area and/or a location. After the interference source is determined, the mechanism of the interference should be analysed.

If the source of interference or entry point is not identified from the measurement information, then additional measurements should be carried out to identify the interference source and location.

The following techniques are helpful to distinguish the cause of trouble and single out a disturbance source in the field:

- using a directional antenna;
- turning on and off the devices one by one;
- moving a cable or device connected to the wired broadband network;
- turning off/on radio devices.

Determining the source of interference is the most important step needed to solve or reduce the interference problem.

If the interference source is identified, the interference identification process should be repeated to confirm the results and to determine the coupling path or entry of emission.

8.2 Mitigation techniques applied to equipment connected to wired broadband networks and cable television networks

8.2.1 Measures applied to cables connected to wired broadband networks

Mitigation techniques for balanced cables are as follows:

- using a shielded cable connected to the earth on both ends or one side, if necessary;
- attaching a magnetic ring on the cable or inserting a common-mode choke (CMC);
- inserting a differential-mode filter into the cable;

NOTE – The relationship between a frequency band of transmission signal and of interference source should be taken into consideration when selecting the differential-mode filter in order to reduce the influence of the transmission signal in the cable.

- changing the distribution of the cable or the cable length.

For unbalanced cables, such as coaxial type, mitigation techniques are as follows:

- replacing cables with a double or triple shielded type;
- attaching a magnetic ring on the cable;

- inserting an isolation transformer.

8.2.2 Measures applied to devices connected to wired broadband networks

Mitigation measures for devices are as follows:

- moving the device from the original location to another location;
- installing an electromagnetic shield to the device.

NOTE – Using a metal plate, a conductive paint, or a sheet that includes electromagnetic materials (e.g., carbon powder, ferrite powder) is an effective and easy method used to increase the shielding effect.

9 Procedure for selecting appropriate mitigation techniques

Mitigation measures used to solve interference cases are given in [ITU-T MTIM]. Procedures to mitigate interference are shown in Figure 9-1.

9.1 Checking information obtained from the measurement or interference phenomena

All information obtained from measurement and interference phenomena should be checked. Useful information to be considered is as follows:

- timing of interference and malfunction status of the device experiencing the interference;
- working mode of the device experiencing the interference and other electric/electronics devices;
- position of devices, layout of cables and distances among cables;
- frequency and level of measurement results;
- analysis and evaluation of measurement results.

9.2 Checking radio devices in normal operation and installation

Before applying mitigation measures, normal operation of the radio devices should be checked again. If a radio device does not work normally, then users of the device should contact the manufacturer. If the radio device is working as intended, then the entire installation, including cables, cabling, devices, connection between cables, or cables and devices, should be rechecked. If any faults or failures are identified, then service personnel or users should attempt to resolve these issues as appropriate.

After the checks and fixes, the interference phenomena should be reconfirmed.

9.3 Adding appropriate mitigation measures

Mitigation measures are given in [ITU-T MTIM]. Countermeasures should be applied near an entry point of disturbance or exit point of unintentional emission. For cables connected to broadband networks, CMC and differential-mode filters should be selected to reduce disturbance effects. For the devices, shielding materials such as metal plates, conductive paint, or sheets made of ferrite or other conductive materials are effective in reducing disturbance effects.

After mitigation has been accomplished, the EM environment should be measured again, in order to check the effectiveness of the mitigation measures.

If the mitigation measures do not provide sufficient effectiveness, then additional measures should be taken.

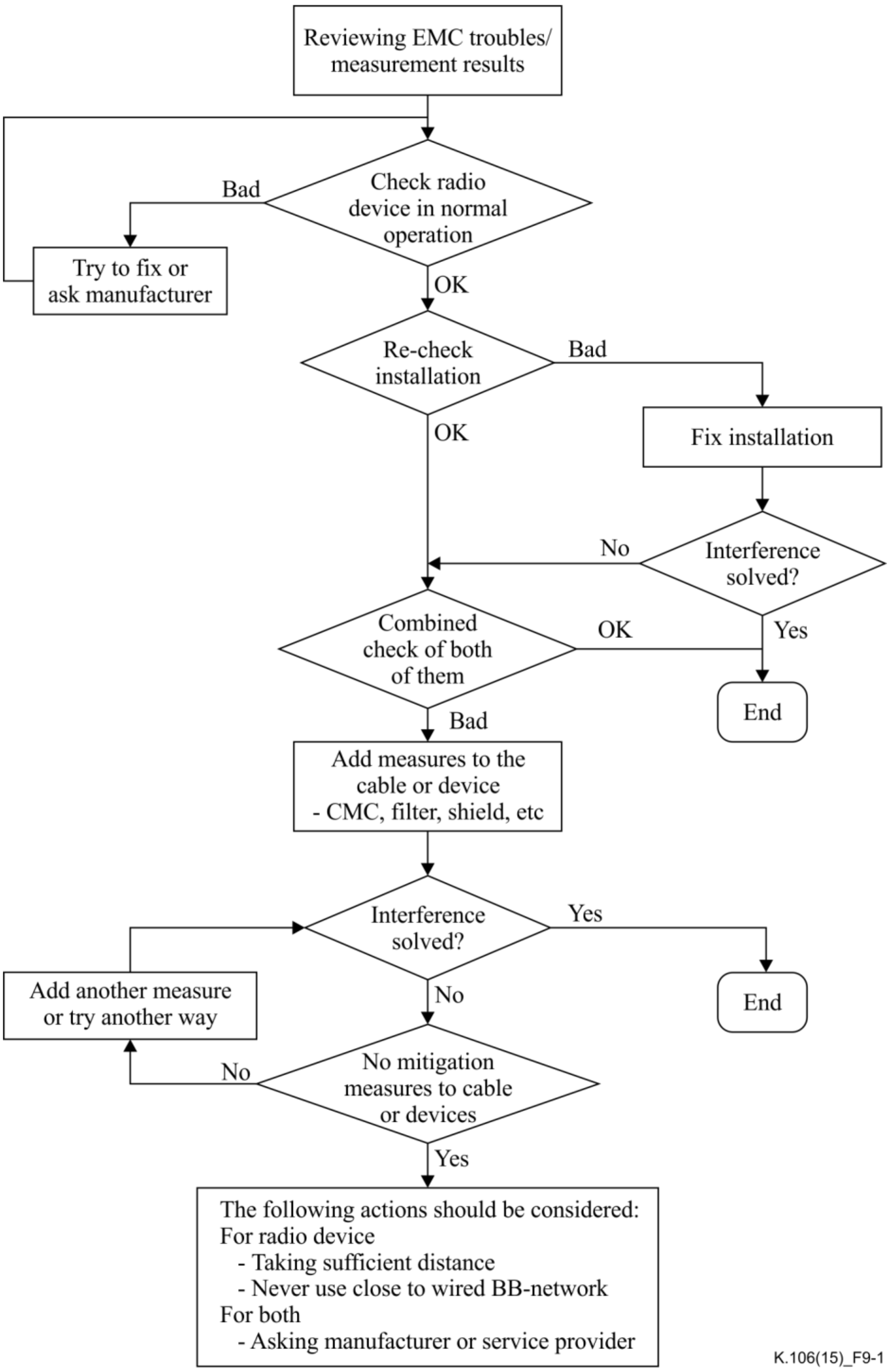


Figure 9-1 – Procedure to mitigate an interference problem

Appendix I

Examples of interference cases in the field

(This appendix does not form an integral part of this Recommendation.)

I.1 Example 1: Interference between a mobile phone and a set top box

The following table give examples of the interference between radio devices and cable or equipment such as a set top box (STB) connected to wired broadband networks or cable television networks.

Table I.1 – Interference between a mobile phone and STB

Recognizing interference and obtaining information about the interference		
Interfered device	Digital video broadcasting (DVB) STB device	
Phenomena and timing	When the mobile phone makes a phone call, the decoding of the HDTV programme may become unstable (e.g., blue screen for several seconds). When the phone call ends, the HDTV programme is recovered automatically. The reason for this is the close proximity of the mobile phone to the STB.	
Checking other possibilities	No hardware or software failures exist.	
Checking the installation	Earthing and bonding	OK
	Cabling	OK. The cabling connected to and around the STB devices are checked and unified into a parallel layout.
Checking EMC standard compliance	Mobile phone and STB devices are marked with certifications showing national and international EMC standards and radio standard compliance.	
Measuring the EM environment	When the mobile phone makes a phone call, a transmission signal is measured on the 900 MHz band or the 1 800 MHz band, depending on the base station.	
Evaluating results and finding the cause of trouble	The DVB STB malfunctioned when the transmission signal was on the 900 MHz band.	

I.2 Example 2: Emission from connection at coaxial outlet and plug

In this example, a malfunction occurs on a keyless entry system that uses a 312 MHz radio signal. The malfunction was caused by an emission from the connection point on the coaxial cable that transmits television signals in a frequency band of 310-340 MHz.

Figure I.1 shows the cabling at a subscriber's house. The television signal is transmitted through the coaxial cable from the optical network unit (ONU) of fibre to the home (FTTH) to a TV receiver via the TV signal amplifier in the house. The radio wave is emitted from a connection point of the coaxial outlet and plug. The spectrum of the interfering radio wave outside the house is shown in Figure I.2.

The source of the interfering emission is caused by inferior workmanship on the connection of the coaxial cable to the plug where the outer conductor of the cable does not have connection to the plug, as illustrated in Figure I.3.

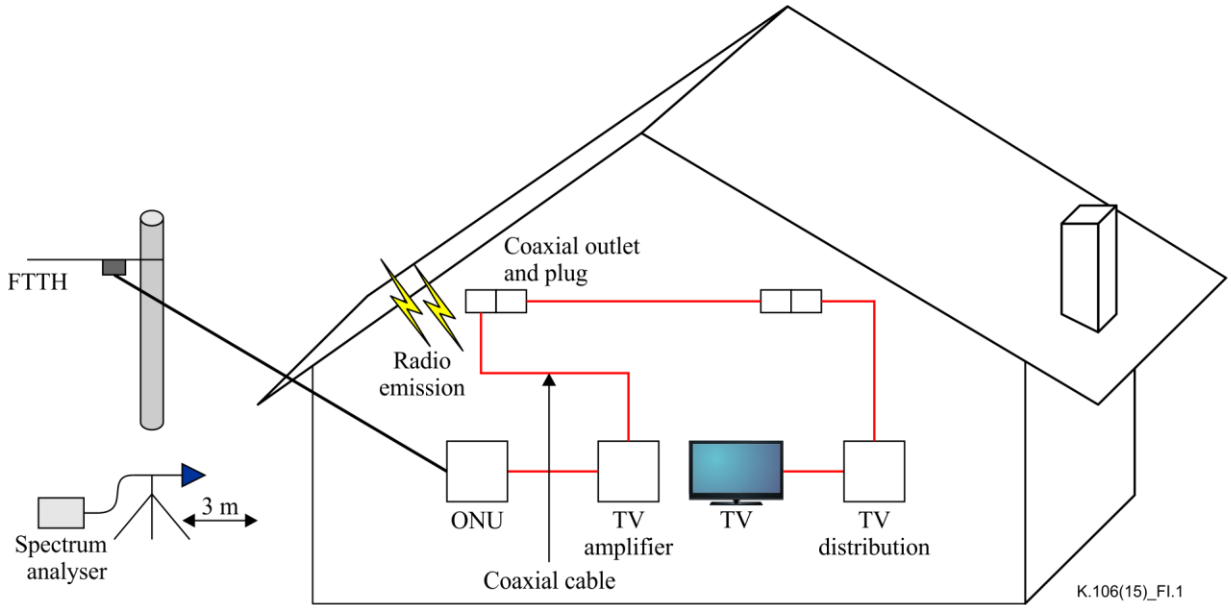


Figure I.1 – Configuration of telecommunication systems in which a radio disturbance occurred (disturbance caused by TV signal from ONU of FTTH)

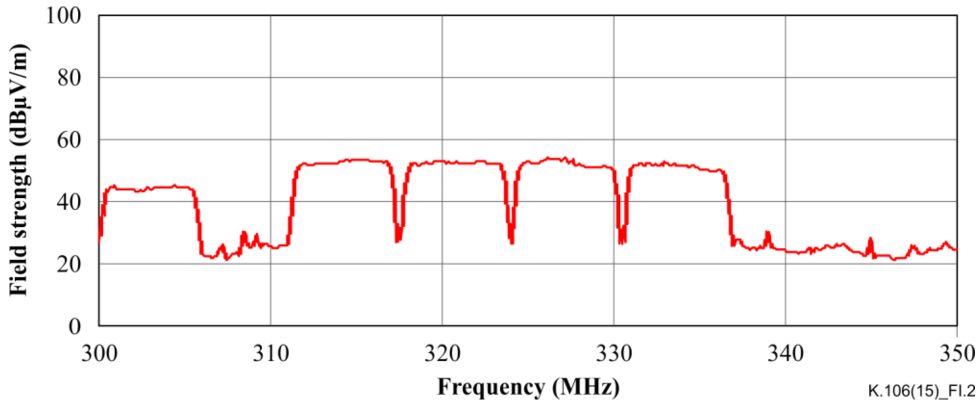


Figure I.2 – Radio spectrum of disturbance from coaxial cabling

Figure I.3 – Inferior workmanship at coaxial plug

I.3 Example 3: Emission from indoor cabling of CS/BS down-converted signal

In this example, a radio disturbance from a coaxial outlet causes the malfunction of a wireless handset of a key telephone system (business telephone system) using a 1.9 GHz digital radio connection.

Figure I.4 shows the configuration of the telecommunication system in which the radio disturbance occurred. The radio signal of the communication satellite (CS)/broadcasting satellite (BS) in the 12 GHz frequency band is converted to an intermediate frequency (IF) of 1-2 GHz at the built-in converter in the parabolic antenna. The IF signals were transmitted from the CS/BS amplifier through the indoor coaxial cable to a CS receiver. The radio disturbance is emitted from the coaxial outlet, shown in Figure I.4, located on the wall.

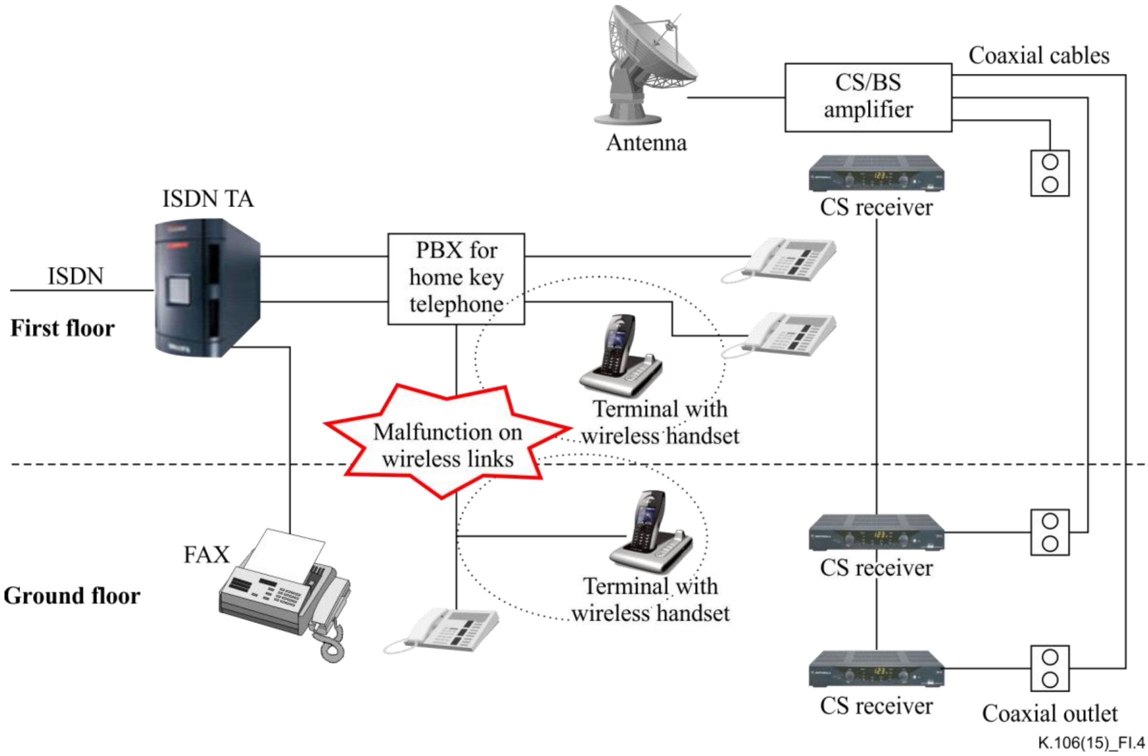


Figure I.4 – Configuration of a telecommunication system in which a radio disturbance occurred (disturbance caused by IF signal of CS/BS antenna)

Appendix II

Examples of regional regulations for cable television networks

(This appendix does not form an integral part of this Recommendation.)

II.1 Overview

In some regions or countries, there are regulations related to interference due to coexistence of wired telecommunication and radio communication systems. These regional or national regulations should be checked before surveying interference cases between wired telecommunication and radio communication systems.

When cable television commercialization began, there were a number of issues related to interference due to the emissions from cable television coaxial cables to radio communication systems, including aeronautical radios as well as cellular phones. Therefore, it is typical for each region or country to have their own regulations, particularly for cable television systems. In such regulations, cable television operators are obliged to monitor the emission levels, not only from headend systems, but also from customers' premises.

II.2 Examples of regional regulations

The following clauses provide relevant information on regional regulations.

II.2.1 United States FCC CFR 47, 76.605

The following example exemplifies the case of United States, Federal Communications Commission (FCC) extracts from FCC CFR 47, 76.605 [b-FCC CFR 47]:

§76.605 Technical standards.

(12) As an exception to the general provision requiring measurements to be made at subscriber terminals, and without regard to the type of signals carried by the cable television system, signal leakage from a cable television system shall be measured in accordance with the procedures outlined in §76.609(h) and shall be limited as follows:

Frequencies	Signal leakage limit (micro-volt/meter)	Distance in meters (m)
Less than and including 54 MHz, and over 216 MHz	15	30
Over 54 and up to and including 216 MHz	20	3

II.2.2 Japan

In Japan, regulations for cable broadcast facilities are contained in ordinance No. 83 of Ministry of Internal Affairs and Communications (2011) "Technical requirement on quality of cable broadcast", [b-Japan] as shown below.

Article 8: The leakage field intensity of a cable broadcast facility shall not be in excess of 0.05 millivolt per meter at a distance of 3 meters from the cable broadcast facility.

Note that this Article shall apply to any leakage of electric field between cable headend systems and the input ports of customers' premises equipment.

II.2.3 China

Currently, there are no specific standards or regulations on the coexistence of cable television and radio communication systems in China, but there are two electromagnetic interference (EMI)/EMC related standards for coaxial cables as follows.

II.2.3.1 GY/T 186-2002

Industry Standard GY/T 186-2002 "Specifications and methods of measurement on shielding performance of RF cable used in CATV systems", [b-GY/T 186] specifies the signal shielding performance requirement of coaxial cables, and Table II.1 below is a translation of part of the standard.

Table II.1 – Shielding performance of RF coaxial cable used in CATV systems

No.	Cable types	Unit	Frequency	Technical Index		
				Shielding attenuation	Shielding effectiveness	
					Before cable shaking	After cable shaking
1	Double-shield coaxial cable	dB	5 MHz	≥ 60	≥ 60	≥ 55
			50 MHz	≥ 60	≥ 60	≥ 55
			200 MHz	≥ 70	≥ 70	≥ 65
			500 MHz	≥ 70	≥ 70	≥ 65
			800 MHz	≥ 70	≥ 70	≥ 65
			1 000 MHz	–	≥ 70	≥ 65
2	Triple-shield coaxial cable	dB	5 MHz	≥ 85	≥ 85	≥ 80
			50 MHz	≥ 85	≥ 85	≥ 80
			200 MHz	≥ 90	≥ 90	≥ 85
			500 MHz	≥ 90	≥ 90	≥ 85
			800 MHz	≥ 90	≥ 90	≥ 85
			1 000 MHz	–	≥ 90	≥ 85
3	Quad-shield coaxial cable	dB	5 MHz	≥ 85	≥ 90	≥ 85
			50 MHz	≥ 85	≥ 90	≥ 85
			200 MHz	≥ 90	≥ 95	≥ 90
			500 MHz	≥ 90	≥ 95	≥ 90
			800 MHz	≥ 90	≥ 95	≥ 90
			1 000 MHz	–	≥ 95	≥ 90

II.2.3.2 GB 13836-2000

Chinese Standard GB 13836-2000 "Cabled distribution systems for television and sound signals – Part 2. Electromagnetic compatibility of equipment", [b-GB 13836], which is based on the earlier edition of [IEC 60728-2], specifies performance requirements and measurement methods of electromagnetic compatibility of equipment, its updated version is pending according to [IEC 60728-2], but tolerance of the signal leakage intensity from coaxial cable or communication systems is out of scope.

This standard deals with performance requirements and measurement methods of electromagnetic compatibility of equipment in cable distribution systems for television and sound signals. It specifies requirements for maximum allowed radiation, minimum immunity and minimum screening effectiveness, and describes test methods for conformance testing.

This standard applies to the radiation characteristics and immunity to electromagnetic disturbance of active and passive equipment (active and passive coaxial wideband distribution equipment, headend equipment, fibre equipment) for the reception, processing and distribution of television and sound signals. This standard refers to the following parts described in GB/T 6510, which is from interface of the headend, or the other signal source, to the system outlet, or the terminal input port if the system outlet does not exist.

This standard covers the following frequency ranges:

- disturbance voltage injected into the mains 9 kHz to 30 MHz;
- radiation from active equipment 30 MHz to 25 GHz;
- immunity of active equipment 150 kHz to 25 GHz;
- screening effectiveness of passive equipment 30 MHz to 1.75 GHz.

The coaxial cable of cabled distribution systems is out of the scope of this standard.

The requirements of electromagnetic compatibility of any user terminals (e.g., tuners, receivers, decoders, media terminals) are excluded.

Table II.2 – Radiation from active equipment

Frequency range (GHz)	**Limit values dB (pW)**
0.03 to 1	20
1 to 2.5	43
2.5-25	57

II.2.4 European standards related to emission from cable TV systems

II.2.4.1 Germany

Cable TV [b-EN 50083-8], not harmonized, contains A-deviations. For example, in Germany for the frequencies according to SchuTSEV (used by security and safety services):

Table II.3 – Limits for total radiation

Frequency range MHz	**Field strength in 3m distance dB(μV/m)**	**Measurement bandwidth kHz**	**Measurement detector**
30 to 1 000 (Note 1)	40	120	Quasi-peak
950 to 2 500 (Note 2)	50	1 000	Peak
2 500 to 3 500	64	1 000	Peak
NOTE 1 – Applicable for cable TV networks with an upper frequency of 1 000 MHz. NOTE 2 – Applicable for cable TV networks with a lowest frequency of 950 MHz (SAT-IF-Network).			

Table II.4 – Limits for narrowband radiation

Frequency range MHz	Field strength in 3 m distance dB(μV/m)	Measurement bandwidth kHz	Measurement detector
30 to 1 000 (Note 1)	27	120	Quasi-peak
950 to 2 500 (Note 2)	50	1’000	Peak
2 500 to 3 500	64	1’000	Peak
NOTE 1 – Applicable for cable TV networks with an upper frequency of 1 000 MHz. NOTE 2 – Applicable for cable TV networks with a lowest frequency of 950 MHz (SAT-IF-Network).			

NOTE – The German Administration is against the introduction of limits for a total radiated power, especially as the measurement bandwidth is equivalent to that of narrowband radiation.

II.2.4.2 Equipment for CATV

Limits for equipment for CATV (EN 50083-2, harmonized) [b-EN 50083-2] are given in Table II.5 and Table II.6 as follows:

Table II.5 – Limits for disturbance voltage at the input port for equipment intended for direct connection to receiving antennas

Frequency range MHz	Disturbance frequency	Level (75 Ω) dB(μV)
30 to 3 000	Oscillator frequency	46
30 to 3 000	Oscillator harmonics	46
30 to 3 000	Other frequencies	46

Table II.6 – Limits for the radiated power

Frequency range MHz	Limits dB (pW)	Measurement bandwidth kHz	Detector
5 to 30	27 to 20 (Notes 1) (Note 2)	9	Quasi-peak
5 to 30	33 (Note 3)	9	Quasi-peak
30 to 1 000 (Note 4)	20	120	Quasi-peak
950 to 2 500 (Note 5)	43	1 000	peak
2 500 to 25 000	**57**	**peak**	
NOTE 1 – Decreasing linear with the logarithm of the frequency. NOTE 2 – For not mains powered active equipment.			

Table II.6 – Limits for the radiated power

Frequency range MHz	Limits dB (pW)	Measurement bandwidth kHz	Detector
NOTE 3 – For mains powered equipment. NOTE 4 – Applicable for equipment with an upper frequency of 1 000 MHz. NOTE 5 – Applicable for equipment with a lowest frequency of 950 MHz			

II.2.4.3 Broadcast receiver

Limits for broadcast receiver equipment (EN 55013, harmonized) [b-EN 55013] are given in Table II.7 as follows:

Table II.7 – Limits for radiated disturbances at 3 m distance

Receiver type	Disturbance source	Frequency range MHz	Limits Quasi-peak dB(μV/m)	Limits AV-RMS dB(μV/m) (Note 1)
TV receivers, video recorders and personal computer (PC) tuner cards	Oscillator Others	≤ 1 000 30 to 300 300 to 1 000 30 to 230 230 to 1 000	fundamental 57 harmonics 52 harmonics 56 40 47	fundamental 57 harmonics 52 harmonics 56 (Note 2) 34/40 47
TV and audio broadcast satellite receivers Infrared remote control Infrared headphones	Others	30 to 230 230 to 1 000	40 47	(Note 2) 34/40 47
FM audio broadcast receivers and PC tuner cards	Oscillator Others	≤ 1 000 30 to 300 300 to 1 000 30 to 230 230 to 1 000	fundamental 60 harmonics 52 harmonics 56 40 47	fundamental 60 harmonics 52 harmonics 56 (Note 2) 34/40 47
NOTE 1 – The AV-RMS limits can be used as an alternative to the quasi-peak limits. NOTE 2 – For narrowband disturbances, the limit is 40 dB(μV/m). For this purpose, a narrowband disturbance is identified if the deviation between peak level and AV-RMS level is < 3 dB. All other signals shall be considered as broadband disturbances. For these signals apply the AV-RMS limit of 34 dB(μV/m) and additional a quasi-peak limit of 54 dB(μV/m).				

Appendix III

Examples of measured emissions from coaxial cables and connectors

(This appendix does not form an integral part of this Recommendation.)

III.1 Introduction

This appendix presents examples of emission levels measured for different types of coaxial cables and connectors. Results obtained from three types of coaxial cables and two types of connectors are compared. The results indicate that in order to avoid interference to radio services, it is necessary to check its cabling before it is used.

III.2 Measurement set-up

Figure III.1 shows the set-up for measuring emissions from coaxial cables and connectors.

- the measurement was carried out in an anechoic chamber;
- the coaxial cable was set at a height of 1 m and had a length of 5 m;
- the inner and outer conductors were terminated by resistance of 75 ohms;
- the outer conductor was connected to a ground by resistance of 150 ohms in order to stabilize common-mode impedance;
- the antenna was set at the near-end of the cable, at a distance of 3 m.

The horizontal and vertical components of the electromagnetic fields were measured.

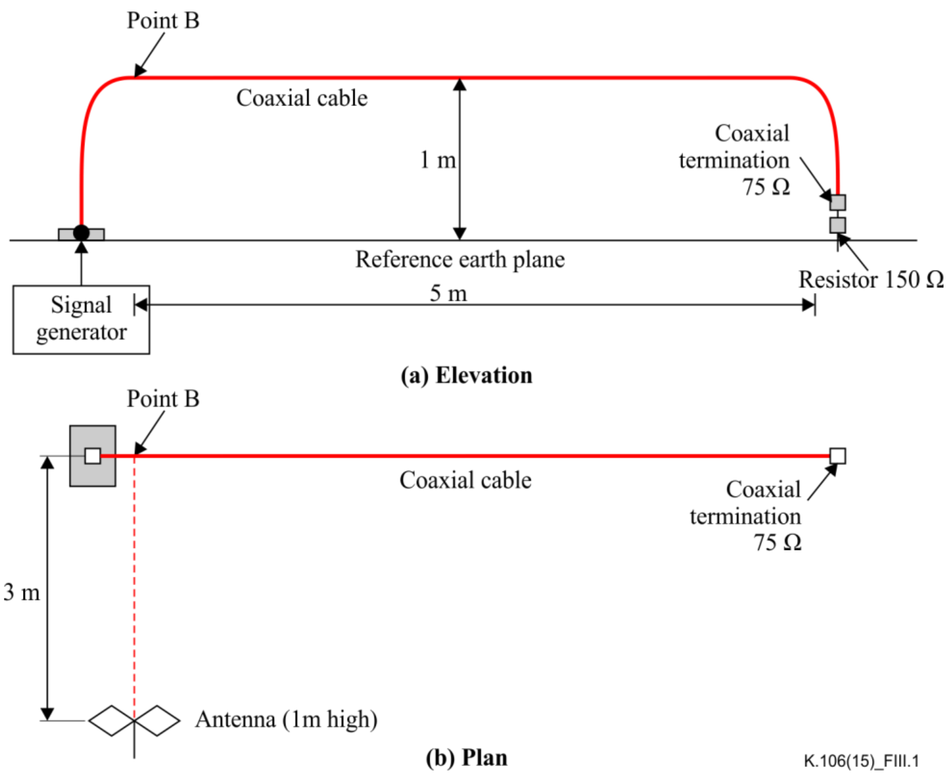


Figure III.1 – Configuration for measurement of emissions from coaxial cables

III.3 Measurement result

III.3.1 Emission from coaxial cables

Emissions from three kinds of cable, i.e., 5C-2V, 5C-2W and S-5C-FB, were measured. Results of vertical and horizontal polarizations are shown in Figure III.2 and Figure III.3, respectively.

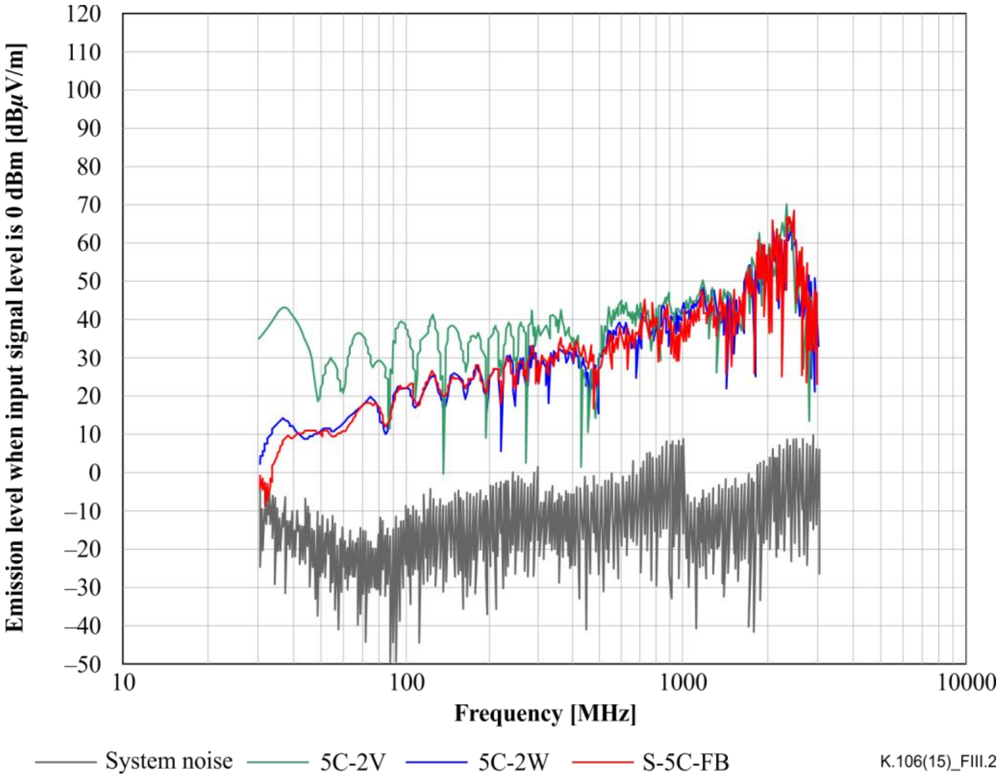


Figure III.2 – Frequency dependency of emission for different structures of coaxial cable (vertical polarization)

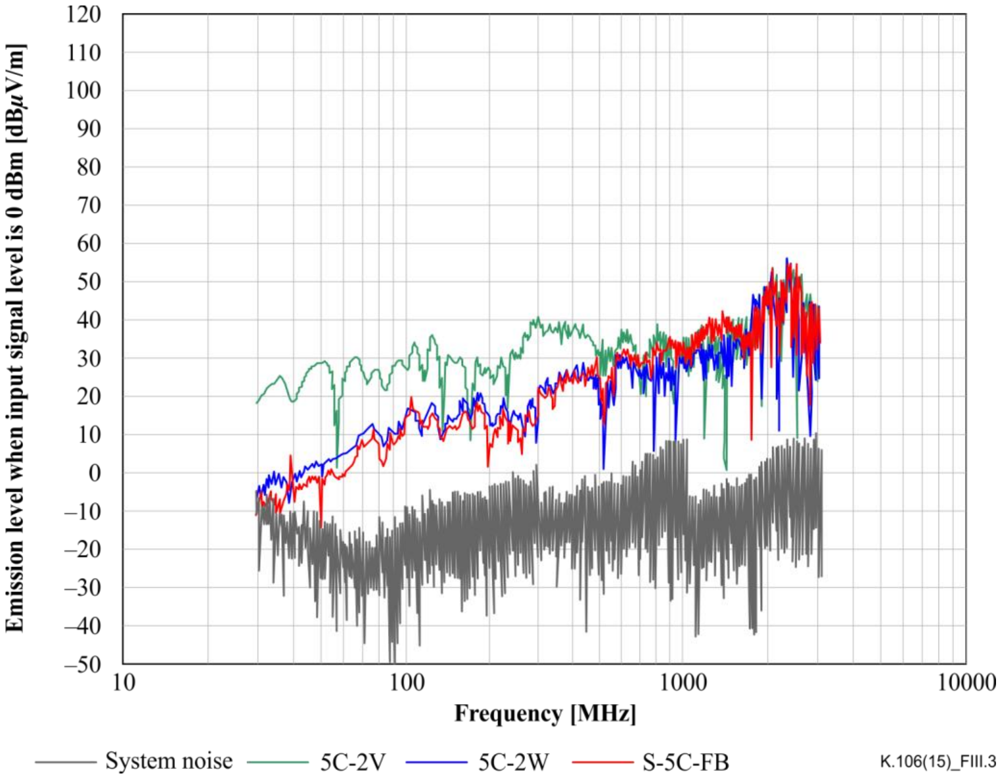


Figure III.3 – Frequency dependency of emission for different structures of coaxial cable (horizontal polarization)

The results indicate that:

- the emission levels from S-5C-FB and 5C-2W are nearly the same;

- below 300 MHz, the emission levels of vertically and horizontally polarized radio wave from 5C-2V cables are greater than those of the other types of cables by 10 to 25 dB and 20 dB for vertically and horizontally polarized waves, respectively;
- there is no noticeable difference between the three cables above 500 MHz because the shielding effect may be affected by very small windows in the cable's outer conductor.

III.3.2 Emissions caused by cable connectors

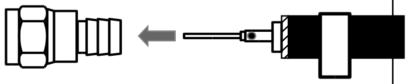
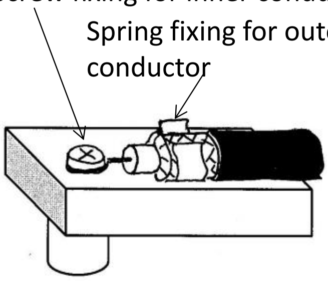
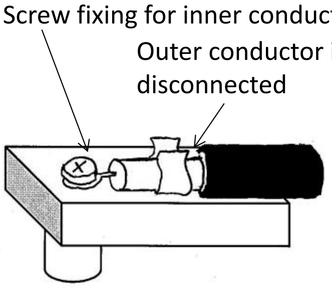
The measurement configuration is as shown in Figure III.1, but with a coaxial outlet, as shown in Figure III.4, and one of the three cases of plug types shown in Table III.1 inserted in the coaxial cable at point B.

Two types of plugs for coaxial cables were used to determine the dependency of the emission level on the plug structure. The type 1 plug has coaxial structure and the type 2 plug has a structure in which the inner conductor is retained by a set screw and the outer conductor by a spring fixture, as shown in Table III.1.

Emissions were also measured when the outer conductor is not connected to the type 2 plug, which is shown as case 3 in Table III.1, to allow consideration of the case where there is a defect in the coaxial cabling.

Figure III.4 – Photograph of a coaxial outlet

Table III.1 – Plugs for coaxial cabling in home environment used in the test

Case	Plug type	Photo of exterior	Photo of interior	Drawing of structure
1	Type 1			
2	Type 2			
3	Outer conductor is not connected			

Measurement results of vertical and horizontal polarizations are shown in Figure III.2 and Figure III.3, respectively. Comparing these results, the following points are summarized:

- The emission of vertically polarized electromagnetic waves from cables with the type 1 plug is almost completely the same as that from coaxial cables without any connector in the measured frequency range. The emission of horizontally polarized electromagnetic waves with the type 1 plug is also about the same as that with no connector below 100 MHz, but it is about 10 dB greater above 200 MHz.
- The emission of vertically and horizontally polarized waves from cabling with a type 2 plug is from 30 to 40 dB higher than that without connectors over the whole measured frequency range. This may be caused by emissions from the exposed open loop formed by the screw fixing of the inner conductor. Electromagnetic waves are also emitted by the longitudinal current in the outer conductor of the coaxial cable exited by a longitudinal electromotive force caused by the inductance at the screw-fixed part of the plug.
- When the outer conductor of the coaxial cable is not connected to the plug, e.g., in case an installation failure may exist in the fields, the emission level reaches 80 dBµV/m to 100 dBµV/m over the entire measured frequency range. This may cause interference to radio services close to the cabling.

Appendix IV

Information of radio communication systems related to safety issues

(This appendix does not form an integral part of this Recommendation.)

Several radio communication systems strongly relate to safety issues. For example, aeronautical radio systems are sensitive when interference occurs. Thus, usage of the radio communication systems and an influence of disturbance should take into consideration when surveying interference cases. This appendix gives information of radio communication related to safety. Information in this appendix will be updated in future.

IV.1 Radio communication related to aeronautical systems

Table IV.1 shows the required level of protection for aeronautical systems operating between 190 kHz and 1 215 MHz. This information is given from ITU-R Working Party 5B (WP5B).

Table IV.1 – The required level of protection for aeronautical systems operating between 190 kHz and 1 215 MHz

Frequency band	System	Receiver location	Receiver protection criteria reference
190-850 kHz	Area navigation (NDB)	Airborne	ICAO Document 9718, Chapter 9, Table 9-1 – General Protection Limits
2.85-22 MHz	HF communications	Airborne/ Ground	ICAO Document 9718, Chapter 9, Table 9-1 – General Protection Limits
74.8-75.2 MHz	Approach navigation (ILS marker beacon)	Airborne	ICAO Document 9718, Chapter 9, Table 9-1 – General Protection Limits
108-117.975 MHz	Approach navigation (ILS localizer)	Airborne	ICAO Document 9718, Chapter 9, Table 9-1 – General Protection Limits
108-117.975 MHz	Area navigation (VOR)	Airborne	ICAO Document 9718, Chapter 9, Table 9-1 – General Protection Limits
117.975-137 MHz & 243 MHz	VHF communications	Airborne/ Ground	ICAO Document 9718, Chapter 9, Table 9-1 – General Protection Limits
328.6-335.4 MHz	Approach/Landing (ILS glide path)	Airborne	ICAO Document 9718, Chapter 9, Table 9-1 – General Protection Limits
960-1 215 MHz	Area navigation (DME)	Ground	ICAO Document 9718, Chapter 9, Table 9-1 – General Protection Limits
978 MHz	Area navigation (UAT)	Airborne/ Ground	ICAO Annex 10, Vol. III, Chapter 12, section 12.3.2 – Receiving Function
1 030 & 1 090 MHz	Area navigation (SSR)	Airborne/ Ground	ICAO Document 9924, Appendix D, Table D-3 – Downlink Margin

Bibliography

[b-EN 50083-2] EN 50083-2:2012, *Cable networks for television signals, sound signals and interactive services. Electromagnetic compatibility for equipment*.

[b-EN 50083-8] EN 50083-8:2013, *Cable networks for television signals, sound signals and interactive services. Electromagnetic compatibility for networks*.

[b-EN 55013] EN 55013:2013, *Sound and television broadcast receivers and associated equipment. Radio disturbance characteristics. Limits and methods of measurement*.

[b-FCC CFR 47] FCC CFR 47, 76.605, USA.

[b-GB 13836] GB 13836-2000, *Cabled distribution systems for television and sound signals – Part 2. Electromagnetic compatibility of equipment*, China.

[b-GY/T 186] GY/T 186-2002, *Specifications and methods of measurement on shielding performance of RF cable used in CATV systems*, China.

[b-ICAO 9718] ICAO Document Doc 9718, *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation (Volume I, ICAO spectrum strategy, policy statements and related information)*. 2014.

[b-ICAO 9924] ICAO Document Doc 9924, *Aeronautical Surveillance Manual*. 2010.

[b-ICAO Annex 10] ICAO Annex 10 Vol III, *Aeronautical Telecommunications - Volume III Communications Systems (Part I - Digital Data Communications Systems)*. 2014.

[b-Japan] Ordinance No. 83 of Ministry of Internal Affairs and Communications (2011), *Technical requirement on quality of cable broadcast* (in Japanese).

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